FP93
Program Controller
COMMUNICATION INTERFACE
(RS-232C/RS-485)
INSTRUCTION MANUAL ADDENDUM

【 MODBUS Protocol Version 】

MFP93-E11-A
May 2016

Preface

MODBUS protocol has been newly added for FP93 serial communication interface. [FP93C-1AE]
See the table below for the reference.

Table1.Communication interface instruction manual reference

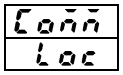
【FP93 communication interface instruction manual】		【this document】
4. Setting of parameters related to communication	⇒	1. Setting of parameters related to communication
5. Outline of standard serial communication protocols	⇒	2. MODBUS protocol overview
6. Communication data addresses list	⇒	3. Communication data addresses list

1. Settings of parameters related to communication

There are 10 types of parameters related to communication for the FP93 Series as follows. The parameters cannot be set or modified by communication; use the keys on the front panel to set or modify the parameters.

1-1. Setting of communication mode

5-35



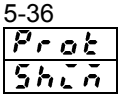
Initial value : Loc
Setting range : Loc, Com

The following selections can be made for communications.
In COM 1 mode, change from LOC to COM by key operation is possible.
When COM 2 mode is selected, change from LOC to COM by key operation is impossible

Selection	Valid command	COM lamp
Loc	Read	Off
Com	Read, write	On

1-2. Setting of communication protocol

5-36

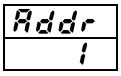


Initial value : shim
Setting range : shim, asc, rtu
Select either one of the communication protocols.

selection	protocol
shim	Shimaden standard protocol
asc	MODBUS ASCII mode
rtu	MODBUS RTU mode

1-3. Setting of communication address

5-37



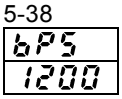
Initial value : 1
Setting range : 1 - 255

In the case of RS-232C, connection between a host computer and FP93 is 1:1, however, in the case of RS-485, because it is a multidrop system, connection up to 1:31 (max.) is possible.
With this system, each machine is provided with an address (machine No.) to distinguish it so only the machine of the specified address can be handled.

Note 1: Address can be set to 1 - 255. Up to 31 machines can be connected.

1-4. Setting of communication speed

5-38

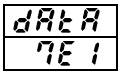


Initial value: 1200 bps
Setting range : 1200, 2400, 4800, 9600, 19200 bps

You can selects/sets communication speed to transmit data to the host.

1-5. Setting of data format

5-39



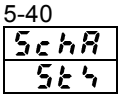
Initial value : 7E1
Setting range : 8 types in the following table

You can select format of communication data from among the following 8 selections.

Selection	Data length	Parity	Stop bits	Shimaden standard	MODBUS/ASCII mode	MODBUS/RTU mode
7E1	7 bits	EVEN	1bit	○	○	—
7E2	7 bits	EVEN	2bit	○	○	—
7N1	7 bits	None	1bit	○	○	—
7N2	7 bits	None	2bit	○	○	—
8E1	8 bits	EVEN	1bit	○	—	○
8E2	8 bits	EVEN	2bit	○	—	○
8N1	8 bits	None	1bit	○	—	○
8N2	8 bits	None	2bit	○	—	○

1-6. Setting of start character

5-40



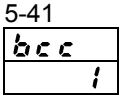
Initial value : STX
Setting range : STX, ATT

You can select the control code to be used. This parameter is valid only when Shimaden standard protocol is used.

Selection	Start character	Text end character	End character
STX	STX(02H)	ETX(03H)	CR(0DH)
ATT	" @ "(40H)	" : "(3AH)	CR(0DH)

1-7. Communication BCC check setting screen

5-41



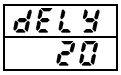
Initial value : 1
Setting range : 1 - 4

You can select a BCC operation method to be used in BCC checking.
This screen shows only for SHIMADEN standard protocol.

Selection	BCC operation
1	Addition
2	Addition +2's complement
3	XOR
4	None

1-8. Setting of delay time

5-42



Initial value : 20
Setting range : 1 -100

You can set minimum delay time from when communication command is received until transmission.

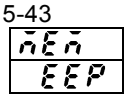
Delay time (msec) = Setting value (count) x 0.512 (msec)

Note 1: In the case of RS-485, it may take a while for 3-state control by line converter and signal collision may occur in some cases. This can be avoided by increasing delay time. Caution is required particularly if communication speed is slow (1200/2400 bps, etc.).

Note 2: Actual delay time from when the communication command is received until transmission is the total of the delay time and time it takes software to process the command. Especially in the case of a write command, it may take about 400 msec to process the command.

1-9. Communication memory mode selecting screen

5-43



Initial value : EEP
Setting range : EEP, Ram, r_E

Because the write cycle of the non-volatile memory (EEPROM) used by the FP93 Series is decided, the life of the EEPROM will be shortened if the SV data is frequently replaced by communications.
In order to prevent this, set to RAM mode when data is to be frequently replaced during communications, so that only RAM data can be replaced rather than replacing the data in the EEPROM, thereby extending the life of the EEPROM.

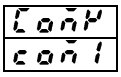
Selection	Processing contents
EEP	Mode whereby EEPROM data is also replaced when data is changed by communications. Consequently data is preserved even if the power is turned off.
RAM	Mode whereby only RAM data is replaced instead of replacing EEPROM data if data is changed by communications. Consequently the data in the RAM is cleared when the power is turned back on, operation boots by the data stored in the EEPROM.
r_E	FIX SV, OUT, STEP SV and START SV data are written in the RAM only and other data is written in the RAM or EEPROM.

* Caution when in communication memory mode "RAM"
If RAM is set for communication memory mode, all of the descriptions which are set by the communication function are only written for RAM.
Therefore, non-matching can result according to the setting description.
Example: if the input range is set to 05: K 0.0-800.0 °C

1. Change event code from higher limit deviation value to higher limit absolute value by using the communication function (this change is written in the RAM).
2. Change the communication mode from COM to LOC.
3. Change the event action point setting from 800.0 to 700.0 by key operation (written to EEPROM as this is the LOC mode.
4. Shut down the power and restart.
5. Event code written in the RAM is cleared and higher limit deviation value is read out from the EPPROM.
6. Event action point setting is set to 700.0 and written in the EEPROM, therefore, 700.0 is read out.
7. The setting range of the higher limit deviation value is originally -1999 – 2000. unit
However, 7000 unit, abnormal value, is set as a value in this case. Therefore, it should be modified to the normal range of value.

1-10. Communication mode type setting

5-44



Initial value : com1
Setting range : com1, com2

Select "Communication mode type" described below.
In COM1 mode, key setting is enabled during parameter-setting by communication.

Communication mode type	COM1		COM2	
Communication mode	COM	LOC	COM	LOC
Parameter setting by key	Yes	Yes	No	Yes
Parameter setting by communication	Yes	Yes	Yes	No

When setting "communication mode type" by communication, see the table below.

Communication mode	LOC	COM
Setting by communication	COM1 ⇒ COM2 Yes	COM1 ⇒ COM2 Yes
	COM2 ⇒ COM1 No	COM2 ⇒ COM1 Yes

2. MODBUS protocol overview

MODBUS protocol includes ASCII and RTU transmission modes.

2-1. Transmission mode overview

(1) ASCII mode

Eight-bit binary data in the command is divided into top and bottom 4 bits and is transmitted as ASCII characters in hexadecimal notation.

■ Data configuration
Data format: Selection of 7E1, 7E2, 7N1 or 7N2
Error check: LRC (horizontal redundancy test)
Data communication interval: Max. 1 sec.

(2) RTU mode

Eight-bit binary data in the command is transmitted as is.

■ Data configuration
Data format: Selection of 8E1, 8E2, 8N1 or 8N2
Error check: CRC-16 (cycle redundancy test)
Data communication interval: 3.5 character transmission time or less

2-2. Message configuration

(1) ASCII mode

Configured to begin with start character [: (colon) (3AH)] and end with end character [CR (carriage return) (0DH)] +[LF (line feed) (0AH)].

Header (:)	Slave address	Function code	Data	Error check LRC	Delimiter (CR)	Delimiter (LF)

(2) RTU mode

Configured to begin after idling over the 3.5 character transmission time and end when idling over the 3.5 character transmission time elapses.

Idle 3.5 character	Slave address	Function code	Data	Error check CRC	Idle 3.5 character

2-3. Slave address

Slave addresses are slave machine numbers 1–255. Individual slaves are distinguished by specifying slave address by request message. The master is informed which slave is responding with the slave setting slave address and returning it for the response message on the slave side.

2-4. Function code

The function code specifies the type of action to the slave.

Function code	Details
03 (03H)	Slave setting value and information read
06 (06H)	Slave write

The function code is also used to show if the response is normal (affirmative response) or what sort of error (negative response) is occurring when the slave returns a response message to the master.

With affirmative response, the original code is set and returned.

With a negative response, the highest bit of the original function code is set to “1” and returned.
If for instance the function code is mistakenly set to 10H and a request message is sent to the slave, because it is a nonexistent function code, the highest bit is set to “1” and returned as 90H.
Also for a negative response, in order to inform the master what sort of error has occurred, an abnormal code is set in the data of the response message and sent.

Abnormal code	Details
1 (01H)	Illegal function (nonexistent function)
2 (02H)	Illegal data address (nonexistent data address)
3 (03H)	Illegal data value (value outside setting range)

2-5. Data

Configuration of data differs according to the function code.
With request messages from master machines, it consists of data items, number of data items and set data.
With response messages from slave machines, it consists of data and number of bytes relative to the request, or abnormal code, etc., for negative response.
The valid range of data is -32768 to 32767.

2-6. Error check

The error check method differs according to transmission mode.

(1) ASCII mode

Error check in the ASCII mode calculates LRC from slave address to final data item; the 8-bit calculated data is converted to 2 ASCII characters and set following the data.

■ LRC calculation method

1. Prepare a message in RTU mode.
2. Add from slave address to final data item and substitute for X.
3. Take the complement of X (bit inverse) and substitute for X.
4. Add 1 to X and substitute for X.
5. Set X as LRC following data.
6. Convert message to ASCII characters.

(2) RTU mode

Error check in the RTU mode calculates CRC-16 from slave address to final data item; the 16-bit calculated data is set in bottom/top order following the data.

■ CRC-16 calculation method

CRC formula divides data to be sent by generating polynomial and the remainder is added to the end of the data and sent.

Generating polynomial: $X^{16}+X^{15}+X^{2}+1$

1. Initialize CRC data (X) (FFFFH)
2. Take the first data item and exclusive OR (XOR) and substitute for X.
3. Shift X 1 bit to the right and substitute for X.
4. If carry is enabled by shifting, take XOR by results X of (3) and fixed value (A001H) and substitute for X.
   If carry is not enabled, proceed to 5.
5. Repeat steps 3 and 4 until shifted 8 times.
6. Take the next data item and XOR of X and substitute for X.
7. Repeat steps 3-5.
8. Repeat steps 3-5 up to the final data item.

X is set as CRC-16 in message following the data in bottom/top order.

2-7. Sample messages

(1) ASCII mode

■ Machine No. 1, SV read

▪ Request message from master machine

Header (:)	Slave address (01H)	Function code (03H)	Data address (0300H)	No. of data items (0001H)	Error check LRC (F8H)	Delimiter (CR・LF)
1	2	2	4	4	2	2 ⟵ No. of characters (17)

▪ Response message from slave when normal (SV = 10.0°C).

Header (:)	Slave address (01H)	Function code (03H)	No. of response bytes (02H)	Data (0064H)	Error check LRC (96H)	Delimiter (CR・LF)
1	2	2	2	4	2	2 ⟵ No. of characters (15)

▪ Response message from slave when abnormal (data item mistaken)

Header (:)	Slave address (01H)	Function code (83H)	Abnormal code (02H)	Error check LRC (7AH)	Delimiter (CR・LF)
1	2	2	2	2	2 ⟵ No. of characters (11)

With response messages when an error occurs, “1” is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, SV = 10.0°C write**

▪ Request message from master machine

Header	Slave address	Function code	Data address	Data	Error check LRC	Delimiter
(:)	(01H)	(06H)	(0300H)	(0064H)	(92H)	(CR・LF)
1	2	2	4	4	2	2

← No. of characters (17)

▪ Response message from slave when normal (SV = 10.0°C).

Header	Slave address	Function code	Data address	Data	Error check LRC	Delimiter
(:)	(01H)	(06H)	(0300H)	(0064H)	(92H)	(CR・LF)
1	2	2	4	4	2	2

← No. of characters (17)

▪ Slave side response message when abnormal (value set outside range)

Header	Slave address	Function code	Abnormal code	Error check LRC	Delimiter
(:)	(01H)	(86H)	(03H)	(76H)	(CR・LF)
1	2	2	2	2	2

← No. of characters (11)

With response messages when an error occurs, "1" is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

(2) RTU mode

■ **Machine No. 1, SV read**

▪ Request message from master machine

Idle 3.5 character	Slave address	Function code	Data address	No. of data items	Error check CRC	Idle 3.5 character
	(01H)	(03H)	(0300H)	(0001H)	(844EH)	
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal (SV = 10.0°C).

Idle 3.5 character	Slave address	Function code	No. of response bytes	Data	Error check CRC	Idle 3.5 character
	(01H)	(03H)	(02H)	(0064H)	(B9AFH)	
	1	1	1	2	2	

← No. of characters (7)

▪ Response message from slave when abnormal (data item mistaken)

Idle 3.5 character	Slave address	Function code	Abnormal code	Error check LRC	Idle 3.5 character
	(01H)	(83H)	(02H)	(C0F1H)	
	1	1	1	2	

← No. of characters (5)

With response messages when an error occurs, "1" is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, SV = 10.0°C setting**

▪ Request message from master machine

Idle 3.5 character	Slave address	Function code	Data address	Data	Error check CRC	Idle 3.5 character
	(01H)	(06H)	(0300H)	(0064H)	(8865H)	
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal (SV = 10.0°C)

Idle 3.5 character	Slave address	Function code	Data address	Data	Error check CRC	Idle 3.5 character
	(01H)	(06H)	(0300H)	(0064H)	(8865H)	
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when abnormal (value set outside range)

Idle 3.5 character	Slave address	Function code	Abnormal code	Error check CRC	Idle 3.5 character
	(01H)	(86H)	(03H)	(0261H)	
	1	1	1	2	

← No. of characters (5)

With response messages when an error occurs, "1" is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

3. Communication data addresses list

In addition to the section 6 “Communication data addresses list” in the “FP93 Communication Interface”instruction Manual. Data address 05B1 (communication mode type) has been newly added.

0581	DI2	DI2 See 7-3 Table of DI types. In the “FP93 Communication Interface” instruction manual	R/W
0582	DI3	DI3 See 7-3 Table of DI types. In the “FP93 Communication Interface” instruction manual	R/W
0583	DI4	DI4 See 7-3 Table of DI types. In the “FP93 Communication Interface” instruction manual.	R/W

05A0	AO1_MD	Analog output mode 0 = PV, 1 = SV, 2 = OUT (option)	R/W
05A1	AO1_L	Analog output scale lower limit value (option)	R/W
05A2	AO1_H	Analog output scale higher limit value (option)	R/W

05B0	COM_MEM	Communication memory mode 0 = EEP, 1 = RAM, 2 = r_E (option)	R/W
05B1	COM_KIND	Communication mode type 0 = COM1,1 = COM2 (option)	R/W

0600	ACTMD	Output characteristic 0 = RA , 1 = DA	R/W
0601	O1_CYC	Control output Proportional cycle	R/W

The contents of this manual are subject to change without notice.

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