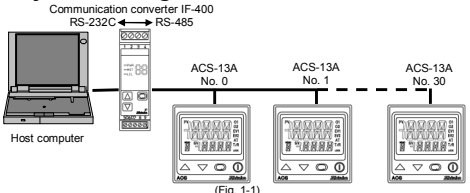
和文は裏面をご覧下さい。

Communication Instruction Manual ACS-13A (C5)

No. ACS11CJE4 2011.04

This manual contains instructions for communication functions. For detailed operating instructions, please download the detailed Communication instruction manual for the ACS-13A (C5) at http://www.shinko-technos.co.jp/e/ by clicking "Download".

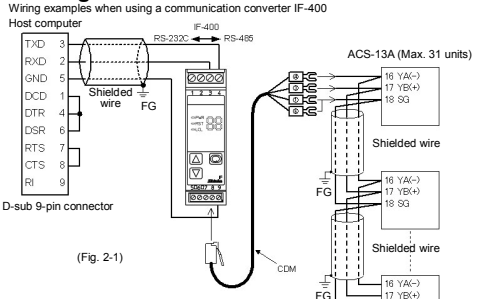
1. System configuration



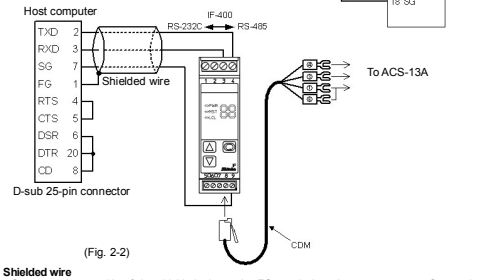
(Fig. 1-1)

2. Wiring

Wiring examples when using a communication converter IF-400



(Fig. 2-1)



(Fig. 2-2)

Shielded wire

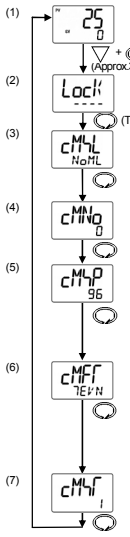
Connect only one side of the shielded wire to the FG terminal so that current cannot flow to the shielded wire. If both sides of the shielded wire are connected to the FG terminal, the circuit will be closed between the shielded wire and the ground. As a result, current will run through the shielded wire and this may cause noise. Be sure to ground the FG terminal.

Terminator (Terminal resistor)

The communication converter IF-400 (sold separately) has a built-in terminator.
The terminator is mounted at the end of the wire when connecting a personal computer with multiple peripheral devices. The terminator prevents signal reflection and disturbance.
Do not connect terminator with the communication line because each ACS-13A has built-in pull-up and pull-down resistors instead of a terminator.

3. Communication parameter setting

Set each communication parameter following the procedures below.



(1) **Proceed to Auxiliary function setting mode.**
Press the ◯ key for approx. 3sec while pressing the ▽ key in the PV/SV display mode.
The unit proceeds to Auxiliary function setting mode.

(2) **Auxiliary function setting mode**
Press the ◯ key twice.
The unit proceeds to Communication protocol selection.

(3) **Communication protocol selection**
Select the communication protocol.
NoML : Shinko protocol (Default)
ModR : Modbus ASCII mode
ModR : Modbus RTU mode

(4) **Instrument number setting**
Set the instrument number of the controller individually when communicating by connecting plural instruments.
0 to 95 (Default: 0)

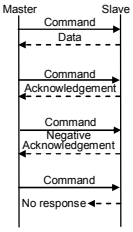
(5) **Communication speed selection**
Set the communication speed equal to that of the host computer.
24 : 2400bps
48 : 4800bps
96 : 9600bps (Default)
192 : 19200bps

(6) **Data bit/Parity selection**
Select the data bit and parity.
8NoN : 8 bits/No parity
8noN : 8 bits/No parity
8EVN : 8 bits/Even
7EVN : 7 bits/Even (Default)
8odd : 8 bits/Odd
7odd : 7 bits/Odd

(7) **Stop bit selection**
Select the stop bit.
1 : 1 (Default)
2 : 2

4. Communication procedure

Communication starts with command transmission from the host computer (Master) and ends with the response of the ACS-13A (Slave).



- **Response with data**
  When the master sends the reading command, the slave responds with the corresponding set value or current status.
- **Acknowledgement**
  When the master sends the setting command, the slave responds by sending the acknowledgement after the processing is terminated.
- **Negative acknowledgement**
  When the master sends a non-existent command or value out of the setting range, the slave returns a negative acknowledgement.
- **No response**
  The slave will not respond to the master in the following cases:
  - Global address, Broadcast address (Modbus protocol) is set.
  - Communication error (framing error, parity error)
  - Checksum error (Shinko protocol)
  - LRC discrepancy (Modbus ASCII mode)
  - CRC-16 discrepancy (Modbus RTU mode)

RS-485 communication timing

Master side (Notice on programming)

Set the program so that the master can disconnect the transmitter from the communication line within a 1 character transmission period after sending the command in preparation for reception of the response from the slave.
To avoid the collision of transmissions between the master and the slave, send the next command after carefully checking that the master received the response.
If a response to the command is not returned due to communication errors, set the Retry Processing so as to send the command again. (Retry twice or more is recommended.)

Slave side

When the slave starts transmission through a communication line, the slave is arranged so as to provide an idle status (mark status) transmission period of 1 or more characters before sending the response to ensure synchronization on the receiving side.
The slave is arranged so as to disconnect the transmitter from the communication line within a 1 character transmission period after sending the response.

5. Shinko protocol

5.1 Transmission mode

Shinko protocol is composed of ASCII codes.
Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.
Data format Start bit : 1
Data bit : 7 bits
Parity : Even
Stop bit : 1 bit
Error detection: Checksum

5.2 Command configuration

All commands are composed of ASCII.
The data (set value, decimal) is converted to hexadecimal numbers.
A negative number is represented by 2's complement.
Numerals written below the command represent number of characters.

(1) Setting command

Header (02H)	Address	Sub address (20H)	Command type(50H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(2) Reading command

Header (02H)	Address	Sub address (20H)	Command type(20H)	Data item	Checksum	Delimiter (03H)
1	1	1	1	4	2	1

(3) Response with data

Header (06H)	Address	Sub address (20H)	Command type(20H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(4) Acknowledgement

Header (06H)	Address	Checksum	Delimiter (03H)
1	1	2	1

(5) Negative acknowledgement

Header (15H)	Address	Error code	Checksum	Delimiter (03H)
1	1	2	1	1

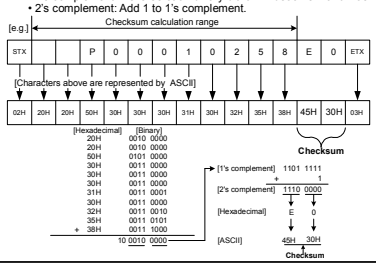
Header : Control code to represent the beginning of the command or the response. ASCII codes are used.
Setting command, Reading command : STX (02H) fixed
Response with data, Acknowledgement : ACK (06H) fixed
Negative acknowledgement : NAK (15H) fixed
Instrument number (Address): Numbers by which the master discerns each slave.
Instrument number 0 to 94 and Global address 95.
ASCII codes (20H to 7FH) are used by adding 20H to instrument numbers 0 to 95 (00H to 5FH). 95 (7FH) is called Global address, which is used when the same command is sent to all the slaves connected. However, the response is not returned.
Sub address : 20H fixed
Command type: Code to discern Setting command (50H) and Reading command (20H)
Data item : Data classification of the command object. Composed of hexadecimal 4 digits, using ASCII. (Refer to 7. Communication command table)
Data : The contents of data (set value) differ depending on the setting command. Composed of hexadecimal 4 digits, using ASCII.
(Refer to 7. Communication command table)
Checksum : 2-character data to detect communication errors (Refer to section 5.3.)
Delimiter : ASCII code ETX (03H) fixed. Control code to represent the end of command.
Error code : Represents an error type with ASCII codes.
1 (31H)-----Non-existent command
2 (32H)-----Not used
3 (33H)-----Setting out of the setting range
4 (34H)-----Status unable to be set (e.g. AT is performing)
5 (35H)-----During setting mode by keypad operation

5.3 Checksum calculation

Checksum is used to detect receiving errors in the command or data.
Set the program for the master side as well to calculate the checksum of the response data from the slaves so that the communication errors can be checked.
The ASCII code (hexadecimal) corresponding to the characters which range from the address to that before the checksum is converted to binary notation, and the total value is calculated. The lower 2-digits of the total value are converted to 2's complement, and then to hexadecimal numbers, that is, ASCII code for the checksum.

Checksum calculation example

SV: 600℃ (0258H) Address (instrument number): 0 (20H)
- 1's complement: Reverse each binary bit. 0 will become 1 and vice versa.
- 2's complement: Add 1 to 1's complement.



6. Modbus protocol

6.1 Transmission mode

There are 2 transmission modes (ASCII and RTU) in Modbus protocol.

6.2 ASCII mode

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.
Data format Start bit : 1 bit
Data bit : 7 bits
Parity : Even (No parity/Odd), Selectable
Stop bit : 1 bit (2 bits), Selectable
Error detection : LRC (Longitudinal Redundancy Check)
Data interval : 1 second or less

(1) Message configuration

ASCII mode message is configured to start by Header [: (colon)(3AH)] and end by Delimiter [CR (carriage return) (0DH) + LF (Line feed)(0AH)].

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

Slave address

Slave address is an individual instrument number on the slave side and is set within the range 0 to 95 (00H to 5FH).
The master identifies slaves by the slave address of the requested message.
The slave informs the master which slave is responding to the master by placing its own address in the response message.
Slave address 0 (00H, broadcast address) can identify all the slaves. However slaves do not respond.

Function code

The function code is the command code for the slave to undertake the following action types.

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.
When acknowledgement is returned, the slave simply returns the original function code.
When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.
For example, when the master sends request message setting 10H to the function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.
For negative acknowledgement, the exception codes below are set to the data of response message and returned to the master in order to inform it of what kind of error has occurred.

Exception code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Shinko error code 4 (Status unable to be set, e.g. AT is performing)
18 (12H)	Shinko error code 5 (During setting mode by keypad operation)

Data

Data depends on the function code.
A request message from the master is composed of data item, number of data and setting data.
A response message from the slave is composed of number of bytes, data and exception code in negative acknowledgements.
The number of data to be dealt with in one message is "1". Therefore, the number of data is fixed as (30H) (30H) (30H) (31H).
Effective range of data is -32768 to 32767 (8000H to 7FFFH).

Error check: 2-character data to detect communication errors.
Refer to (2) Error check of ASCII mode below.

(2) Error check of ASCII mode

After calculating LRC (Longitudinal Redundancy Check) from the slave address to the end of data, the calculated 8-bit data is converted to two ASCII characters and are appended to the end of message.

[How to calculate LRC]

① Create a message in RTU mode.
② Add all the values from the slave address to the end of data. This is assumed as X.
③ Make a complement for X (bit reverse). This is assumed as X.
④ Add a value of 1 to X. This is assumed as X.
⑤ Set X as an LRC to the end of the message.
⑥ Convert the whole message to ASCII characters.

6.3 RTU mode

8-bit binary data in command is transmitted as it is.
Data format Start bit : 1 bit
Data bit : 8 bits
Parity : No parity (Even, Odd), Selectable
Stop bit : 1 bit (2 bits), Selectable
Error detection: CRC-16 (Cyclic Redundancy Check)
Data interval: 3.5 characters transmission time or less

(1) Message configuration

RTU mode is configured to start after idle time is processed for more than 3.5 character transmissions and end after idle time is processed for more than 3.5 character transmissions.

3.5 idle characters	Slave address	Function code	Data	Error check CRC-16	3.5 idle characters

Slave address : The same as that of ASCII mode
Function code : The same as that of ASCII mode
Data : Data depends on the function code.

A request message from the master is composed of data item, number of data and setting data.
A response message from the slave is composed of number of bytes, data and exception codes in negative acknowledgement.
The number of data to be dealt with in one message is "1". Therefore the number of data is fixed as 0001H. The number of response byte is 02H.
Effective range of data is -32768 to 32767 (8000H to 7FFFH).

Error check: 16-bit data to detect communication errors. Refer to "(2) Error check of RTU mode".

(2) Error check of RTU mode

After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of data, the calculated 16-bit data is appended to the end of message in sequence from low order to high order.

How to calculate CRC-16

In the CRC-16 system, the information is divided by polynomial series. The remainder is added to the end of the information and transmitted. The generation of polynomial series is as follows. (Generation of polynomial series: $X^{16} + X^{15} + X^2 + 1$)

① Initialize the CRC-16 data (assumed as X) (FFFFH).
② Calculate exclusive OR (XOR) with the 1st data and X. This is assumed as X.
③ Shift X one bit to the right. This is assumed as X.
④ When a carry is generated as a result of the shift, XOR is calculated by X of ③ and the fixed value (A001H). This is assumed as X. If a carry is not generated, go to step ⑤.
⑤ Repeat steps ③ and ④ until shifting 8 times.
⑥ XOR is calculated with the next data and X. This is assumed as X.
⑦ Repeat steps ② to ⑥.
⑧ Repeat steps ② to ⑦ up to the last data.
⑨ Set X as CRC-16 to the end of the message in sequence from low order to high order.

7. Communication command table

Shinko command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0001H	SV	Set value, Decimal point ignored
20H/50H	03H/06H	0003H	Auto-tuning/Auto-reset	0000H: Cancel 0001H: Perform
20H/50H	03H/06H	0004H	OUT1 proportional band	Set value, Decimal point ignored
20H/50H	03H/06H	0005H	OUT2 proportional band	Set value, Decimal point ignored
20H/50H	03H/06H	0006H	Integral time	Set value
20H/50H	03H/06H	0007H	Derivative time	Set value
20H/50H	03H/06H	0008H	OUT1 proportional cycle	Set value
20H/50H	03H/06H	0009H	OUT2 proportional cycle	Set value
20H/50H	03H/06H	000BH	Alarm 1 value	Set value, Decimal point ignored
20H/50H	03H/06H	000CH	Alarm 2 value	Set value, Decimal point ignored
20H/50H	03H/06H	000FH	Heater burnout alarm value	Set value, Decimal point ignored
20H/50H	03H/06H	0012H	Set value lock	0000H: Unlock 0002H: Lock 2 0001H: Lock 1 0003H: Lock 3
20H/50H	03H/06H	0015H	Sensor correction	Set value, Decimal point ignored
20H/50H	03H/06H	0016H	Overlap/Dead band	Set value
20H/50H	03H/06H	0018H	Scaling high limit	Set value, Decimal point ignored
20H/50H	03H/06H	0019H	Scaling low limit	Set value, Decimal point ignored
20H/50H	03H/06H	001AH	Decimal point place	0000H: xxxx 0002H: xx.xx 0001H: xxx.x 0003H: x.xxx
20H/50H	03H/06H	001BH	PV filter time constant	Set value, Decimal point ignored
20H/50H	03H/06H	001CH	OUT1 high limit	Set value
20H/50H	03H/06H	001DH	OUT1 low limit	Set value
20H/50H	03H/06H	001EH	OUT1 ON/OFF hysteresis	Set value, Decimal point ignored
20H/50H	03H/06H	001FH	OUT2 action mode	0000H: Air cooling 0001H: Oil cooling 0002H: Water cooling
20H/50H	03H/06H	0020H	OUT2 high limit	Set value
20H/50H	03H/06H	0021H	OUT2 low limit	Set value
20H/50H	03H/06H	0022H	OUT2 ON/OFF hysteresis	Set value, Decimal point ignored
20H/50H	03H/06H	0023H	Alarm 1 type	0000H: No alarm action 0001H: High limit alarm 0002H: Low limit alarm 0003H: H/L limits alarm 0004H: H/L limit range 0005H: Process high alarm 0006H: Process low alarm 0007H: High limit w/standby 0008H: Low limit w/standby 0009H: H/L limits w/standby
20H/50H	03H/06H	0024H	Alarm 2 type	The same as Alarm 1 type
20H/50H	03H/06H	0025H	Alarm 1 hysteresis	Set value, Decimal point ignored
20H/50H	03H/06H	0026H	Alarm 2 hysteresis	Set value, Decimal point ignored
20H/50H	03H/06H	0029H	Alarm 1 action delay timer	Set value
20H/50H	03H/06H	002AH	Alarm 2 action delay timer	Set value
20H/50H	03H/06H	0032H	Indication when output OFF	0000H: OFF indication 0001H: No indication 0002H: PV indication 0003H: PV+ Alarm action
20H/50H	03H/06H	0033H	SV rise rate	Set value, Decimal point ignored
20H/50H	03H/06H	0034H	SV fall rate	Set value, Decimal point ignored
20H/50H	03H/06H	0037H	Control output OUT/OFF	0000H: Control output ON 0001H: Control output OFF
20H/50H	03H/06H	0038H	Auto/Manual control	0000H: Automatic control 0001H: Manual control
20H/50H	03H/06H	0039H	Manual control MV	Set value
20H/50H	03H/06H	0040H	Alarm 1 Energized/ De-energized	0000H: Energized 0001H: De-energized
20H/50H	03H/06H	0041H	Alarm 2 Energized/ De-energized	0000H: Energized 0001H: De-energized

Shinko command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0044H	Input type	
			0000H: K -200 to 1370℃	000FH: K -320 to 2500℉
			0001H: K -200.0 to 400.0℃	0010H: K -320.0 to 750.0℉
			0002H: J -200 to 1000℃	0011H: J -320 to 1800℉
			0003H: R 0 to 1760℃	0012H: R 0 to 3200℉
			0004H: S 0 to 1760℃	0013H: S 0 to 3200℉
			0005H: B 0 to 1820℃	0014H: B 0 to 3300℉
			0006H: E -200 to 800℃	0015H: E -320 to 1500℉
			0007H: T -200.0 to 400.0℃	0016H: T -320.0 to 750.0℉
			0008H: N -200 to 1300℃	0017H: N -320 to 2300℉
			0009H: PL-Ⅱ 0 to 1390℃	0018H: PL-Ⅱ 0 to 2500℉
			000AH: C(W/Re5-26) 0 to 2315℃	0019H: C(W/Re5-26) 0 to 4200℉
			000BH: Pt100 -200.0 to 850.0℃	001AH: Pt100 -320.0 to 1500.0℉
			000CH: JPt100 -200.0 to 500.0℃	001BH: JPt100 -320.0 to 900.0℉
			000DH: Pt100 -200 to 850℃	001CH: Pt100 -320 to 1500℉
			000EH: JPt100 -200 to 500℃	001DH: JPt100 -320 to 900℉
			001EH: 4 to 20mA -2000 to 10000	
			001FH: 0 to 20mA -2000 to 10000	
			0020H: 0 to 1V -2000 to 10000	
			0021H: 0 to 5V -2000 to 10000	
			0022H: 1 to 5V -2000 to 10000	
			0023H: 0 to 10V -2000 to 10000	
20H/50H	03H/06H	0045H	Direct/Reverse action	0000H: Reverse action 0001H: Direct action
20H/50H	03H/06H	0047H	AT bias	Set value
20H/50H	03H/06H	0048H	ARW	Set value
20H/50H	03H/06H	0049H	Heater burnout alarm 2 value	Set value, Decimal point ignored
20H/50H	03H/06H	004AH	OUT1 rate-of-change	Set value
20H/50H	03H/06H	0050H	Backlight	0000H: All are backlit 0001H: PV display backlit 0002H: SV display backlit 0003H: Action indicators backlit 0004H: PV+SV displays backlit 0005H: PV+Action indicators backlit 0006H: SV+Action indicators backlit
20H/50H	03H/06H	0051H	PV color	
			0000H: Green 0001H: Red 0002H: Orange 0003H: When Alarm ON: Green ▶ Red	0004H: When Alarm ON: Orange ▶ Red 0005H: PV continuous change+ Alarm ON, Red 0006H: PV continuous change+ Alarm ON, Red
20H/50H	03H/06H	0052H	PV color range	Set value, Decimal point ignored
20H/50H	03H/06H	0053H	Backlight time	Set value
50H	06H	0070H	Key operation change flag clearing	0000H: No action 0001H: Clear all
20H	03H	0080H	PV (Process variable)	Current PV (Process variable), Decimal point ignored
20H	03H	0081H	OUT1 MV	OUT1 MV, Decimal point ignored
20H	03H	0082H	OUT2 MV	OUT2 MV, Decimal point ignored
20H	03H	0083H	SV (When SV rises or falls)	Current SV (Desired value), Decimal point ignored
20H	03H	0085H	Status flag	
			2^0: OUT1	0: OFF, 1: ON (DC current output: Not fixed)
			2^1: OUT2	0: OFF, 1: ON
			2^2: Alarm 1 output	0: OFF, 1: ON
			2^3: Alarm 2 output	0: OFF, 1: ON
			2^5: Heater burnout alarm output	0: OFF, 1: ON (When sensor burnout, 0: OFF)
			2^8: Overscale	0: OFF, 1: ON
			2^9: Underscale	0: OFF, 1: ON
			2^{10}: Control output OUT/OFF	0: ON, 1: OFF
			2^{11}: During AT/Auto-reset	0: OFF, 1: During AT/Auto-reset
			2^{12}: OUT/OFF key function	0: OUT/OFF function 1: Auto/Manual control
			2^{14}: Auto/Manual control	0: Auto, 1: Manual
			2^{15}: Change in key operation	0: No, 1: Yes
			2^4, 2^6, 2^7, 2^{13}	Not used, Always 0
20H	03H	0086H	CT1 current value	CT1 current value, Decimal point ignored
20H	03H	0087H	CT2 current value	CT2 current value, Decimal point ignored

8. Specifications

Cable length : 1.2km (Max.), Cable resistance: 50Ω or less (Terminators are not necessary, but if used, use 120Ω or more on one side.)
Communication line : EIA RS-485
Communication method : Half-duplex communication
Communication speed : 9600bps (2400, 4800, 19200bps) Selectable by keypad
Synchronization method : Start-stop synchronization
Code : ASCII, Binary
Error correction : Command request repeat system

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