Instruction Manual

SPOOL PIECE ULTRASONIC FLOWMETER COMMUNICATION FUNCTIONS

TYPE: FST

INF-TN5A2746b-E Fuji Electric Co., Ltd.

Note: MODBUS® is the trade mark or registered trade mark of Schneider Electric.

NOTICE

Disclaimer

The contents of this document may be changed without prior notice.
We paid the utmost care for the accuracy of the contents. However, we are not liable for direct and indirect damages resulting from incorrect descriptions, omission of information, and use of information in this document.

CONTENTS

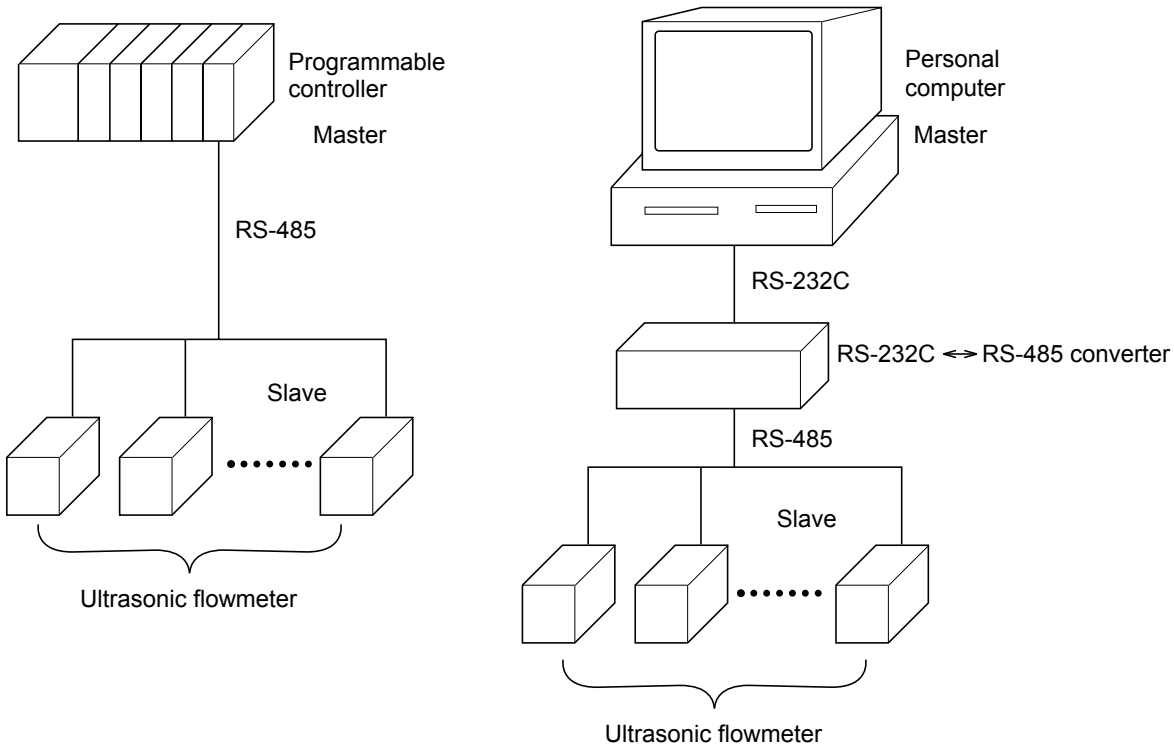
1. INTRODUCTION

- The flowmeter FST with an RS-485 interface can provide data transmission from and to a host computer, programmable controller, graphic display panel, etc.
- When using the RS-485 interface, the communication system consists of a master station and slave stations. Up to 31 slave stations (this instrument) can be connected per master station.
  Note that, because the master station can communicate with only one slave station at a time, a party to communicate with must be specified by the “Station No.” set at each slave station.
- In order that the master station and slave station can communicate, the format of the transmitted/received data must coincide. The flowmeter FST uses the MODBUS protocol.
- If you use a personal computer or other devices which have an RS-232C interface as a master station, use an RS-232C to RS-485 converter.

[Recommended RS-232C to RS-485 converter]

K3SC-10 (isolated type) manufactured by OMRON Corporation

System configuration



When using an RS-232C to RS-485 converter, correctly connect the cable between the converter and the master station, and setup the communication settings such as baud rate and parity.

2. SPECIFICATIONS

Item	Specification	
Electrical specification	EIA RS-485	
Transmission system	2-wire, half-duplex	
Synchronizing system	Start-stop synchronization	
Connection format	1 : N (RS-485)	
Number connectable units	31 (RS-485)	
Transmission distance (total extension)	1,000 m max. (RS-485)	
Transmission speed	9600, 19200, 38400 bps	
Data format	Data length	8 bits
	Stop bit	1 bit, 2 bit
	Parity	none, even, odd (selectable)
Isolation	Functional isolation between transmission circuit and ground (withstand voltage : 500V AC)	

MODBUS protocol

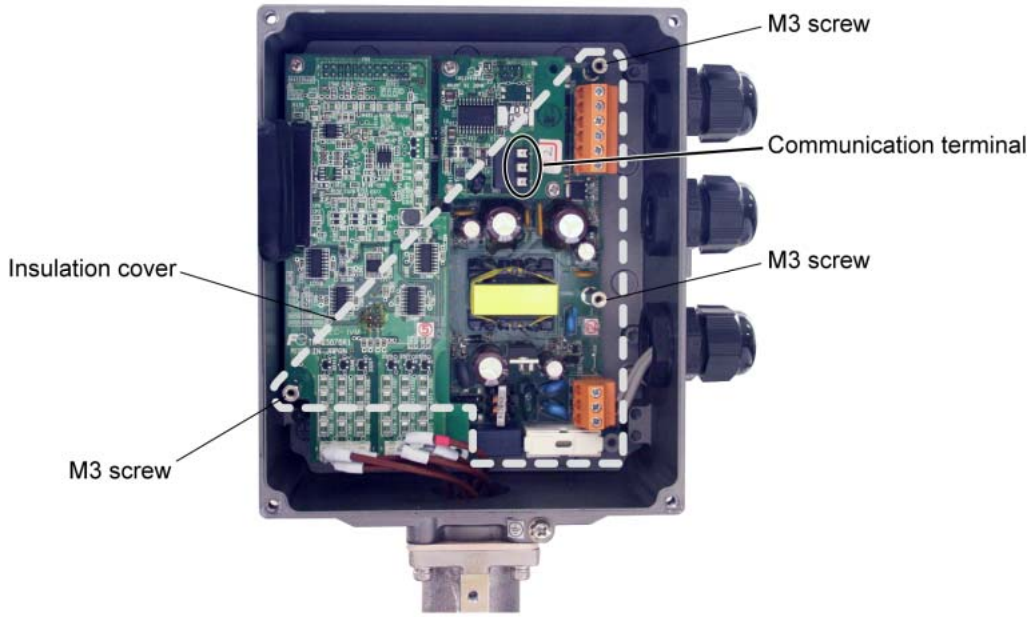
Item	Specification
Transmission code	HEX value (MODBUS RTU mode)
Error detection	CRC-16

3. CONNECTION

> ⚠ WARNING
>
> To avoid an electric shock and malfunctions, do not turn on the power supply untill all wiring has been completed.

3.1 Terminal Allocation

Remove the M3 screws at three points and the insulation cover before wiring work.



Communication terminal

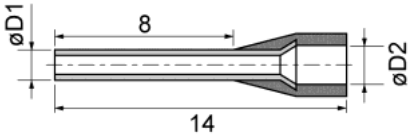
3	B+	—
2	A-	—
1	SG	—

DC4-20mA

■Useable wire

・Electric wire
Size: AWG20 (0.5 mm^2) to AWG16 (1.5 mm^2)
Strip length: 8 to 10 mm

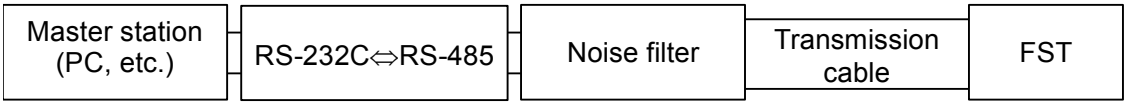
・ Bar terminal
Weidmüller
www.weidmüller.com
Wire end ferrule with insulating collar

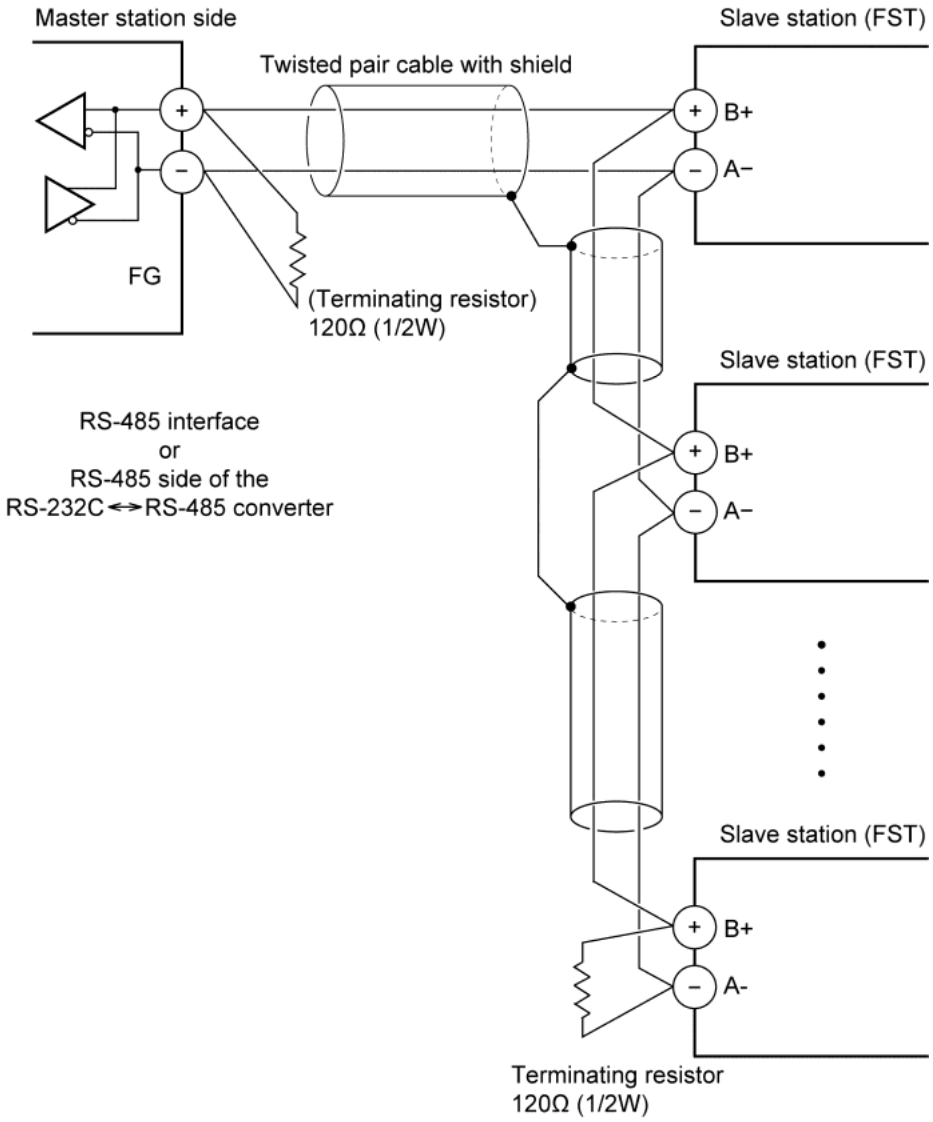


Wire size (mm^2)	D1 (mm)	D2 (mm)	Model
0.5	1	2.6	H0.5/16
0.75	1.2	2.8	H0.75/16
1	1.4	3	H1/16
1.5	1.7	3.5	H1.5/16

3.2 Wiring RS-485 Interface

- Use twisted pair cables with shield.
- The extension length of the cable is up to 1000 m. A master station and up to 31 units of this instrument can be connected per line.
- Terminate the both ends of the cable with 120Ω (1/2 W or higher) terminating resistors.
  Note: See the specifications of the master for the terminating resistors of the master station unit.
- The shields of the cables should be grounded at one place on the master station unit side.
- If this instrument is to be installed where the level of noise applied to this instrument may exceed 1000 V, it is recommended to install a noise filter in the master station side as below.





4. COMMUNICATION SETTINGS

In order that the master station and slaves (flowmeters) can communicate, make sure that:

- All the communication settings of the master station are the same as those of slaves (flowmeters).
- Each slave (flowmeter) connected on a line are identified with a unique “Station No.”

Set the following parameters in (MAINTENANCE MODE > COMMUNICATION) by operating the front panel keys. For detail of operation, refer to the separate *Instruction Manual* (INF-TN1FST-E).

Item	Value at delivery	Setting range	Remarks
Station No.	1	1 to 31 (0:communication function stop)	Set a different value to each station.
Transmission speed	9600 bps	9600 bps, 19200 bps, 38400 bps	Apply the same settings to the master station and all slave stations.
Parity	Odd	None Odd Even	
Data length	8 bits	Fixed (can not be changed)	
Stop bit	1 bit	1 bit, 2 bits	

5. MODBUS COMMUNICATION PROTOCOL

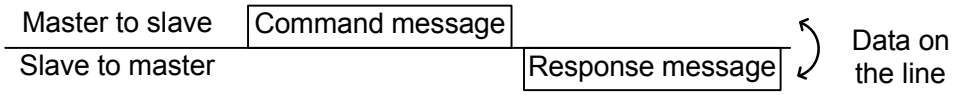
5.1 General

In MODBUS communication, a communication always starts with a command message transmitted by the master station, and then a slave station responds to the message.

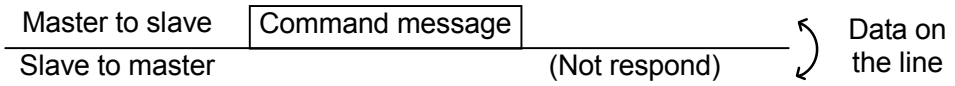
A communication flows as shown below.

1) The master station sends a command message to a slave station.
2) The slave station checks that the station No. in the received message matches with the own station No. or not.
3) If matched, the slave station executes the command and sends back the response message.
4) If mismatched, the slave station leaves the command message and wait for the next command message.

a) Matched



b) Unmatched



By addressing different station number in each command message, the master station can communicate with multiple slave stations.

5.2 Composition of Message

Fig. 5-1 shows the composition of a message and the order by which contents are sent.

Station No. (1 byte)
Function code (1 byte)
Data (2 to 133 bytes)
Error check code (CRC-16) (2 bytes)

Fig. 5-1 Composition of message

(1) Station No.

The number specifiing a slave station. A command message is received and operated only by the addressed slave station (FST) .

(2) Function code

A code which defines the task that the addressed slave station should do. For details, refer to Section 5.4.

(3) Data

Data required for executing a function. The composition of data varies with function codes. For details, refer to Chapter 6.

A register number is assigned to each data in the flowmeter. To read/write data through communication, the master needs to specify a register number. Note that the register number transmitted on a message is expressed as its relative address.

The relative address is obtained by the following expression.

$$\boxed{\text{Relative address}} = \left(\text{The lower 4 digits of the } \boxed{\text{register number}} \right) - 1$$

For example, when the resister number that a function code is going to designate is 40003,

Relative address = (lower 4 digits of 40003) – 1

= 0002

is used in the message.

(4) Error check code

The code to detect message errors (change in bit) occur in the cource of a signal transmission.

MODUBUS protocol (RTU mode) uses CRC-16 (Cycric Redundancy Check).

For CRC calculation, refer to Section 5.5.

5.3 Response of Slave Station

(1) Response to normal command

The slave station creates and sends back a response message which corresponds to the command message. The composition of message in this case is the same as in Section 5.2. Contents of the data field vary with function codes. For details, refer to Chapter 6.

(2) Response to abnormal command

If contents of a command message have an abnormality (for example, an invalid function code is designated) other than transmission error, the slave station does not execute that command but creates and sends back a response message at error detection. The composition of response message at error detection is as shown in Fig. 5-2 The value used for function code field is function code of command message plus 80_H. Table 5-1 shows error codes.

Station No.
Function code + 80_H
Error code
Error check （CRC-16）

Fig. 5-2 Response message at error detection

Table 5-1 Error Code

Error code	Contents	Description
01H	Incorrect function code	Invalid function code is designated. Check the function code.
02H	Incorrect data address	A relative address of a resister number not available for the designated function code is used
03H	Incorrect data number	Designated data number is larger than the range that the register numbers exist.

(3) No response

A slave station takes no action nor respond to a command message if:

- A station number in the command message differs from that of the slave station.
- An error check code does not match with the calculation result
- The slave has detected a transmission error (parity error, for example)
- The time interval between data components of a message is longer than 24 bit time. (Refer to Section 5.6 Transmission Control)
- Station No. of the slave station is set to 0.
- When a operator is changing parameters with the operation keys.
- When the slave received a write-in command while the LCD of flowmeter is not in the measurement screen.

5.4 Function Code

In MODBUS protocol, specific register numbers are assigned for each function code. In other word, each function code acts only on the specified register numbers. This correspondence is shown in Table 5-2, and the message length of each function is shown in Table 5-3.

Table 5-2 Correspondence between function codes and objective address

Function code			⟷	Resister No.	
No.	Function	Object		No.	Contents
03_H	Read-out (continuously)	Holding register		4xxxx	Read-out/write-in word data
04_H	Read-out (continuously)	Input register		3xxxx	Read-out word data
06_H	Write-in	Holding register		4xxxx	Read-out/write-in word data
10_H	Write-in (continuously)	Holding register		4xxxx	Read-out/write-in word data

Table 5-3 Function code and message length

[Unit:byte]

Function code	Contents	Number of designatable data	Command message		Response message	
			Minimum	Maximum	Minimum	Maximum
03_H	Read-out of word data	64 words	8	8	7	133
04_H	Read-out of word data (read-out only)	64 words	8	8	7	133
06_H	Write-in of word data	1 word	8	8	7	7
10_H	Write-in of continuous word data	64 words	11	137	8	8

5.5 Calculation of Error Check Code (CRC-16)

CRC-16 is the 2-byte (16-bit) error check code. The slave station calculates the CRC of the received message, from the top of the message (station No.) to the end of the data field. If the calculated CRC is different from the received CRC, the slave won't respond to the command message.

Fig. 5-3 shows the flow of the CRC-16 calculation.

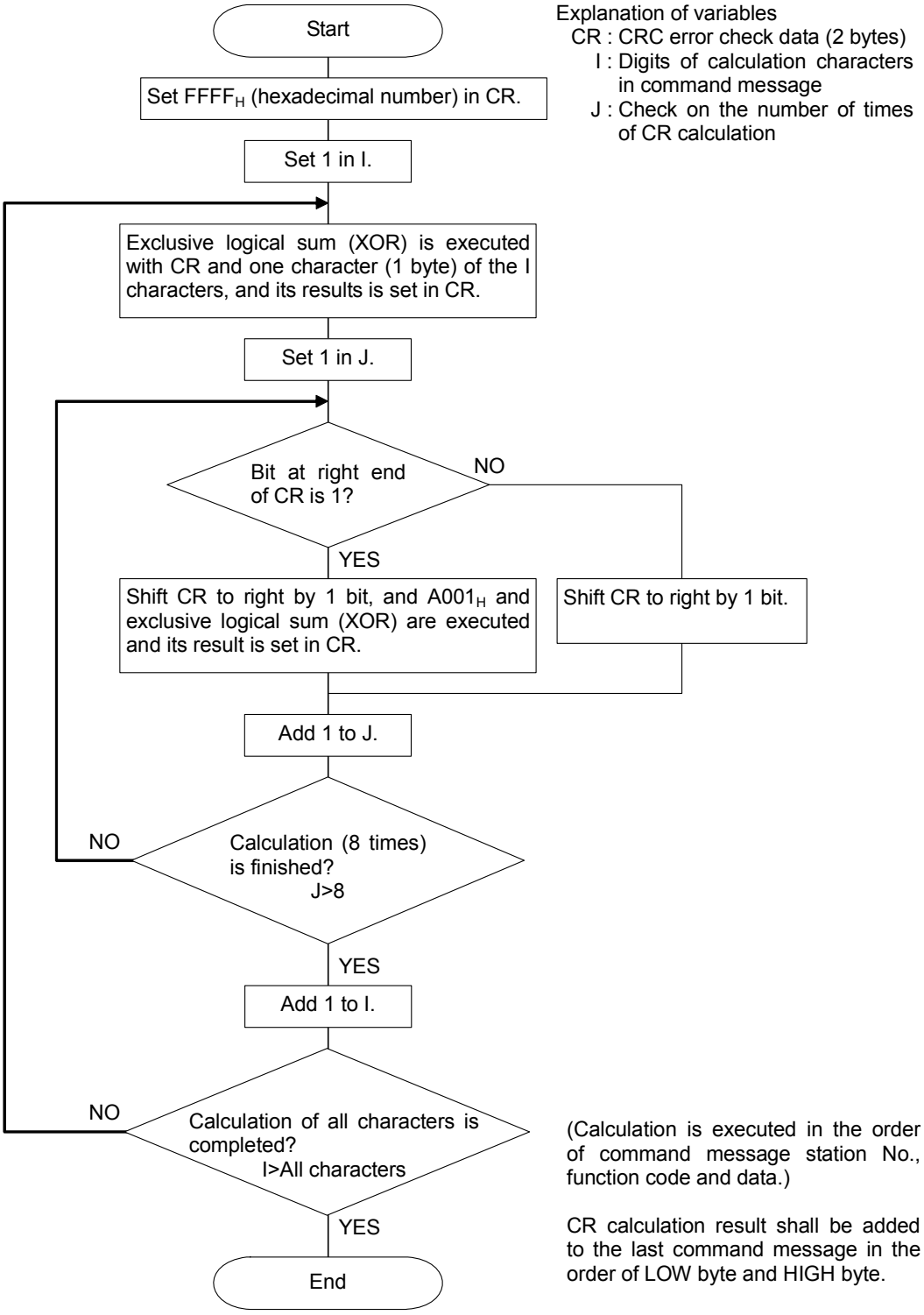


Fig. 5-3 Flow of CRC-16 calculation

5.6 Transmission Control

(1) Transmission procedure of master station

The master station must fulfill the followings:

(1-1) Before sending a command message, provide 48 bit time or more vacant status.

(1-2) The interval between bytes of a command message shall be less than 24 bit time.

(1-3) Within 24 bit time after sending a command message, the master shall be in the receiving status.

(1-4) Provide 48 bit time or more vacant status between the end of response message reception and beginning of next command message [same as in (1-1)].

(1-5) Check the response message and provide at least three retries when there is no response or error occurs.

Note) The values in the above sentennses are the most unfavorable value. It is recommended to write the program for the master station with the values two or three times larger than the above values. For example, recommended values for the program for 9600 bps communication are as follows: vacant status (1-1): >10 ms, byte interval (1-2): ≤1 ms, and status change from sending to receiving (1-3): ≤1 ms.

(2) Description

1) Detection of the message frame

In this system, thare are the following two statuses in the communication line.

(a) Vacant status (no data on line)

(b) Communication status (data exists)

Instruments connected on the line are in a receiving status and monitoring the line. When the vacant status has continued 24 bit time or longer, the instruments assume that the frame is finished, and set in the receiving status within the following 24 bit time. When data appears on the line, instruments start receiving the data and finish receiving when vacant status continues 24 bit time or more. In other words, the instruments assume the data appears between two vacant statuses (of 24 bit time or more) as one frame to receive. Therefore, to send a frame of command message, the master station must:

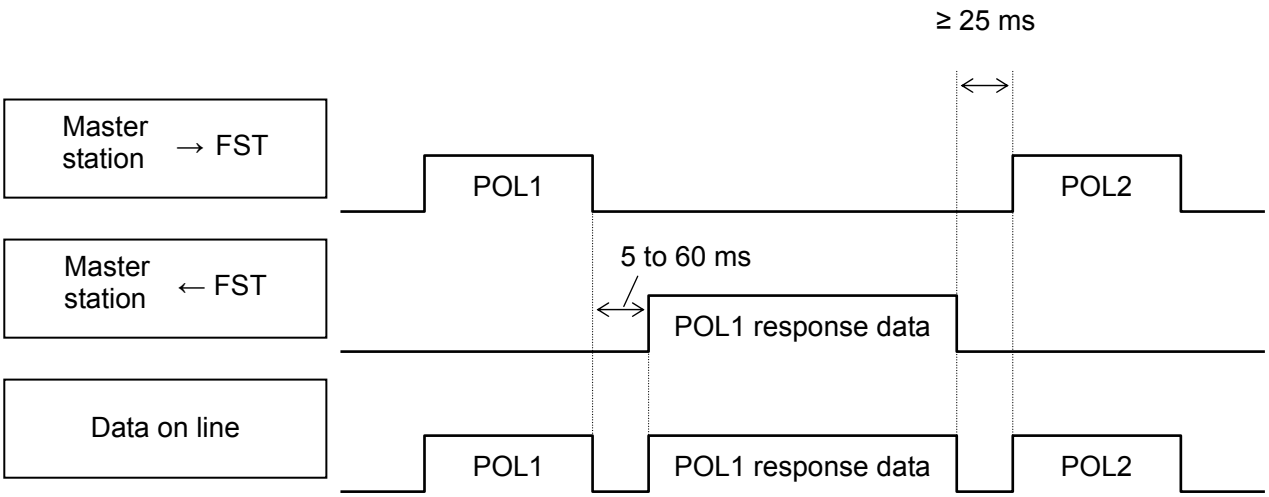
(1-1) Keep a 48 bit time or more vacant status before sending a command message.

(1-2) Keep the interval between bytes of a command message smaller than 24 bit time.

2) Response of the flowmeter (FST)

After a frame detection (24 bits time or more vacant status), the flowmeter processes the frame as a command message. If the command message is the one addressed to it, the flowmeter sends a response message. The processing time is 5 to 60 ms (depends on the contents of a command message). After sending a command message, therefore, the master station must:

(1-3) Set in the receiving status within 24 bits time after sending a command message.


≥ 25 ms
Master station → FST
POL1
POL2
Master station ← FST
5 to 60 ms
POL1 response data
Data on line
POL1
POL1 response data
POL2

5.7 FIX Processing (data writing)

The flowmeter FST has a non-volatile memory (FRAM) to store the parameter setting data. If you want to save parameter data written via communication even after you turn off the power, you need to carry out the FIX process. Fig.5-4 shows the FIX procedure.

Notes:

- Write in the non-volatile memory takes approximately 2 seconds.
- Do not turn off the power of the flowmeter during data writing. Otherwise, the data in the non-volatile memory may be corrupted, and the flowmeter may fail.
- Do not change parameters from the front panel during the FIX process, or memory error may occur.
- Carry out the FIX process only when needed.

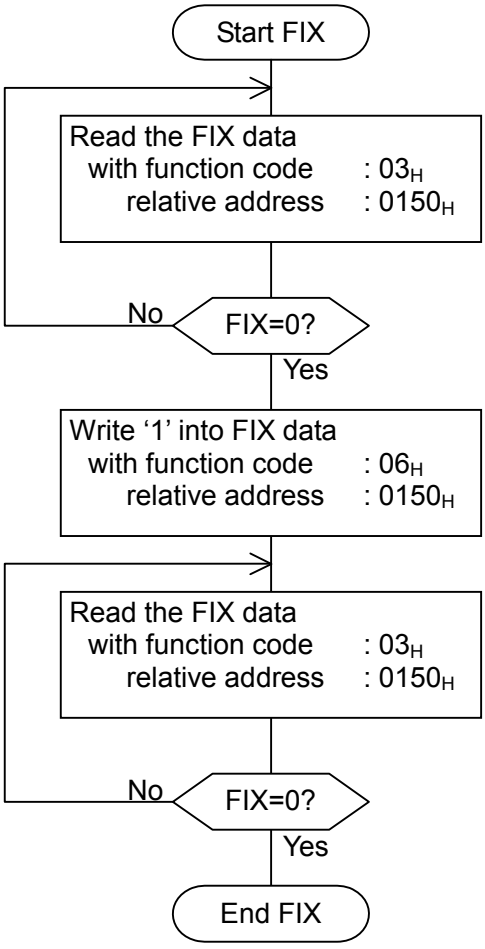


Fig.5-4 FIX procedure

6. MESSAGES

6.1 Read-out of Word Data [Function code:03_H]

Function code	Max. word number read-out in one message	Relative data address	Register No.	Kind of data
03_H	64 words	0000_H－$014F_H$	40001－40336	Storage enable data
		0150_H－0171_H	40337－40370	Storage disable data

(1) Message composition

Command message composition (byte)

Station No.		
Function code		
Read-out start No. (relative address)	Upper	
	Lower	
Read-out word number	Upper	1 to 64
	Lower	
CRC data	Lower	
	Upper	

Response message composition (byte)

Station No.		
Function code		
Read-out byte number		Read-out word number×2
Contents of the first word data	Upper	
	Lower	
Contents of the next word data	Upper	
	Lower	
～		
Contents of the last word data	Upper	
	Lower	
CRC data	Lower	
	Upper	

* Arrangement of read-out word data

MSB　　LSB
Upper byte of contents of the first word data
Lower byte of contents of the first word data
Upper byte of contents of the next word data
Lower byte of contents of the next word data
～
Upper byte of contents of the last word data
Lower byte of contents of the last word data

(2) Function

Word data of continuous word numbers from the read-out start No. can be read. Read-out word data are transmitted from the slave station in the order from upper to lower bytes.

(3) Message transmission example

Reading “Damping” from No. 2 station is shown below.

Relative address of damping: 0000_H (Register No.40001), Data number: 01_H

Command message composition (byte)

Station No.		02_H
Function code		03_H
Read-out start No. (relative address)	Upper	00_H
	Lower	00_H
Read-out word number	Upper	00_H
	Lower	01_H
CRC data	Lower	84_H
	Upper	39_H

Response message composition (byte)

Station No.		02_H
Function code		03_H
Read-out byte number		02_H
Contents of the first word data	Upper	00_H
	Lower	64_H
CRC data	Lower	FD_H
	Upper	AF_H

* Meaning of data to be read

Damping 00 64_H = 100

(contents of the first word data)

Where the unit is sec with decimal point position set at 1,

Damping = 10.0 sec

Point For the handling of the decimal point, refer to Section 7.1.

6.2 Read-out of Read-out Only Word Data [Function code:04_H]

Function code	Max. word number read-out in one message	Relative data address	Register No.
04_H	64 words	0000_H－1173_H	30001－34468

(1) Message composition

Command message composition (byte)

Station No.	
Function code	
Read-out start No. (relative address)	Upper
	Lower
Read-out word number	Upper
	Lower
CRC data	Lower
	Upper

} 1 to 64

Response message composition (byte)

Station No.	
Function code	
Read-out byte number	
Contents of the first word data	Upper
	Lower
Contents of the next word data	Upper
	Lower
～	～
Contents of the last word data	Upper
	Lower
CRC data	Lower
	Upper

Read-out word number×2

* Arrangement of read-out word data

MSB	LSB
Upper byte of contents of the first word data	
Lower byte of contents of the first word data	
Upper byte of contents of the next word data	
Lower byte of contents of the next word data	
～	～
Upper byte of contents of the last word data	
Lower byte of contents of the last word data	

(2) Function

Word data of continuous word numbers from the read-out start No. can be read. Read-out word data are transmitted from the slave station in the order from upper to lower bytes.

(3) Message transmission example

The following is an example of reading out the flow rate from station No. 1.

Relative address of the flow rate: 0004_H (Register No. 30005), Number of data to be read out: 02_H

Command message composition (byte)

Station No.		01_H
Function code		04_H
Read-out start No. (relative address)	Upper	00_H
	Lower	04_H
Read-out word number	Upper	00_H
	Lower	02_H
CRC data	Lower	30_H
	Upper	$0A_H$

Response message composition (byte)

Station No.		01_H
Function code		04_H
Read-out byte number		04_H
Contents of the first word data	Upper	43_H
	Lower	40_H
Contents of the next word data	Upper	00_H
	Lower	00_H
CRC data	Lower	EF_H
	Upper	$D4_H$

Meaning of read-out data

Data having the unit m^3/h and floating decimal point

The read-out data is expressed as a 32-bit single-precision floating value.

Connect the read-out 4-byte data, and convert it into an actual value using an appropriate conversion program.

Flow rate, 192.0 m^3/h = 1.5x (2 to the 7th power)

= 0100 0011 0100 0000 0000 0000 0000 0000 (binary number)

Point For handling of floating data, refer to Section 7.1.

6.3 Write-in of Word Data [Function code:06_H]

Function code	Max. word number write-in in one message	Relative data address	Register No.	Kind of data
06_H	1 word	0140_H－$014F_H$	40321－40336	Storage enable data
		0150_H－0171_H	40337－40370	Storage disable data

(1) Message composition

Command message composition (byte)

Station No.		
Function code		
Write-in designate No. (relative address)	Upper	
	Lower	
Write-in word data	Upper	
	Lower	
CRC data	Lower	
	Upper	

Response message composition (byte)

Station No.		
Function code		
Write-in designate No. (relative address)	Upper	
	Lower	
Write-in word data	Upper	
	Lower	
CRC data	Lower	
	Upper	

(2) Function

Designated word data is written in write-in designate No. Write-in data are transmitted from master station in the order from upper to lower bytes.

The current value is returned when the write-in data does not fall within the effective range.

(3) Message transmission example

The following shows an example of transmitting the "Zero adjustment" key command to No.1 station.

Key operation command Relative address: 0140_H

Command message composition (byte)

Station No.		01_H	
Function code		06_H	
Write-in designate No. (relative address)	Upper	01_H	
	Lower	40_H	
Write-in word data	Upper	00_H	Zero adjustment command
	Lower	01_H	
CRC data	Lower	48_H	
	Upper	22_H	

Response message composition (byte)

Station No.		01_H
Function code		06_H
Write-in designate No. (relative address)	Upper	01_H
	Lower	40_H
Write-in word data	Upper	00_H
	Lower	01_H
CRC data	Lower	48_H
	Upper	22_H

6.4 Write-in of continuous word data [Function code:10_H]

Function code	Max. word number write-in in one message	Relative data address	Register No.	Kind of data
10_H	64 word	0000_H－$013F_H$	40001－40320	Storage enable data

(1) Message composition

Command message composition (byte)

Station No.		
Function code		
Write-in start No. (relative address)	Upper	
	Lower	
Write-in word number	Upper	} 1 to 64
	Lower	
Write-in byte number		} Write-in word number × 2
First write-in word data	Upper	
	Lower	
Next write-in word data	Upper	
	Lower	
～		
Last write-in word data	Upper	
	Lower	
CRC data	Lower	
	Upper	

Response message composition (byte)

Station No.	
Function code	
Write-in start No. (relative address)	Upper
	Lower
Write-in word number	Upper
	Lower
CRC data	Lower
	Upper

* Arrangement of write-in word data

MSB LSB
Upper byte of contents of the first word data
Lower byte of contents of the first word data
Upper byte of contents of the next word data
Lower byte of contents of the next word data
～
Upper byte of contents of the last word data
Lower byte of contents of the last word data

(2) Function

Word data of continuous word number is written from write-in start address. The master station transmits the write-in word data in the order from upper to lower bytes. If write-in data does not fall within the effective range, the master will respond without counting the write-in word number. If an attempt is made to write data in an unused address, the master does not carry out write-in, and respond without counting the write-in word number.

(3) Message transmission example

Writing Flow unit = m^3/h, Range type = single range, Full scale 1 = 300.0 m^3/h in the station No.1.

Flow unit = 0006_H (= 6_D)

Range type = 0000_H (= 0_D)

Full scale 1 = 4072 C000 0000 0000 (= 300.0_D) (64-bit double precision float type)

Relative address of Flow unit: 0004_H (Register No. 40005), Data number: 06_H

Command message composition (byte)

Station No.		01_H
Function code		10_H
Write-in start No. (relative address)	Upper	00_H
	Lower	04_H
Write-in word number	Upper	00_H
	Lower	06_H
Write-in byte number		$0C_H$
First write-in word data	Upper	00_H
	Lower	06_H
Next write-in word data	Upper	00_H
	Lower	00_H
Next write-in word data	Upper	40_H
	Lower	72_H
Next write-in word data	Upper	$C0_H$
	Lower	00_H
Next write-in word data	Upper	00_H
	Lower	00_H
Last write-in word data	Upper	00_H
	Lower	00_H
CRC data	Lower	51_H
	Upper	AB_H

Response message composition (byte)

Station No.		01_H
Function code		10_H
Write-in start No. (relative address)	Upper	00_H
	Lower	04_H
Write-in word number	Upper	00_H
	Lower	06_H
CRC data	Lower	01_H
	Upper	CA_H

Point For the handling of floating data, refer to Section 7.1.
For the transmission format of each data, refer to the address map (Chapter 7.)

Caution If the master sends a write-in command message to any slave station during the FIX process, no response will be made.

7. ADDRESS MAP AND DATA FORMAT

7.1 Data Format

7.1.1 Transmission data format

The MODBUS protocol used in this product is RTU (Remote Terminal Unit) mode. The transmitted data is "numerical value", but ASCII code data is partly included.

7.1.2 Handling of decimal point

Numerical value data includes integer data, decimal point position fixed data and floating data. Handling of data containing a decimal point is described below.

(1) Data with determined decimal point position (int type, long type)

No decimal point is added in the transmission data. For the data which contains a decimal point, carry out the decimal point position alignment processing (elimination of decimal point at the time of transmission, addition of decimal point at the time of reception).

Example: damping data

Read-out data: $03\ E8_H = 1000$

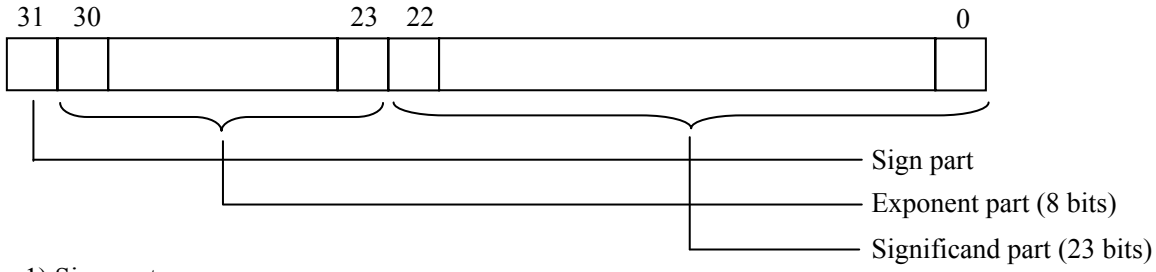
Decimal point position: 1 digit

Value: 100.0sec

(2) 32-bit floating data (float type)

Instantaneous values or the like are expressed by 32-bit single precision float type.

The meaning of each bit is as follows (standard format specified in IEEE).



1) Sign part

Indicates the sign of the floating decimal point. "0" represents "positive", and "1" represents "negative".

2) Exponent part

Indicates the exponent of the floating decimal point by a power of 2. The value obtained by subtracting 127 from this value is the actual exponent.

3) Significand part

This is the data that corresponds to the significant figure of the floating decimal point. The actual numerical value is interpreted by adding 1 to the top.

Example: 1 10000000 11000000000000000000000

Sign : Minus

Exponent : $10000000_{(2)} - 127 = 1$

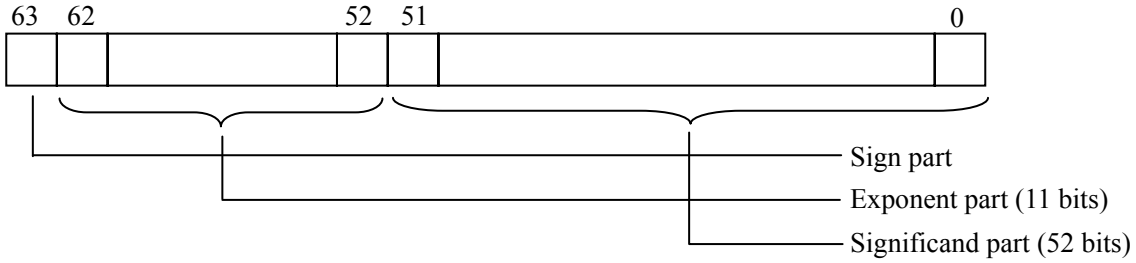
Significand : $1.11_{(2)} = 1 + 1/2 + 1/4 = 1.75$

Value : $-1.75 \times$ (1st power of 2) $= -3.5$

(3) 64-bit floating data (double type)

Instantaneous values or the like are expressed by 64-bit double precision float type.

The meaning of each bit is as follows (standard format specified in IEEE).



1) Sign part

Indicates the sign of the floating decimal point. “0” represents “positive”, and “1” represents “negative”.

2) Exponent part

Indicates the exponent of the floating decimal point by a power of 2. The value obtained by subtracting 1023 from this value is the actual exponent.

3) Significand part

This is the data that corresponds to the significant figure of the floating decimal point. The actual numerical value is interpreted by adding 1 to the top.

Example: 0 01111111111 1110000000000000000000000000000000000000000000000000

Sign	:	Plus
Exponent	:	$01111111111_{(2)} - 1023 = 0$
Significand	:	$1.111_{(2)} = 1 + 1/2 + 1/4 + 1/8 = 1.875$
Value	:	$1.875 \times$ (0th power of 2) = 1.875

7.1.3 Handling of over-range readings

Even if the measured data (instantaneous value) is in excess of the scale range, the measured data (velocity or flow rate) is transmitted as it is as the instantaneous value Read-out data.

7.2 Address Map

See the instruction manual for the details of each parameter.

Data type unsigned char: Byte data without sign. This data is handled in byte units. One data per address
int : Word data with sign. This data is handled in word units. One data per two addresses
unsigned int : Word data without sign. This data is handled in word units. One data per two addresses
Long : 2-word data with sign. This data is handled in 2-word units. One data per four addresses
float : Floating data. This data is handled in 2-word units. One data per four addresses
double : Floating data. This data is handled in 4-word units. One data per eight addresses

7.2.1 Word data [Read-out/Write-in]: Function code [03H, 10H]

Relative address	Register No.	Data type	Parameter	Read-out data/Write-in data setting range	Remarks
	4XXXX				
0000	40001	int	Damping	1 place after the decimal point, 0.0 to 100.0sec	
0002	40003	int	Range kind	0: Velocity, 1: Flow rate	
0004	40005	int	Flow rate unit	Metric system : 0:L/s, 1:L/min, 2:L/h, 3:L/d, 4:kL/d, 5:ML/d, 6:m^3/s, 7:m^3/min, 8:m^3/h, 9:m^3/d, 10:km^3/d, 11:Mm^3/d, 12:BBL/s, 13:BBL/min, 14:BBL/h, 15:BBL/d, 16:kBBL/d, 17:MBBL/d English system : 0:gal/s, 1:gal/min, 2:gal/h, 3:gal/d, 4:kgal/d, 5:Mgal/d, 6:ft^3/s, 7:ft^3/min, 8:ft^3/h, 9:ft^3/d, 10:kft^3/d, 11:Mft^3/d, 12:BBL/s, 13:BBL/min, 14:BBL/h, 15:BBL/d, 16:kBBL/d, 17:MBBL/d	
0006	40007	int	Range type	0: Single range, 1: Auto 2 range, 2: Forward-reverse range, 3: Forward-reverse auto 2 range	
0008	40009	double	Full scale 1	Metric system: 64-bit floating data; 0, ±0.3 to ±10m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0010	40017	double	Full scale 2	Metric system: 64-bit floating data; 0, ±0.3 to ±10m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0018	40025	int	Range hysteresis	2 places after the decimal point, 0.00 to 20.00%	
001A	40027	int	Burnout	0: Not use, 1: Hold, 2: Upper, 3: Lower, 4: Zero	
001C	40029	int	Burnout timer	Decimal point fixed, 0 to 900sec	
001E	40031	int	Output limit low	Decimal point fixed, –20 to 0%	
0020	40033	int	Output limit high	Decimal point fixed, 100 to 120%	
0022	40035	int	Rate limit timer	Decimal point fixed, 0 to 900sec	
0024	40037	double	Rate limit	Metric system: 64-bit floating data; 0 to 5m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
002C	40045	double	Low flow rate cut	Metric system: 64-bit floating data; 0 to 5m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0034	40053	double	Calibration zero	Metric system: 64-bit floating data; ±5m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
003C	40061	int	Calibration span	2 places after the decimal point, 0.00 to 200.00%	
003E	40063	int			Not use, write-in inhibited.
0040	40065	int	Total unit *1	Metric system : 0:mL, 1:L, 2:m^3, 3:km^3, 4:Mm^3, 5:mBBL, 6:BBL, 7:kBBL English system : 0:gal, 1:kgal, 2:ft^3, 3:kft^3, 4:Mft^3, 5:mBBL, 6:BBL, 7:kBBL, 8:ACRf	

Relative address	Register No.	Data type	Parameter	Read-out data/Write-in data setting range	Remarks
0042	40067	int	Total mode	0: Start, 1: Stop, 2: Total reset	
0044	40069	double	Total constant *1	64-bit floating data, 0 to 99999999	Unit: Total
004C	40077	double	Total preset *1	64-bit floating data, 0 to 99999999	Unit: Total
0054	40085	int	Pulse width *1	0: 5.0 msec, 1: 10.0 msec, 2: 50.0 msec, 3: 100.0 msec, 4: 200.0 msec, 5: 500.0 msec, 6: 1000.0 msec	
0056	40087	int	Burnout	0: Hold, 1: Not use	
0058	40089	int	Burnout timer	Decimal point fixed, 0 to 900sec	
005A	40091	int	DO1 out	0: Not use, 1: + Total pulse, 2: – Total pulse, 3: Full scale 2, 4: Alarm, 5: Flow switch, 6: Total switch,7: Ao range over,8: Pulse range over,9: – Flow direction	
005C	40093	int	Alarm	0: All, 1: Equipment error, 2: Process error	
005E	40095	int	Flow rate switch	0: Upper flow rate, 1: Lower flow rate	
0060	40097	double	Upper flow rate	Metric system: 64-bit floating data; 0 to 10m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0068	40105	double	Lower flow rate	Metric system: 64-bit floating data; 0 to 10m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0070	40113	double	Total switch *1	64-bit floating data, 0 to 99999999	Unit: Total
0078	40121	int	DO1 contact action	0: Active ON, 1: Active OFF	
007A	40123	int	DO2 out	0: Not use, 1: + Total pulse, 2: – Total pulse, 3: Full scale 2, 4: Alarm, 5: Flow switch, 6: Total switch,7: Ao range over,8: Pulse range over,9: – Flow direction	
007C	40125	int	Alarm	0: All, 1: Equipment error, 2: Process error	
007E	40127	int	Flow rate switch	0: Upper flow rate, 1: Lower flow rate	
0080	40129	double	Upper flow rate	Metric system: 64-bit floating data; 0 to 32m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0088	40137	double	Lower flow rate	Metric system: 64-bit floating data; 0 to 32m/s as converted to flow rate English system: 64-bit floating data	Unit: Flow rate
0090	40145	double	Total switch *1	64-bit floating data, 0 to 99999999	Unit: Total
0098	40153	int	DO2 contact action	0: Active ON, 1: Active OFF	
009A	40155	int			Not use, write-in inhibited.
009C	40157	int			Not use, write-in inhibited.
009E	40159	int			Not use, write-in inhibited.
00A0	40161	double			Not use, write-in inhibited.
00A8	40169	double			Not use, write-in inhibited.
00B0	40177	double			Not use, write-in inhibited.
00B8	40185	int			Not use, write-in inhibited.
00BA	40187	int			Not use, write-in inhibited.
00BC	40189	int			Not use, write-in inhibited.
00BE	40191	int			Not use, write-in inhibited.
00C0	40193	int	1st row	0: Velocity, 1: Flow rate, 2: Flow rate (%), 3: + Total (actual), 4: + Total pulse, 5: – Total (actual), 6: – Total pulse	
00C2	40195	int	Decimal point position of 1st row	0: *.******, 1: **.*****, 2: ***.****, 3: ****.***, 4: *****.**, 5: ******.*, 6: ********.	Write-in is not permitted in case the row is "Velocity", "+ Total pulse" or "– Total pulse".

Relative address	Register No.	Data type	Parameter	Read-out data/Write-in data setting range	Remarks
00C4	40197	Int	2nd row	0: Velocity, 1: Flow rate, 2: Flow rate (%), 3: + Total (actual), 4: + Total pulse, 5: – Total (actual), 6: – Total pulse	
00C6	40199	int	Decimal point position of 2nd row	0: *.******, 1: **.*****, 2: ***.****, 3: ****.***, 4: *****.**, 5: ******.*, 6: ********.	Write-in is not permitted in case the row is "Velocity", "+ Total pulse" or "– Total pulse".
00C8	40201	int			Not use, write-in inhibited.
00CA	40203	int	LCD Backlight out time	0 to 99 min	
00CC	40205				Not use, write-in inhibited.
00CE	40207				Not use, write-in inhibited.
00D0	40209	int			Not use, write-in inhibited.
00D2	40211	int			Not use, write-in inhibited.
to	to				
0100	40257	int	System unit *1	0: Metric, 1: English	
0102	40259	int	System language	0: English, 1: Japanese, 2: German, 3: French, 4: Spanish	
0104	40261	int	ID No. setup	Decimal point fixed, 0 to 9999	
0106	40263				Not use, write-in inhibited.
to	to				
041A	41051	int	Path abnormal	0: calculation ON, 1: calculation OFF	
to	to				Not use, write-in inhibited.
06F8	41785	int			Not use, write-in inhibited.

*1) Setting the total set value and the system unit is available only when the total mode is set to stop. (If write-in is attempted without stopping, response occurs without counting in the write-in byte count.)

*2) Read only in the setting screen. No response is made against write-in. Setting from communication is permitted during protection.

7.2.2 Word data [Read-out/Write-in]: Function code [03H, 06H]

Relative address	Register No.	Data type	Parameter	Read-out data/Write-in data setting range	Remarks
0140	40321	int	Zero adjustment	0: Clear, 1: Adjust	
0142	40323	unsigned int	4mA	No decimal point, 50 to 28592	
0144	40325	unsigned int	20mA	No decimal point, 28592 to 65534	
0146	40327	int			Not use, write-in inhibited.
0148	40329	int			Not use, write-in inhibited.
to	to				Not use, write-in inhibited.
014E	40335	int			Not use, write-in inhibited.

The address data indicated below is not stored in the main unit.

Relative address	Register No.	Data type	Parameter	Read-out data/Write-in data setting range	Remarks
0150	40337	int	Set value storage request	Read-out data: 0: Completed, 1: Being stored Write-in data : 1: Storage	
0152	40339	int	Memory initialize	Read-out data: 0 Write-in data : 100: Initialize	Communication is disabled for about 5 seconds after initialization.
0154	40341	int	Output setting (current check)	Decimal point fixed, –20 to 120%	
0156	40343	int	Total pulse check	Decimal point fixed, 1 to 100PULSE/s	
0158	40345	int	DO check	0: ON, 1: OFF	
015A	40347	int			Not use, write-in inhibited
015C	40349	int	Test mode	0: Not use, 1: Set	
015E	40351	int	Input data	Decimal point fixed, ±120%	
0160	40353	int	Tracking time	Decimal point fixed, 0 to 900sec	
0162	40355	int	LCD & LED check *3	0: Not use, 1: Check	
0164	40357	int	Key test *3	Read-out data: 10: No key pressing, 20: ESC key, 40: UP key, 80: ENT key, 100: SET key Write-in data : 0: Not use, 1: Start	
0166	40359	int	Test cancel	Read-out data: 0: Termination, 1: Being tested Write-in data : 0: Termination	Cancellation of testing of current, total pulse, DO check and test mode
0168 to 0170	40361 to 40369	int			Not use, write-in inhibited.

*3) No response is made if execution is attempted in a screen other than measure screen.

7.2.3 Word data [Read-out only]: Function code [04H]

Relative address	Register No.	Data type	Parameter	Setting range	Remarks
	3XXXX				
0000	30001	float	Velocity	Metric system: 32-bit floating data, Unit: m/s English system: 32-bit floating data, Unit: ft/s	
0004	30005	float	Flow rate	32-bit floating data	Unit: Flow rate
0008	30009	float	Flow rate %	32-bit floating data, Unit: %	
000C	30013	double	+ Total value	64-bit floating data	Unit: Total
0014	30021	double	– Total value	64-bit floating data	
001C	30029	long	+ Total pulse	No decimal point, Unit: Pulse	
0020	30033	long	– Total pulse	No decimal point, Unit: Pulse	
0024	30037	unsigned int	RAS information CH1	Data of hexadecimal number	
0026	30039	int	RAS information CH2	Data of hexadecimal number	
0028	30041	int	RAS information CH3	Data of hexadecimal number	
002A	30043	int	RAS information CH4 ALL	Data of hexadecimal number	
002C	30045	int			Not use
002E	30047	int			Not use
0030	30049	int			Unused
to	to				Unused
0086	30135	unsigned char	1st and 2nd characters of the version	ASCII code, 14 characters	
0088	30137	unsigned char	3rd and 4th characters of the version		
008A	30139	unsigned char	5th and 6th characters of the version		
008C	30141	unsigned char	7th and 8th characters of the version		
008E	30143	unsigned char	9th and 10th characters of the version		
0080	30145	unsigned char	11th and 12th characters of the version		
0092	30147	unsigned char	13th and 14th characters of the version		
0094	30149				Unused
to	To				Unused
10C0	34289	int	CH1: Total time (T0 C)	No decimal point, unit: μs	
10C2	34291	int	CH1: Window open (Win C)	No decimal point, unit: μs	
10C4	34293	long	CH1: Forward time (T1)	Three decimal places, unit: μs	
10C8	34297	long	CH1: Reverse time (T2)	Three decimal places, unit: μs	
10CC	34301	long	CH1: Total time (T0)	Three decimal places, unit: μs	
10D0	34305	long	CH1: Transit time (DT)	Four decimal places, unit: ns	
10D4	34309	float	CH1: Flow velocity (V1)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
10D8	34313	float	CH1: Flow velocity (V2)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
10DC	34317	float	CH1: Flow velocity (V3)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
10E0	34321	float	CH1: Flow velocity (V4)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
10E4	34325	float	CH1: Flow velocity (V5)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
10E8	34329	int	CH1: U: Signal power (AGC U)	Two decimal places, 0.00 to 100.00%	
10EA	34331	int	CH1: D: Signal power (AGC D)	Two decimal places, 0.00 to 100.00%	
10EC	34333	unsigned int	CH1: U: Signal peak (P/H U)	No decimal point	

Relative address	Register No.	Data type	Parameter	Setting range	Remarks
10EE	34335	unsigned int	CH1: D: Signal peak (P/H D)	No decimal point	
10F0	34337	int	CH1: U: Trigger level (TRG U)	Two decimal places, 0.00 to 100.00%	
10F2	34339	int	CH1: D: Trigger level (TRG D)	Two decimal places, 0.00 to 100.00%	
10F4	34341	long	CH1: U: Filter max value	No decimal point	
10F8	34345	long	CH1: D: Filter max value	No decimal point	
10FC	34349	int	CH2: Total time (T0 C)	No decimal point, unit: μs	
10FE	34351	int	CH2: Window open (Win C)	No decimal point, unit: μs	
1100	34353	long	CH2: Forward time (T1)	Three decimal places, unit: μs	
1104	34357	long	CH2: Reverse time (T2)	Three decimal places, unit: μs	
1108	34361	long	CH2: Total time (T0)	Three decimal places, unit: μs	
110C	34365	long	CH2: Transit time (DT)	Four decimal places, unit: ns	
1110	34369	float	CH2: Flow velocity (V1)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1114	34373	float	CH2: Flow velocity (V2)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1118	34377	float	CH2: Flow velocity (V3)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
111C	34381	float	CH2: Flow velocity (V4)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1120	34385	float	CH2: Flow velocity (V5)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1124	34389	int	CH2: U: Signal power (AGC U)	Two decimal places, 0.00 to 100.00%	
1126	34391	int	CH2: D: Signal power (AGC D)	Two decimal places, 0.00 to 100.00%	
1128	34393	unsigned int	CH2: U: Signal peak (P/H U)	No decimal point	
112A	34395	unsigned int	CH2: D: Signal peak (P/H D)	No decimal point	
112C	34397	int	CH2: U: Trigger level (TRG U)	Two decimal places, 0.00 to 100.00%	
112E	34399	int	CH2: D: Trigger level (TRG D)	Two decimal places, 0.00 to 100.00%	
1130	34401	long	CH2: U: Filter max value	No decimal point	
1134	34405	long	CH2: D: Filter max value	No decimal point	
1138	34409	int	CH3: Total time (T0 C)	No decimal point, unit: μs	
113A	34411	int	CH3: Window open (Win C)	No decimal point, unit: μs	
113C	34413	long	CH3: Forward time (T1)	Three decimal places, unit: μs	
1140	34417	long	CH3: Reverse time (T2)	Three decimal places, unit: μs	
1144	34421	long	CH3: Total time (T0)	Three decimal places, unit: μs	
1148	34425	long	CH3: Transit time (DT)	Four decimal places, unit: ns	
114C	34429	float	CH3: Flow velocity (V1)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1150	34433	float	CH3: Flow velocity (V2)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1154	34437	float	CH3: Flow velocity (V3)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1158	34441	float	CH3: Flow velocity (V4)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	

Relative address	Register No.	Data type	Parameter	Setting range	Remarks
115C	34445	float	CH3: Flow velocity (V5)	Metric system: 32-bit floating point data, unit: m/s Imperial and US system: 32-bit floating point data, unit: ft/s	
1160	34449	int	CH3: U: Signal power (AGC U)	Two decimal places, 0.00 to 100.00%	
1162	34451	int	CH3: D: Signal power (AGC D)	Two decimal places, 0.00 to 100.00%	
1164	34453	unsigned int	CH3: U: Signal peak (P/H U)	No decimal point	
1166	34455	unsigned int	CH3: D: Signal peak (P/H D)	No decimal point	
1168	34457	int	CH3: U: Trigger level (TRG U)	Two decimal places, 0.00 to 100.00%	
116A	34459	int	CH3: D: Trigger level (TRG D)	Two decimal places, 0.00 to 100.00%	
116C	34461	long	CH3: U: Filter max value	No decimal point	
1170	34465	long	CH3: D: Filter max value	No decimal point	
1174	34469	Last address			

8. PARAMETER LOADER SOFTWARE

8.1 Copyright

8.2 Outline

By using this software, you can set, read and display relevant graphs of the data from the flowmeter FST on your PC. Your data can be easily edited with Microsoft Excel because you can save your data in CSV file format.
Note: Microsoft Excel is a registered trademark of Microsoft Corporation in the United States and/or other countries.

8.3 PC Requirements

IBM PC compatible computer

CPU	: Pentium IV 1 GHz/Celeron 1 GHz or more installed,
Display resolution	: 1024 × 768, use of small font recommended.
Memory capacity	: 128 MB or more (256 MB or more recommended) [at least 52 MB free space required]
Interface	: RS232C port or RS485 port, MODBUS communication protocol
OS	: Microsoft Windows7 (Home Premium, Professional) Microsoft Windows8 (Professional) Microsoft Windows10 (Enterprise)

8.4 Installation

(1) Insert the setup disk into the drive, and double-click “UltrasonicFlowmeter2_eng.msi.”

Fig. 8-1 Install file

(2) Setting wizard will start up. Click the [Next] button to proceed, or click the [Cancel] button to cancel the installation.

Fig. 8-2 Setup wizard

(3) There is a query about selection of installation folder. Click the [Next] button to install the software in that folder. To specify a folder click the [Browse] button and select, or enter directly. To return to the previous screen, click the [Previous] button. Click the [Cancel] button to cancel the installation.

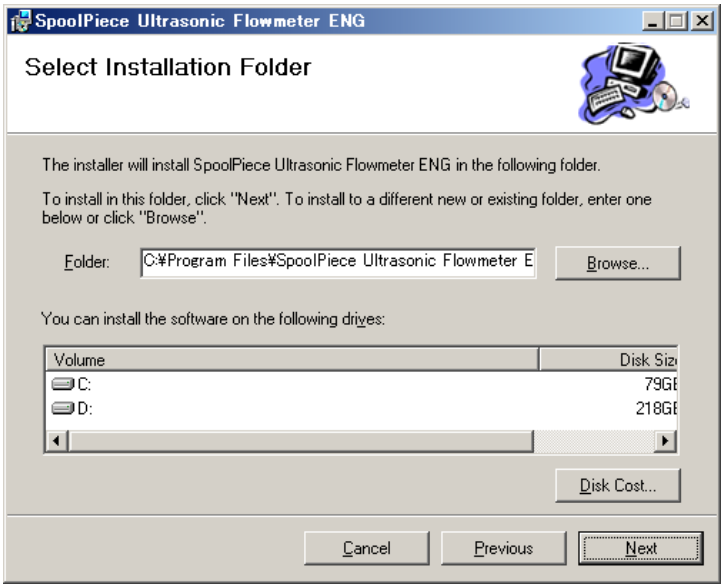


Fig. 8-3 Select installation folder screen

(4) Confirm installation screen appears. Click the [Next] button to execute the installation. Click the [Previous] button to return to the previous screen. Click the [Cancel] button to cancel the installation.

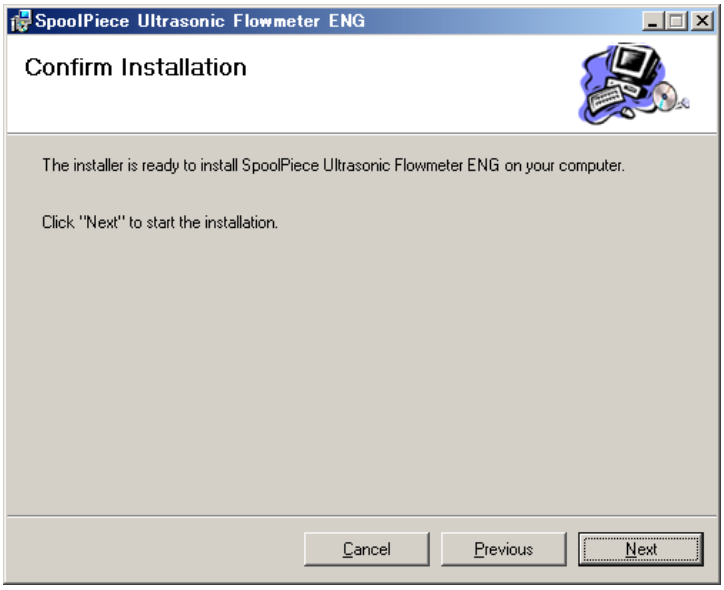


Fig. 8-4 Installation confirmation screen

(5) Execution of Installation

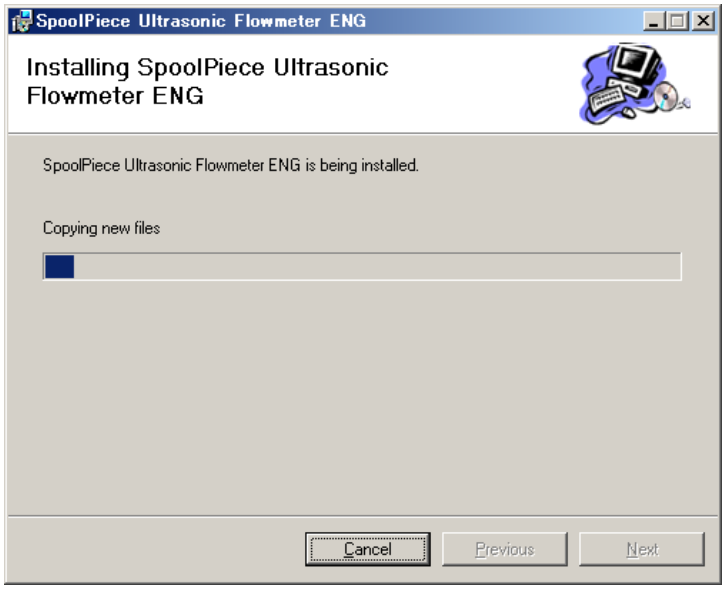


Fig. 8-5 Installing screen

(6) The Installation Complete screen is displayed. Click the [Close] button to exit the installation screen.

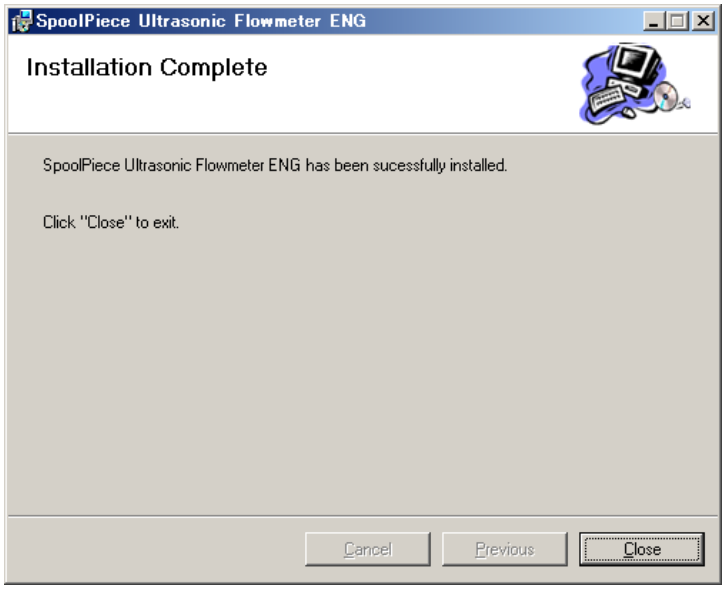


Fig. 8-6 Installation complete screen

(7) After installation, the shortcut for the software “SpoolPiece Ultrasonic Flowmeter” will be added on the desktop and in the start menu.

8.5 Startup

Start “SpoolPiece Ultrasonic Flowmeter” from the start menu or the desktop shortcut.

Fig. 8-7 Start screen

The software acquire the information on language and unit by communicating with the flow transmitter. If error occurs during communication, an error message appears, asking whether or not to continue communication. Select [Continue] or [Cancel]. Then check the communication settings from the “Communication” menu, and edit it if necessary.

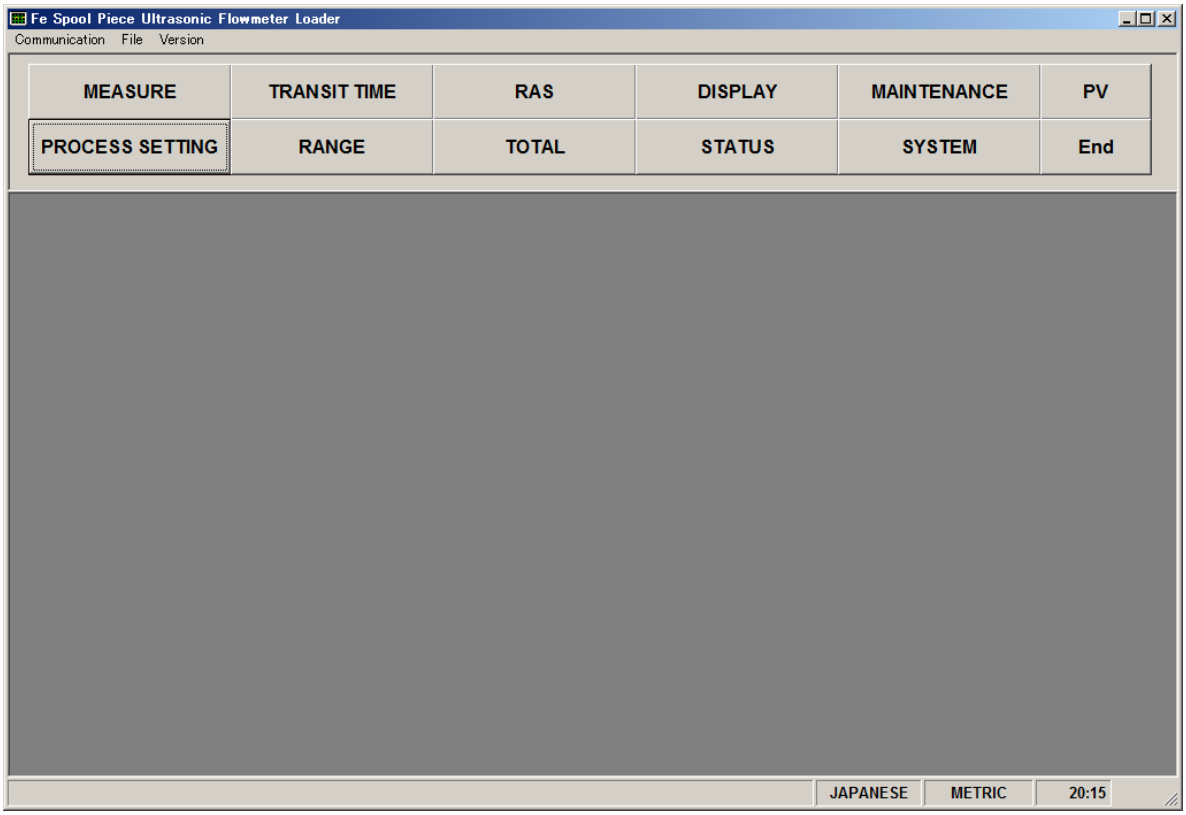


Fig. 8-8 Menu screen

Note: If you disconnect the communication cable and then connecte it again, restart the loader software.

8.5.1 Communication Settings

Click “Communication” on the menu bar on the Menu screen, and the following setup screen appears.

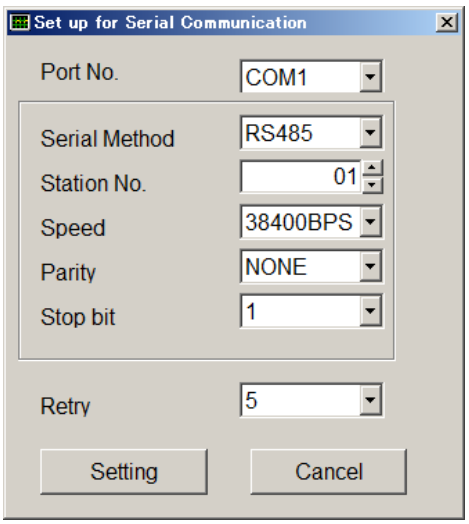


Fig. 8-9 Serial communication setup screen

Edit the contents if necessary, and click [Setting] to save the change. The software communicates with the flow transmitter to obtain the data on language and unit. Click [Cancel] to invalidate the setting.

Table 8-1 Communication Settings

Item	Setting range
Port No.	COM1, COM2, COM3, COM4, COM5
Serial Method	RS485
Station No.	01 to 31
Speed	9600BPS, 19200BPS, 38400BPS
Parity	NONE, EVEN, ODD
Stop Bit	1-bit or 2-bit
Retry	0 to 5

8.5.2 Saving and Reading the Setting

Click the “File” menu on the menu bar, and select “Save setting” or “Read setting”.

8.5.2.1. Saving the setting

Click “Save Setting”, and the following screen appears. Specify the location and file name, and click [Save]. Click the [Cancel] button not to save the setting. File format is ini.

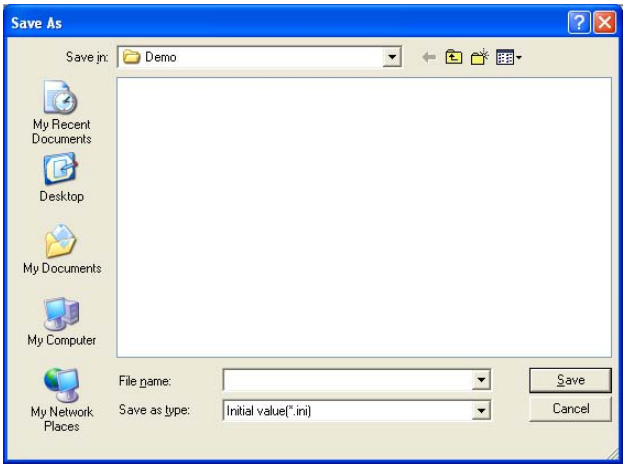


Fig. 8-10 Save setting: save as screen

* Note: Do not rewrite the initial setting file (USF.ini).

8.5.2.2. Reading the setting

Click “Read Setting”, and the following screen appears. Select the location and the file, and click [Open]. Click the [Cancel] button not to read the setting. File format is ini.

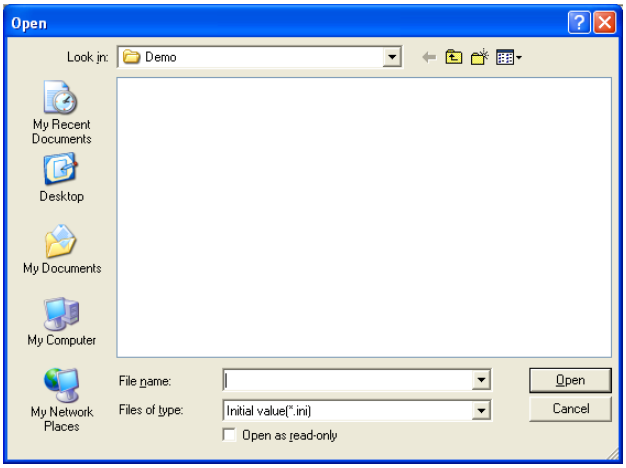


Fig. 8-11 Read setting: Open screen

8.5.3 Version

Click the “Version” menu on the menu bar, and the following screen appears.

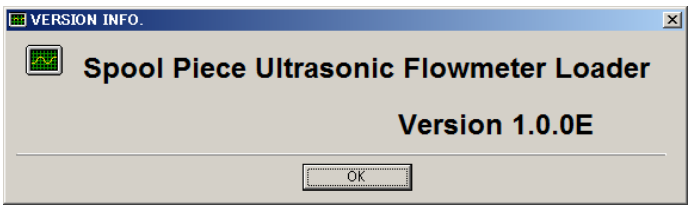


Fig. 8-12 Version screen

* The version number in Fig. 8-13 is an example.

Click [OK] to close the screen.

8.6 Function

The parameter loader software allows you to configure the follwing items.

Table 8-2 Function

Function	Outline
PROCESS	Sets piping specifications, sensor type, etc.
RANGE	Sets range-related matters.
TOTAL	Sets total-related matters.
STATUS	Sets status output-related matters.
DISPLAY	Sets LCD display-related matters.
SYSTEM	Sets system related to language, etc.
MEASURE	Displays trend of flow rate, etc.
TRANSIT TIME	Displays graphs on detailed setting of transit time difference, operation information and received waveform, etc.
RAS	Read-in RAS.
MAINTENANCE	Conducts AO adjustment and AO/DO test.
PV	Measures station No. 1 to No. 31. Available only when RS485 communication.

8.7 Process Setting

Click the “PROCESS SETTING” button on the Menu screen, and the following screen appears.

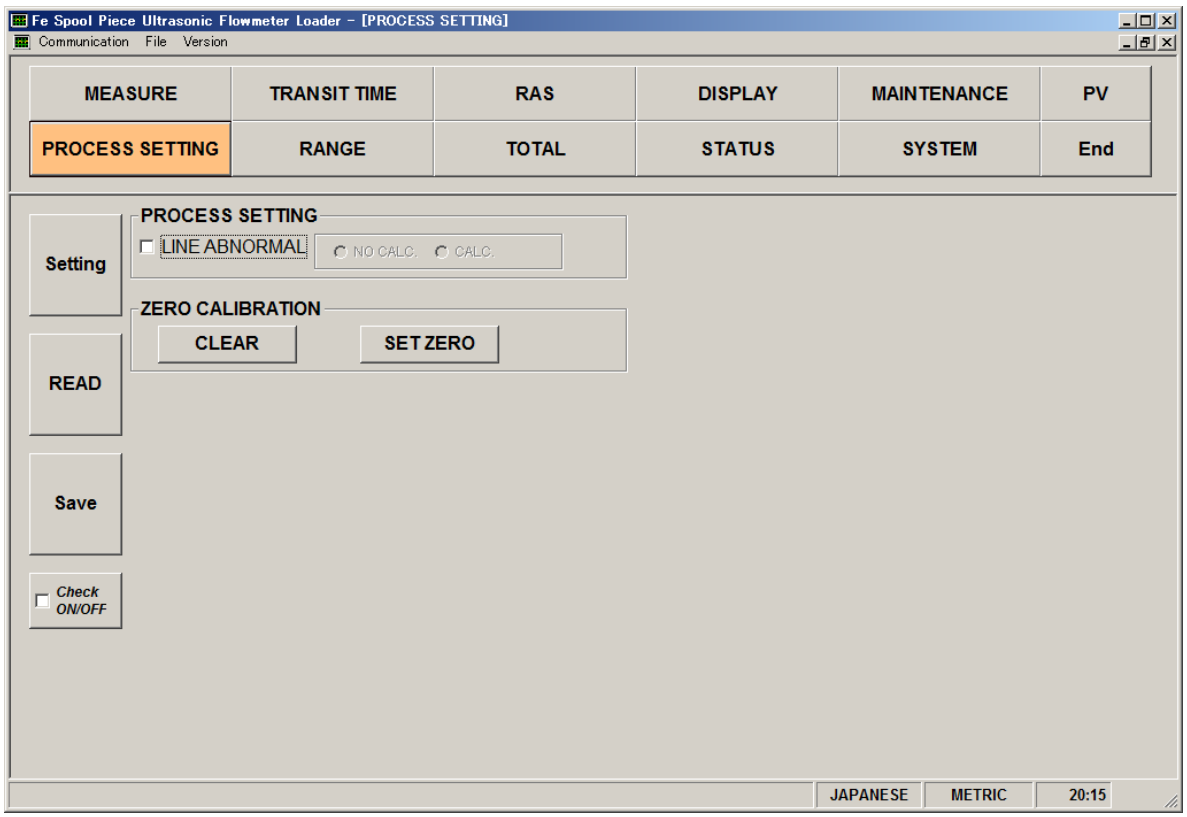


Fig. 8-13 Process setting screen

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐).

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

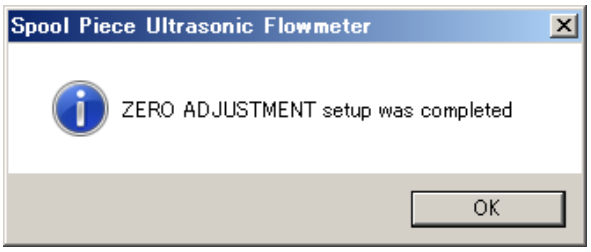
[Check ON/OFF]..... You can select all the items by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

ZERO CALIBRATION

[CLEAR]..... Resets the zero point to the factory setting.

[SET ZERO].....Starts zero calibration. When the calibration has completed, either of the following dialog box appears to tell you if the calibration was completed successfully or failed.

When the zero point is calibrated successfully: “ZERO ADJUSTMENT setup was completed”
When the zero calibration failed: “ZERO ADJUSTMENT setup was not completed”



<Calibration completed >

<Calibration failed>

Table 8-3 Process Setting

Item	Setting range
PATH ABNORMAL	Calculation ON, calculation OFF

8.8 Range Setting

Click the “RANGE” button on the Menu screen, and the following screen appears.

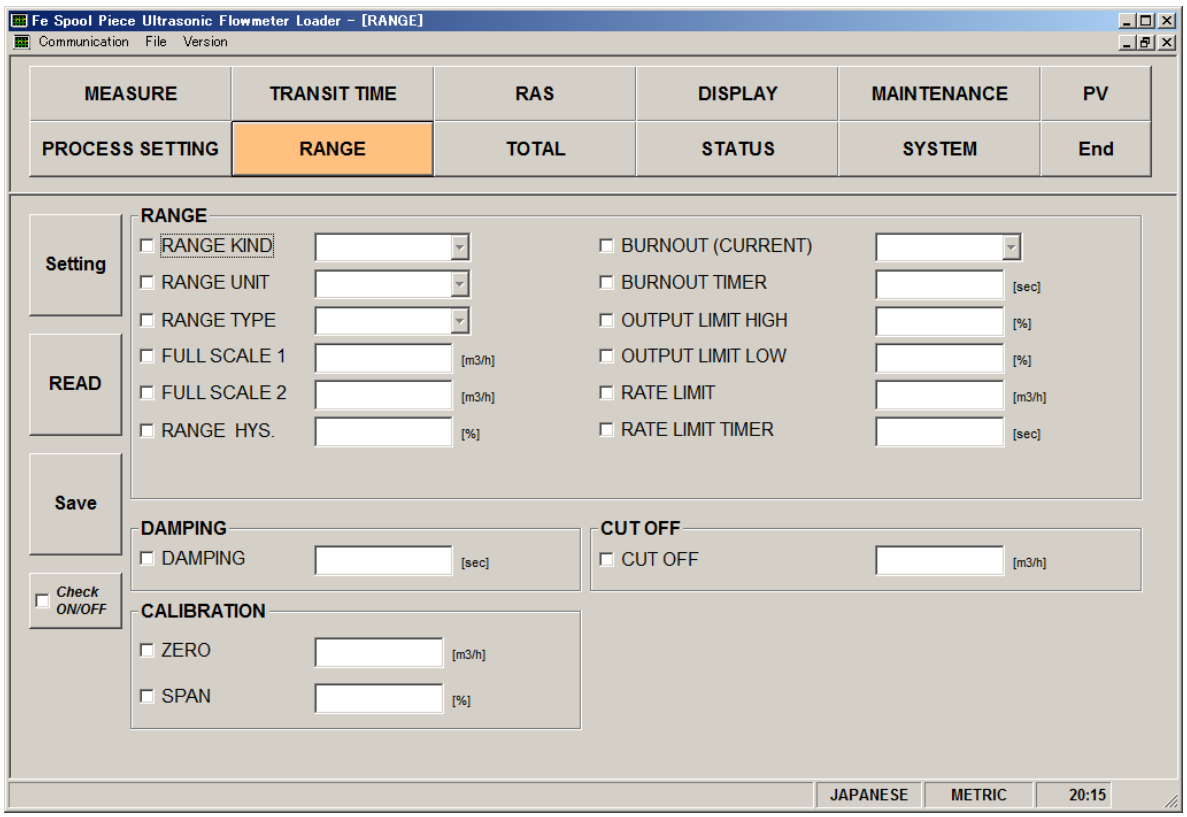


Fig. 8-14 Range setting screen

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐).

When the RANGE TYPE is set to “Single”, FULL SCALE 2 and RANGE HISTERESIS are not available to be set.

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

[Check ON/OFF]..... You can select all the items by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

Table 8-4 Range Setting

Item		Setting range
KIND OF RANGE		Velocity, Flow rate
RANGE UNIT	metric	L/s, L/min, L/h, L/d, kL/d, ML/d, m^3/s, m^3/min, m^3/h, m^3/d, k $m^3$3/d, M m^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d
	inch	ft3/s, ft3/min, ft3/h, ft3/d, kft/d, Mft3/d, gal/s, gal/min, gal/h, gal/d, kgal/d, Mgal/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d
RANGE TYPE		SINGLE, AUTO 2, BI-DIR, BI-DIR AUTO 2
FULL SCALE 1		0, ±0.3 to 10 m/s (comply with range unit)
FULL SCALE 2		0, ±0.3 to 10 m/s (comply with range unit)
HYSTERISIS		0.00 to 20.00% (2 decimal places)
OUTPUT LIMIT LOW		-20 to 0%
OUTPUT LIMIT HIGH		100 to 120%
OUTPUT BURNOUT		NOT USED, HOLD, UPPER, LOWER, ZERO
BURNOUT TIMER		10 to 900 sec.
RATE LIMIT		0 to 5 m/s (comply with range unit)
RATE LIMIT TIMER		0 to 900 sec.

Table 8-5 Damping

Item	Setting range
DAMPING	0.0 to 100.0 sec. (1 decimal place)

Table 8-6 Low Flow Rate Cut

Item	Setting range
CUT OFF	0 to 5 m/s (comply with range unit)

Table 8-7 Output Correction

Item	Setting range
ZERO	–5 to 5 m/s (comply with range unit)
SPAN	±200.00% (2 decimal places)

8.9 Total Setting

Click the “TOTAL” button on the Menu screen, and the following screen appears.

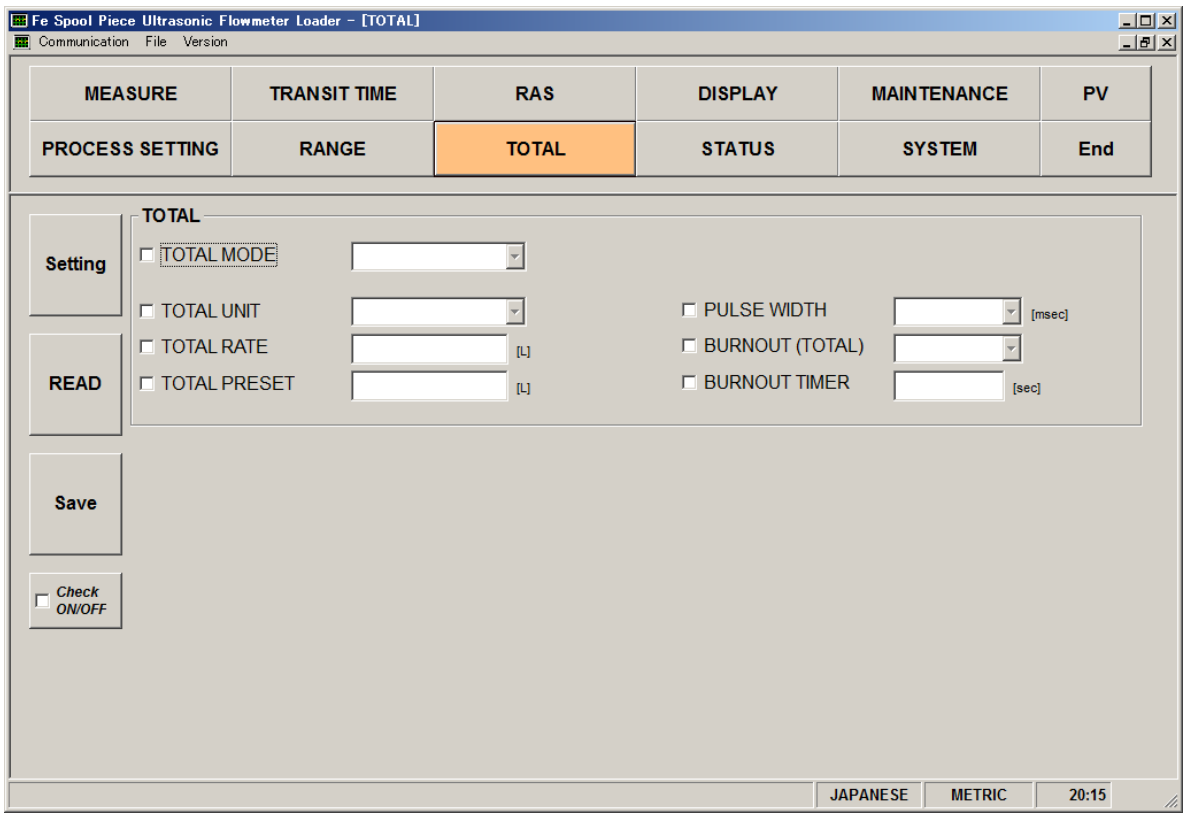


Fig. 8-15 < Total setting screen >

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐).

- When the TOTAL MODE is set to “start” or “reset”, items available to be set are:
  BURNOUT(TOTAL), BURNOUT TIMER
- When the TOTAL MODE is set to “stop”, items available to be set are:
  TOTAL UNIT, TOTAL RATE, TOTAL PRESET, PULSE WIDTH

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

[Check ON/OFF]..... You can select all the items by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

Table 8-8 Total Setting

Item		Setting range
TOTAL MODE		START, STOP, TOTAL RESET
TOTAL UNIT	Metric	mL, L, m^3, km^3, Mm^3, mBBL, BBL, kBBL,
	Inch	ft3, kft3, Mft3, kgal, gal, mBBL, BBL, kBBL, ACRf
TOTAL RATE		0 to 99999999 (comply with total unit)
TOTAL PRESET		0 to 99999999 (comply with total unit)
PLUSE WIDTH		5.0, 10.0, 50.0, 100.0, 200.0, 500.0, 1000.0 msec
OUTPUT BURNOUT		NOT USED, HOLD
BURNOUT TIMER		0 to 900 sec.

Note: The change in TOTAL UNIT will be applied to TOTAL RATE and TOTAL PRESET when you click the [Read] button.

Note: You need to set TOTAL MODE to stop before changing TOTAL UNIT, TOTAL RATE, TOTAL PRESET, and PULSE WIDTH.

8.10 Status Output Setting

Click the “STATUS” button on the Menu screen, and the following screen appears.

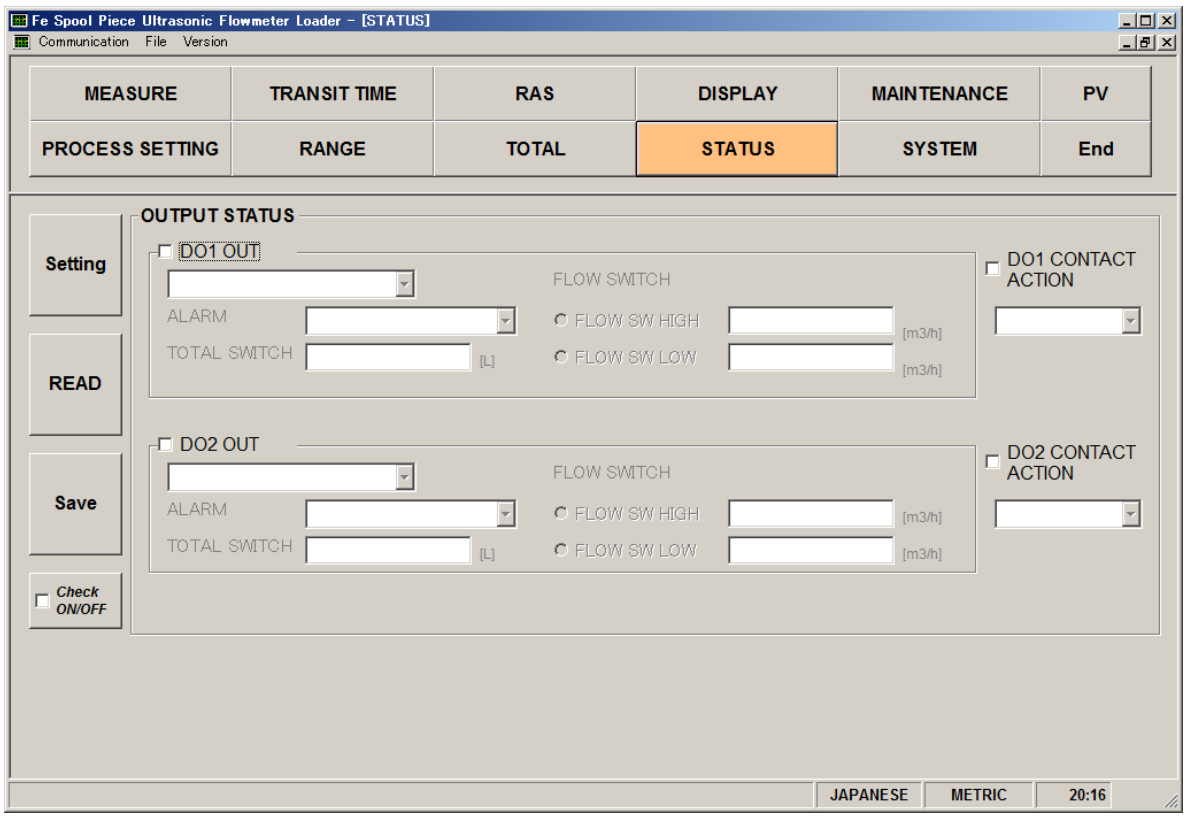


Fig. 8-16 Status output setting screen

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐).

Items available to be set vary according to DO1 OUT and DO2 OUT.

- DO1, DO2 output: Items other than alarm, flow rate switch, and total switch
  Display invalid..... Alarm, flow rate switch (Flow switch High/Flow switch Low), total switch
- DO1, DO2 output: Alarm
  Display valid..... Alarm
  Display invalid..... Flow rate switch（Flow switch High/Flow switch Low）, total switch
- DO1, DO2 output: Flow rate switch
  Display valid..... Flow rate switch（Flow switch High/Flow switch Low）
  Display invalid..... Alarm, total switch
- DO1, DO2 output: Total switch
  Display valid..... Total switch
  Display invalid..... Alarm, flow rate switch (Flow switch High/Flow switch Low)

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

[Check ON/OFF].....You can select all the items by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

Table 8-9 Status output setting

Item		Setting range
DO1 OUT		Not used, + Total pulse, – Total pulse, Full scale 2, Alarm, Flow switch, Total switch, AO range over, Pulse range over, – Flow direction.
	Alarm	All, Hardware error, Process error (when alarm is selected for DO1 output).
	Flow rate switch	Flow switch High, Flow switch Low (when flow rate switch is selected for DO1 output).
	Flow switch High	0 to 10 m/s or equivalent (Use the same unit as the range unit.)
	Flow switch Low	0 to 10 m/s or equivalent (Use the same unit as the range unit.)
	Total switch	0 to 99999999 (Use the same unit as the total unit.)
DO2 OUT		Not use, + Total pulse, – Total pulse, Full scale 2, Alarm, Flow switch, Total switch, AO range over, Pulse range over, and – Flow direction.
	Alarm	All, Hardware error, Process error (when alarm is selected for DO2 output).
	Flow rate switch	Flow switch High, Flow switch Low (when flow rate switch is selected for DO2 output).
	Flow switch High	0 to 10 m/s or equivalent (Use the same unit as the range unit.)
	Flow switch Low	0 to 10 m/s or equivalent (Use the same unit as the range unit.)
	Total switch	0 to 99999999 (Use the same unit as the total unit.)
DO1 contact operation		Active ON (normally off), Active OFF (normally on)
DO2 contact operation		Ditto

8.11 Display Setting

Click the “DISPLAY” button on the Menu screen, and the following screen appears.

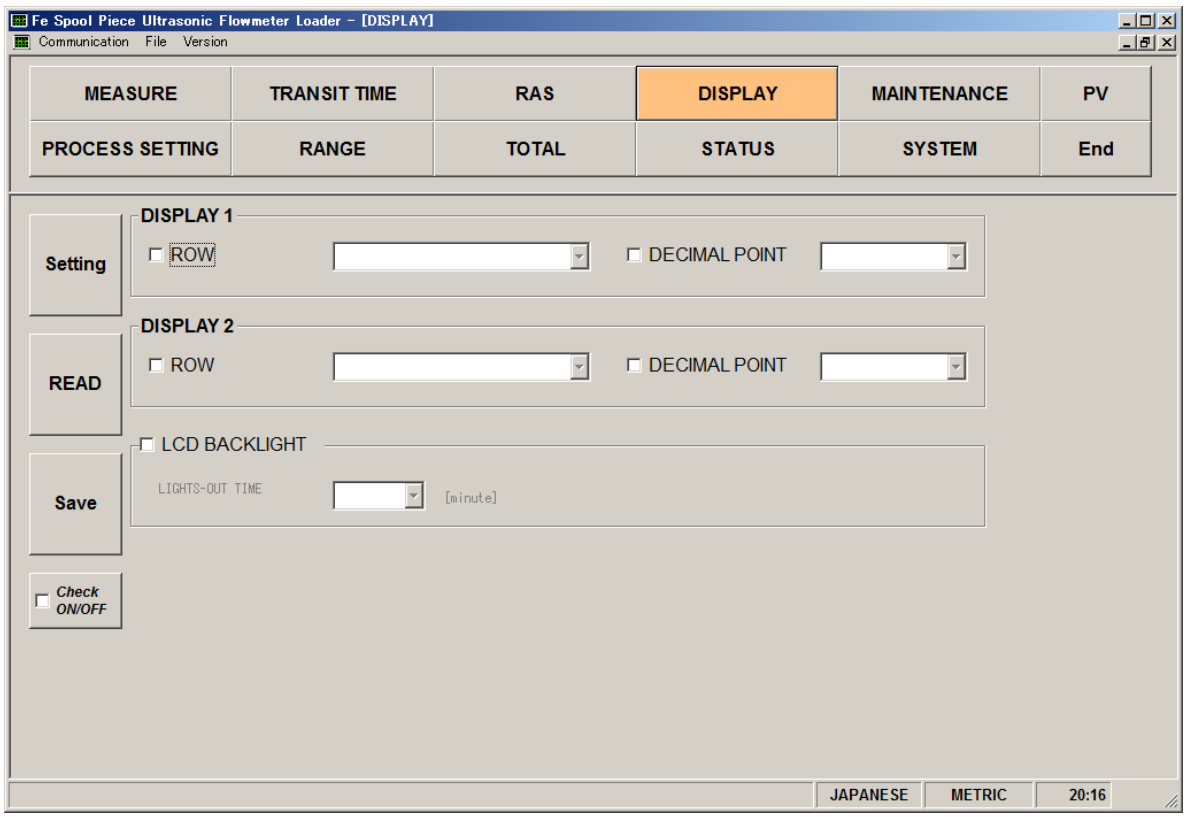


Fig. 8-17 Display setting screen

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐).

When the Display is set to VELOCITY, +TOTAL PULSE, or –TOTAL PALSE, DECIMAL POINT setting is unavailable.

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

[Check ON/OFF]..... You can select all the items by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

Table 8-10 Display Setting

Item		Setting range
DISPLAY 1		VELOCITY, FLOW RATE, +TOTAL (ACTUAL), –TOTAL (ACTUAL), +TOTAL PULSE, –TOTAL PULSE
	Decimal Point Position	0: *.******, 1: **.*****, 2: ***.****,3: ****.***, 4: *****.**, 5: ******.*, 6: ********.
DISPLAY 2		Same as the selection of DISPLAY 1
	Decimal Point Position	Same as the decimal point position of DISPLAY 1
LCD BACKLIGHT	Light off tine	0 to 99 min

8.12 System Setting

Click the “SYSTEM” button on the Menu screen, and the following screen appears.

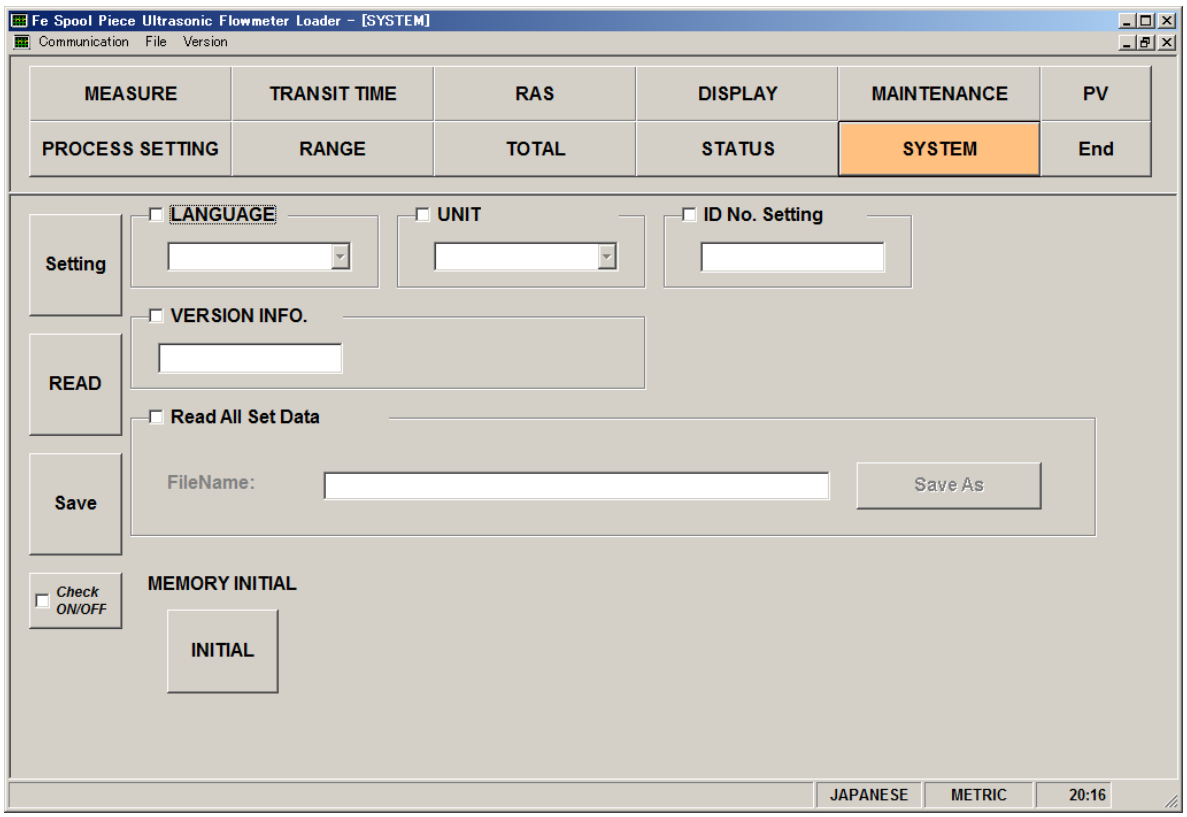


Fig. 8-18 System setting screen

To select an item to be set or read, set the relevant check box to ON (☑). Not to select (or to reset the selection), set the relevant check box to OFF (☐). Note that the version info (version number) is read-only.

[Setting]..... Sends the entered value of the checked item to the flowmeter, and reflects the response value on the setting.

[READ] ..... Reads the setting of the checked item, and reflects the response value on the setting.

[Save] ..... The values set by the [Setting] button are saved in the flowmeter. Be sure to click [Save] after you change the setting.

[Check ON/OFF]..... You can select all the items, except for Read All Set Data, by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

[INITIAL] ..... Returns all the settings of the flowmeter to the factory default values.

Table 8-11 System Setting

Item	Description
LANGUAGE	ENGLISH, JAPANESE, GERMAN, FRENCH, SPANISH
UNIT SYSTEM	METRIC, INCH
ID No. Setting	0000 to 9999
Version information	(Read only)
Read All Set Data	Saves all the settings of the flowmeter with the specified file name in CSV format.

8.13 Data Loading

Click the “MEASURE” button on the Menu screen, and the following screen appears.

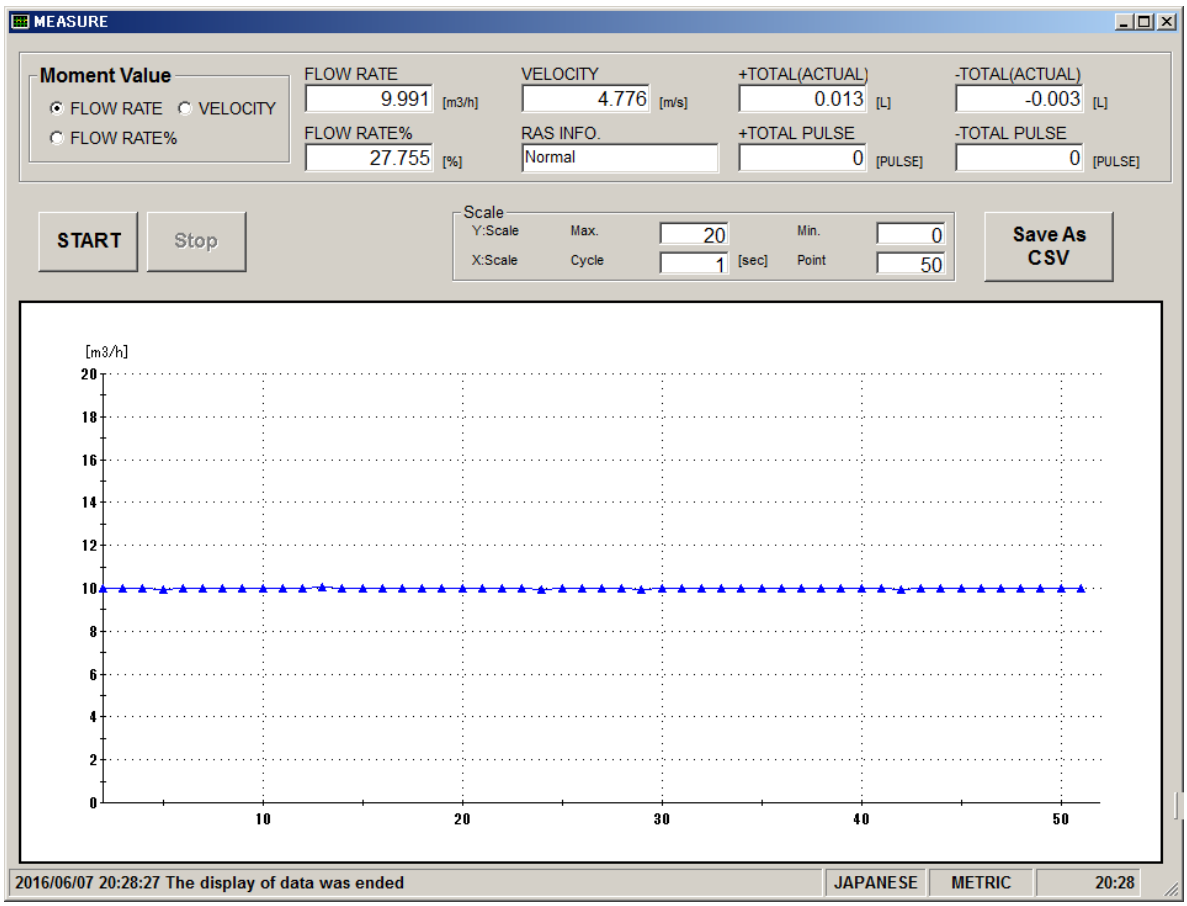


Fig. 8-19 Measure screen

Select the type of instantaneous value you want to get among Flow rate, Flow rate%, and velocity, and click the [START] button. The software obtains data from the flowmeter at specified cycle, and updates the indications of FLOW RATE, FLOW RATE%, VELOCITY, RAS, +TOTAL, +TOTAL PULSE, –TOTAL, and -TOTAL PULSE. The result is also displayed in trend chart, in which the X-axis shows the time and Y-axis shows the measured value with the scale you defined.

[Start].....Starts data loading. If you click the [Save as CSV] button, [Start] button will be enabled again after you finish setting the save location and the file name.

[Stop].....Stops data loading.

[Save as CSV] .....When you click this button, you will be asked to enter the file name and the save location. When the setting of saving file is completed, a CSV file is created and the [Start] button will be enabled.

If the number of data in the saving file exceeds 32000 line, new file will be created separately. Check that hard disc has enough space to save the data. The new file will be named with year, month, date, hour, minute, and second of the file created (YYYYMMDDHHMMSS).

Table 8-12 Measurement/Detailed Setting

Item		Description
Instantaneous value		Flow rate, Flow rate %, Velocity
Flow rate		Read only
Flow rate %		Read only
Velocity		Read only
RAS		Read only
+Total		Read only
–Total		Read only
Scale	Y scale	Enter the maximum and minimum values.
	X scale	Enter the cycle (1–3600) and number of points.

8.14 Transit Time Difference Measurement

Click the [TRANSIT TIME] button on the Menu screen.

8.14.1 Received Signal

Click “RECEIVED SIGNAL”, and the following screen appears.

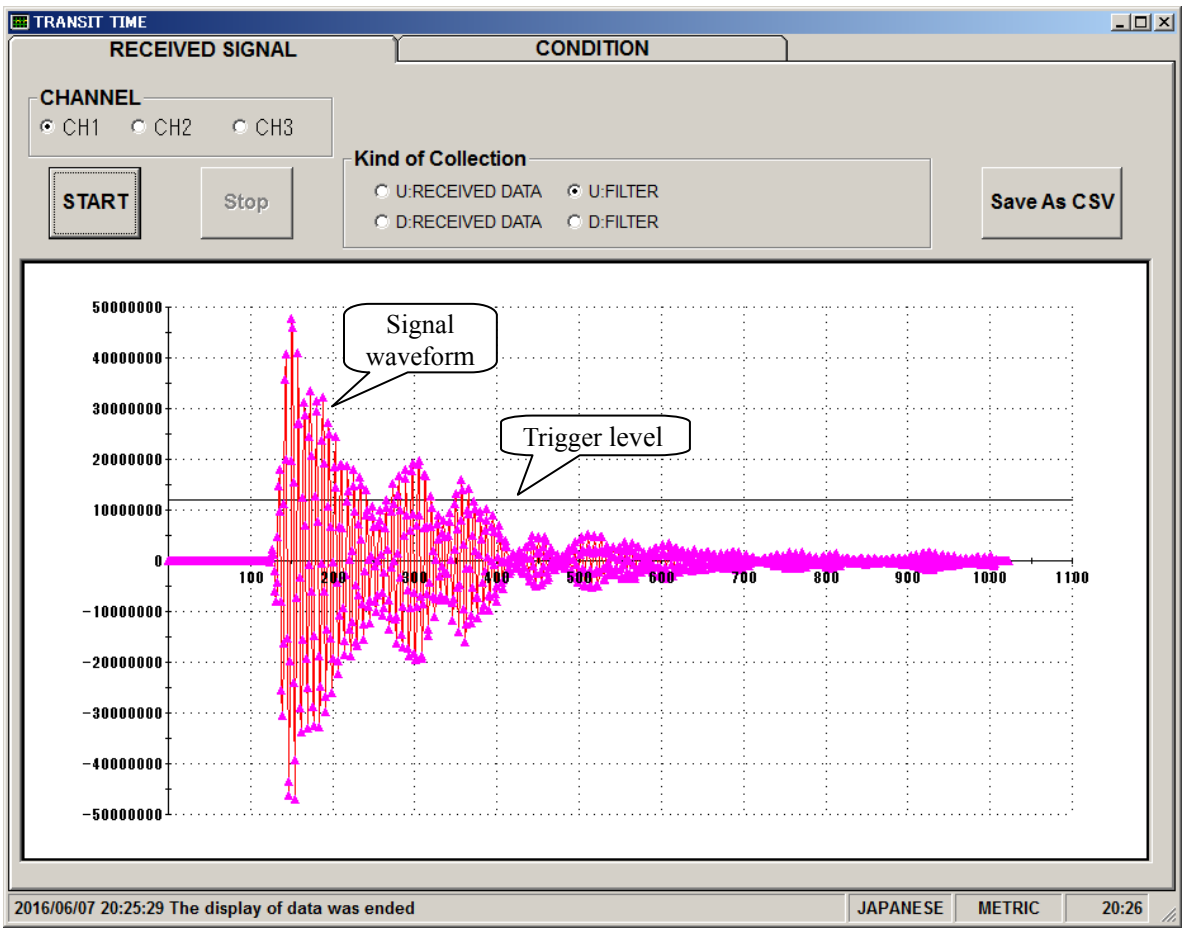


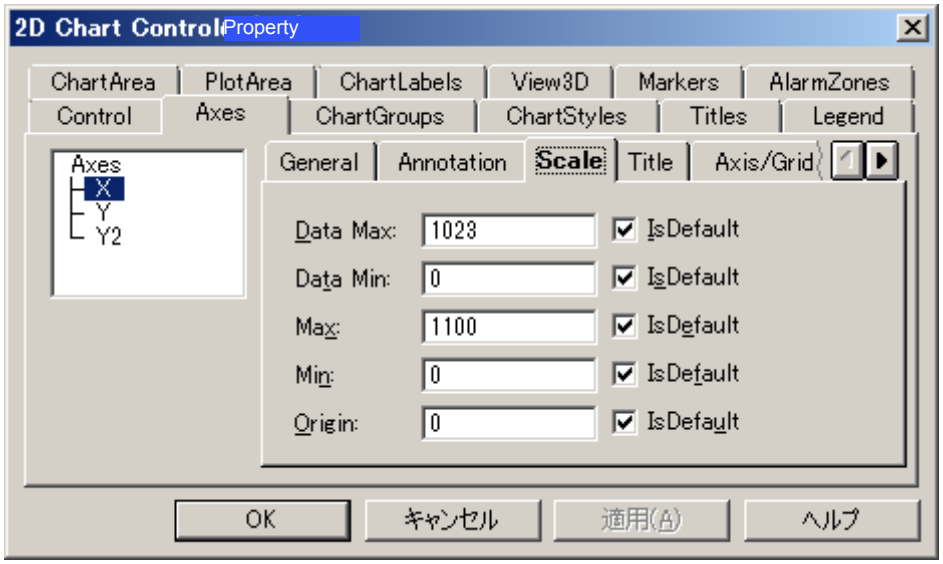
Fig. 8-20 Received signal screen

Select a channel and the kind of collection, and the waveform and the trigger level will be displayed.
Left-click the mouse while pressing the shift key to specify the screen range, and the selected range is magnified. Press the R key to return to original status.

[Start].....Starts reading.
[Stop].....Stops reading.
[Save As CSV].....Saves the measurement result in a file in CSV format. When you click this button, you will be asked to enter the file name and the save location. When the setting of saving file is completed, a CSV file is created.

Point

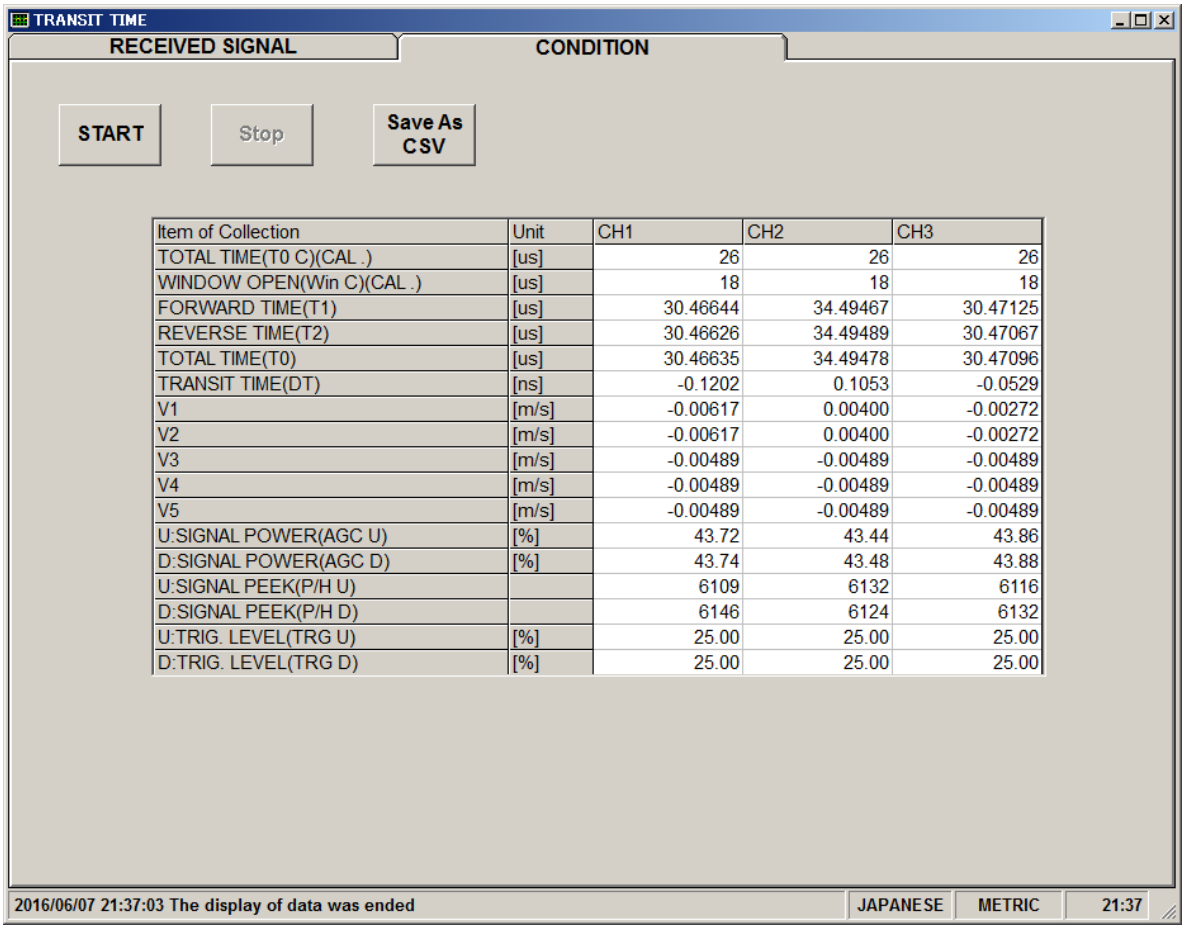
1. The waveform startup should be within 3 to 6 waves.
2. There should be no peak (amplitude) fluctuation observed. If there is fluctuation, air bubbles may exist in the fluid.



* Right-click on the [Measurement] or [Receive waveform] screen, and scale can be adjusted.

8.14.2 Measurement Data

Click “CONDITION”, and the following screen appears.



Item of Collection	Unit	CH1	CH2	CH3
TOTAL TIME(T0 C)(CAL .)	[us]	26	26	26
WINDOW OPEN(Win C)(CAL .)	[us]	18	18	18
FORWARD TIME(T1)	[us]	30.46644	34.49467	30.47125
REVERSE TIME(T2)	[us]	30.46626	34.49489	30.47067
TOTAL TIME(T0)	[us]	30.46635	34.49478	30.47096
TRANSIT TIME(DT)	[ns]	-0.1202	0.1053	-0.0529
V1	[m/s]	-0.00617	0.00400	-0.00272
V2	[m/s]	-0.00617	0.00400	-0.00272
V3	[m/s]	-0.00489	-0.00489	-0.00489
V4	[m/s]	-0.00489	-0.00489	-0.00489
V5	[m/s]	-0.00489	-0.00489	-0.00489
U:SIGNAL POWER(AGC U)	[%]	43.72	43.44	43.86
D:SIGNAL POWER(AGC D)	[%]	43.74	43.48	43.88
U:SIGNAL PEEK(P/H U)		6109	6132	6116
D:SIGNAL PEEK(P/H D)		6146	6124	6132
U:TRIG. LEVEL(TRG U)	[%]	25.00	25.00	25.00
D:TRIG. LEVEL(TRG D)	[%]	25.00	25.00	25.00

Fig. 8-21 Operation Information screen

[START] .....Reads the measurement data of CH1, CH2, and CH3 in a batch.

[Save As CSV].....Saves the measurement result in a file in CSV format. When you click this button, you will be asked to enter the file name and the save location. When the setting of saving file is completed, a CSV file is created.

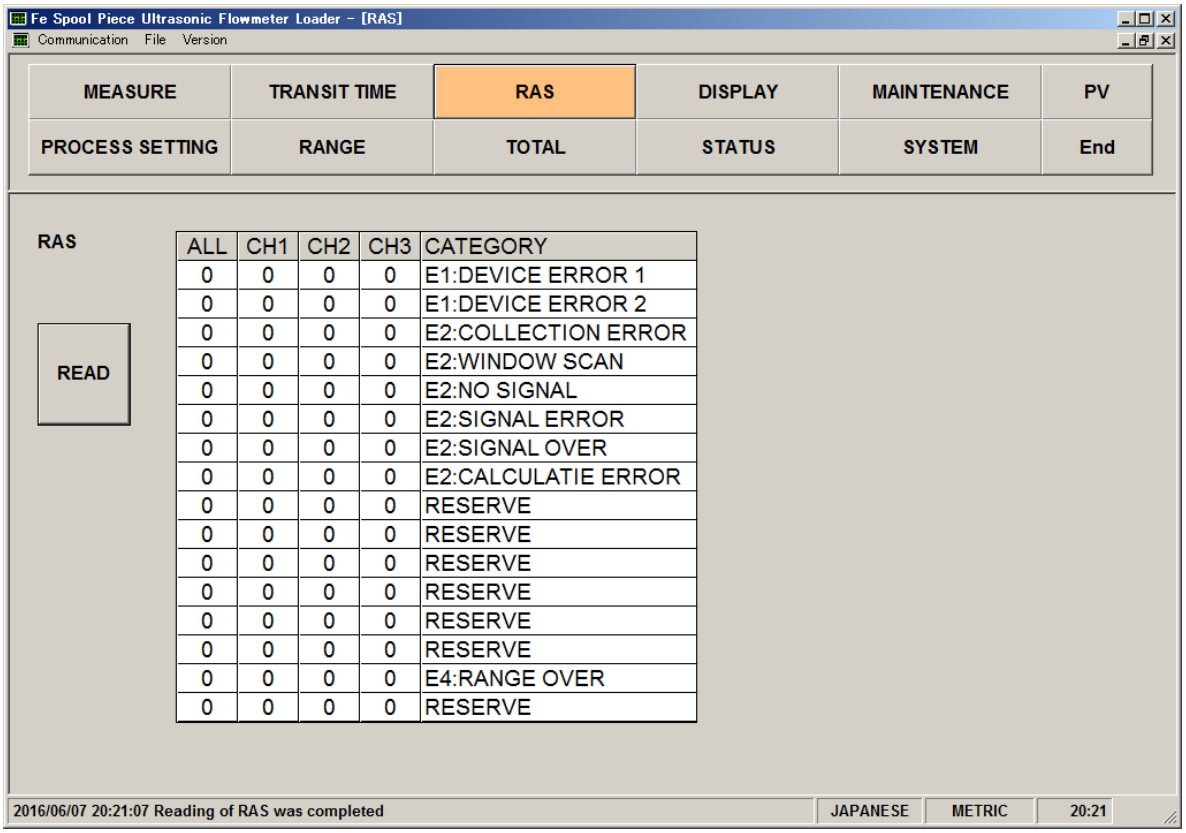
Table 8-13 Operation Information

Item	
TOTAL TIME (T0 C)	μs
WINDOW OPEN (Win C)	μs
FORWARD FLOW TRANSIT TIME (T1)	μs
REVERSE FLOW TRANSIT TIME (T2)	μs
AVERAGE TRANSIT TIME (T0)	μs
TRANSIT TIME DIFFERENCE (DT)	μs
V1	m/s [ft/s]
V2	m/s [ft/s]
V3	m/s [ft/s]
V4	m/s [ft/s]
V5	m/s [ft/s]
U: SIGNAL POWER (AGC U)	% * When measurement is normal: 20% or higher
D: SIGNAL POWER (AGC D)	% * When measurement is normal: 20% or higher
U: SIGNAL PEEK (P/H U)	* When measurement is normal: Stabilizes within the range from 5528 to 6758.
D: SIGNAL PEEK (P/H D)	* When measurement is normal: Stabilizes within the range from 5528 to 6758.
U: TRIG. LEVEL (TRG U)	%
D: TRIG. LEVEL (TRG D)	%

For more details, see “Diagnostic Data” in “5.3 Troubleshooting” of the separate instruction manual, “SPOOL PIECE ULTRASONIC FLOWMETER” INF-TN1FST-E.

8.15 RAS

Click the [RAS] button on the menu screen to display the RAS screen shown below.



ALL	CH1	CH2	CH3	CATEGORY
0	0	0	0	E1:DEVICE ERROR 1
0	0	0	0	E1:DEVICE ERROR 2
0	0	0	0	E2:COLLECTION ERROR
0	0	0	0	E2:WINDOW SCAN
0	0	0	0	E2:NO SIGNAL
0	0	0	0	E2:SIGNAL ERROR
0	0	0	0	E2:SIGNAL OVER
0	0	0	0	E2:CALCULATIE ERROR
0	0	0	0	RESERVE
0	0	0	0	RESERVE
0	0	0	0	RESERVE
0	0	0	0	RESERVE
0	0	0	0	RESERVE
0	0	0	0	RESERVE
0	0	0	0	E4:RANGE OVER
0	0	0	0	RESERVE

Fig. 8-22 < RAS screen >

[READ] button ..... Displays RAS information (0 or 1 for 16 items).

8.16 Maintenance

Click the “MAINTENANCE” button on the Menu screen, and the following screen appears.

Note: When you click [Setting] or [READ] on this screen, the flowmeter goes into the Maintenance mode. Do not forget to click the [TEST Cancel] button after you finish maintenance.

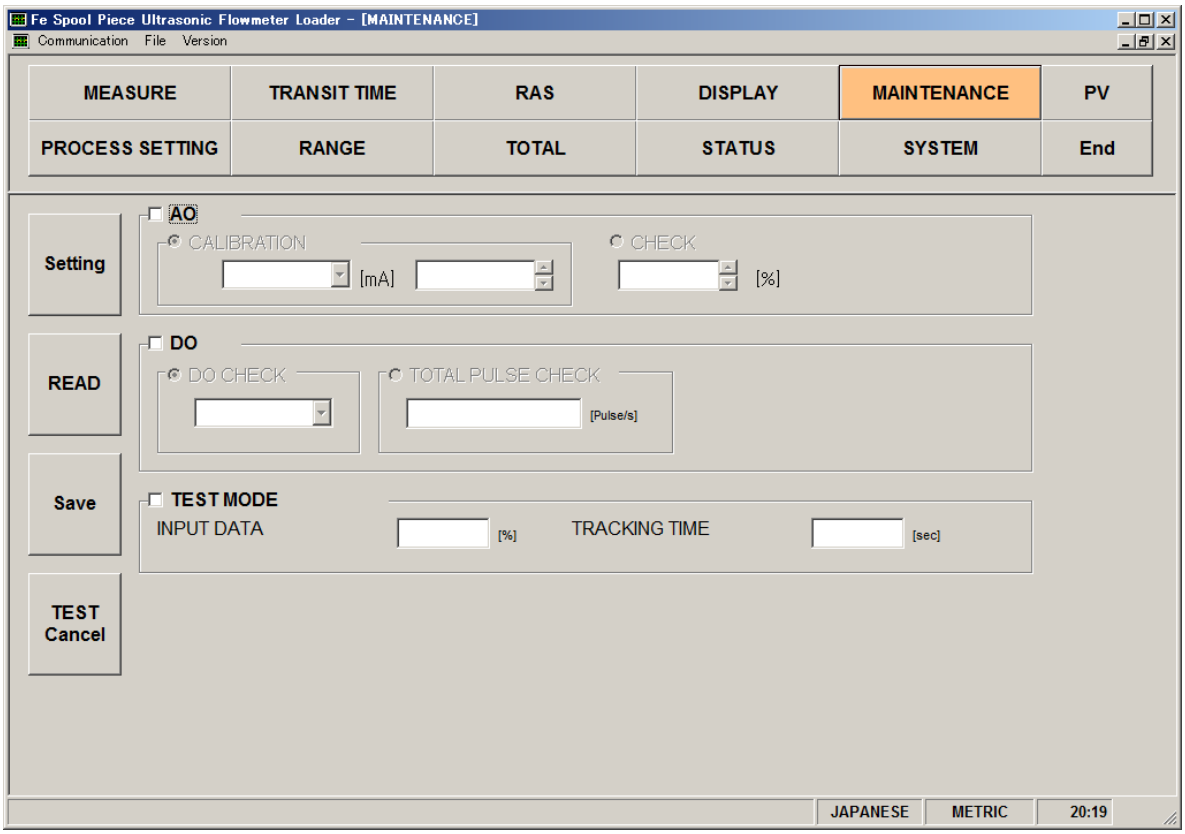


Fig. 8-23 Maintenance screen

Click the check box (☑) of the items you want to perform.

[Setting] button.....Sends the setting of the selected items (☑) and reflects the response value to the setting.
[READ] button .....Read the setting of the selected items (☑) and reflects the response value to the setting.
[Save] button .....The values set by the [Setting] button are saved in the flowmeter. Note that AO check, DO check, total pulse check, test mode, input data, and tracking time are not saved. Be sure to click the [Save] button if AO is adjusted.
[TEST Cancel].....Cancels the AO, DO, and Test mode.
* Be sure to press the [TEST Cancel] button when maintenance is completed.

Table 8-14 Maintenance/setting

Item	Content
AO adjustment	When 4mA is selected, without decimal point, Enter in the range from 50 to 7148. When 20mA is selected, without decimal point, Enter in the range from 7148 to 15950.
AO check	Without decimal point, Enter in the range from -20 to 120%.
DO check	Select ON or OFF.
DO total pulse check	Without decimal point, Enter in the range from 1 to 100 Pulse/s.
Test mode	Click the check box (☑) to enter the test mode. The test mode is cancelled even if either input data or tracking time is entered but the check box is blank (☐).
Input data	Without decimal point, Enter in the ±120% range.
Tracking time	Without decimal point, Enter in the range from 0 to 900 sec.

8.17 PV

Click the [PV] button on the menu screen to display the PV screen (for RS-485 communication system only).

⚠ CAUTION

- Do not start or operate other applications while data loading. Otherwise, data loading may fail.

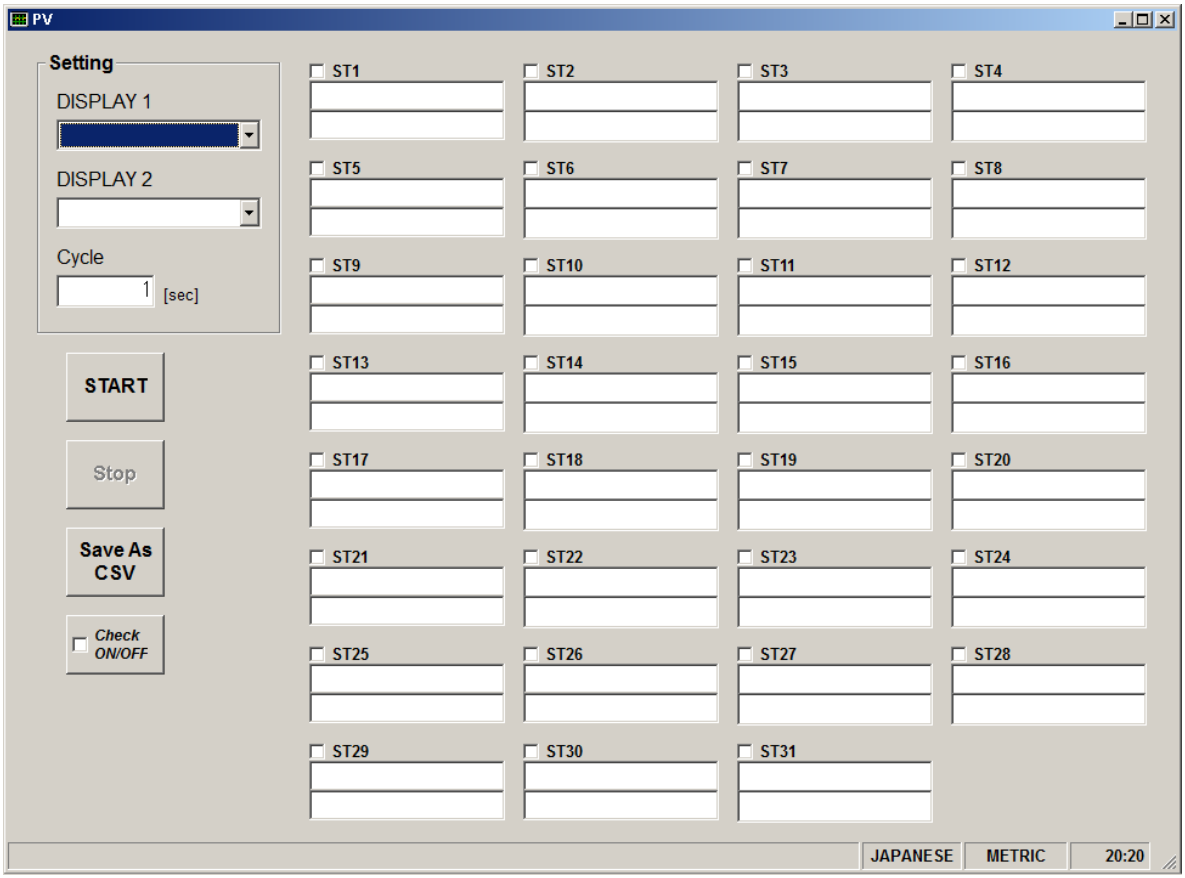


Fig. 8-24 PV screen

Click the check box of the station from which you want to take data.

The number of measurable units = Cycle (sec) / 0.5 sec

[START].....Starts loading data from the selected device (☑). If you click the [Save as CSV] button, [Start] button will be enabled again after you finish setting the save location and the file name.

[Stop].....Stops the data loading.

[Save as CSV] ....When you click this button, you will be asked to enter the file name and the save location. When the setting of saving file is completed, a CSV file is created and the [Start] button will be enabled.

If the number of data in the saving file exceeds 32000 line, new file will be created separately. Check that hard disc has enough space to save the data. The new file will be named with year, month, date, hour, minute, and second of the file created (YYYYMMDDHHMMSS).

[Check ON/OFF] .....You can select all the items, except for Read All Set Data, by checking the box (☑), or cancel the selection of all the items by clearing the box (☐).

Table 8-15 PV Setting

Item	Setting range
DISPLAY 1	VELOCITY, FLOW RATE, +TOTAL (ACTUAL), –TOTAL (ACTUAL), +TOTAL PULSE, –TOTAL PULSE, RAS.
DISPLAY 2	Same as the selection of DISPLAY 1
CYCLE	1 to 60 sec

8.18 End

Click the [End] button on the Menu screen, and the following screen appears.

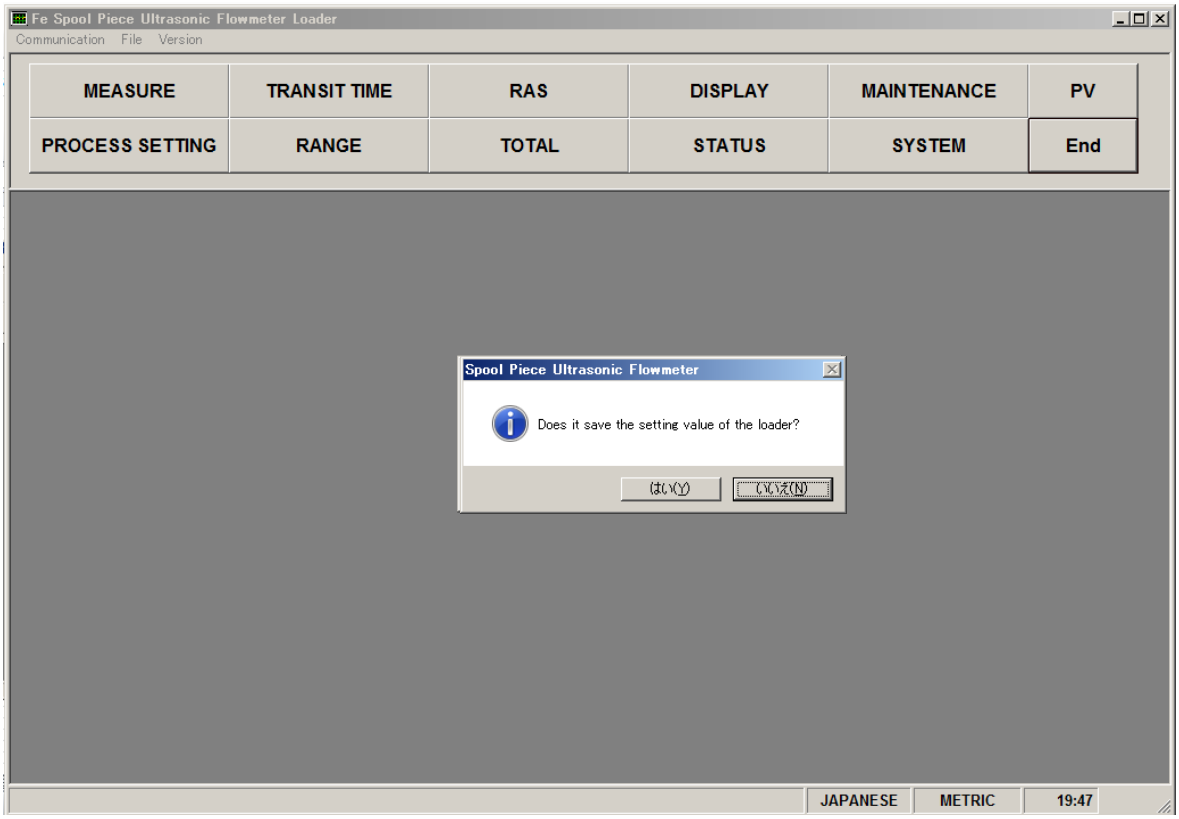


Fig. 8-25 Menu screen

Click either the [End] button or the (☒) button, and a message appears, asking you whether you want to save the loader setting. To save the setting values, select “Yes”, and specify the save location. Then the loader is terminated. If you do not need to save the setting values, select “No”, and the loader is terminated without saving the setting.

8.19 Uninstallation

From the control panel of Windows, select “Addition and Deletion of Application”, and click [Change and Deletion] to uninstall the software.

9. TROUBLESHOOTING

If communication is unavailable, check the following items.

- ☐ Whether all devices related to communication are turned on.
- ☐ Whether connections are correct.
- ☐ Whether the number of connected instruments and connection distance are as specified.
- ☐ Whether communication conditions coincide between the master station (host computer) and slave stations.
  - ☐ Transmission speed: ☐ 9600bps
    ☐ 19200bps
    ☐ 38400bps
  - ☐ Data length: 8 bits
  - ☐ Stop bit: 1 bit
  - ☐ Parity: ☐ odd
    ☐ even
    ☐ none
- ☐ Whether send/receive signal timing conforms to Section 5.6 in this manual.
- ☐ Whether the station No. designated as send destination by the master station coincides with the station No. of the connected FST.
- ☐ Whether more than one instrument connected on the same transmission line shares the same station No.
- ☐ Whether the station No. of instruments is set at other than 0.
  If it is 0, the communication function does not work.
- ☐ Whether the 10th digit of model code of the flowmeter is D.
  (FST□□□□1–□D□□)

Fuji Electric Co., Ltd.

Global Sales Section
Instrumentation & Sensors Planning Dept.
1, Fuji-machi, Hino-city, Tokyo 191-8502, Japan
http://www.fujielectric.com
Phone: +81-42-514-8930 Fax: +81-42-583-8275
http://www.fujielectric.com/products/instruments/