

8.3 Modbus Protocol Communication

8.3.1 Introduction

MASTER-K120S built-in communication supports Modbus, the Modicon product's communication protocol. It supports ASCII mode, using ASCII data and RTU mode using Hex data. Function code used in Modbus is supported by instruction and especially function code 01, 02, 03, 04, 05, 06, 15 and 16. Refer to "Modicon Modbus Protocol Reference Guide"

8.3.2 Basic Specification

1) ASCII mode

- (1) It communicates, using ASCII data.
- (2) Each frame uses ':' (colon : H3A)', for header, CRLF (Carriage Return-Line Feed : H0D H0A), for tail.
- (3) It allows Max. 1 second interval between characters.
- (4) It checks errors, using LRC.
- (5) Frame structure (ASCII data)

Item	Header	Address	Function code	Data	LRC	Tail(CR/LF)
Size	1 byte	2 bytes	2 bytes	n bytes	2 bytes	2 bytes

2) RTU mode

- (1) It communicates, using hex data.
- (2) There's no header and tail. It starts with address and finishes frame with CRC.
- (3) It has at least 3.5 character times between two frames.
- (4) It ignores the current frame when 1.5 character times elapse between characters.
- (5) It checks errors, using 16 bit CRC.
- (6) Frame structure (hex data).

Item	Address	Function code	Data	CRC
Size	1 byte	1 bytes	n bytes	2 bytes

REMARK

- 1) The size constituting 1 letter is 1 character. So 1 character is 8 bits that is 1 byte.
- 2) 1 character time means the time lapsed for sending 1 character.
Ex) Calculation of 1 character time at 1200 bps.
1200 bps means that it takes 1 second to send 1200 bits. To send 1 bit, $1 \text{ sec} / 1200 \text{ bits} = 0.83 \text{ ms}$.
Therefore 1 character time is $0.83 \text{ ms} * 8 \text{ bits} = 6.64 \text{ ms}$.
- 3) 584, 984 A/B/X executes frame division, using intervals of more than 1 sec without LRC in processing internally.

3) Address area

- (1) Setting range is available from 1 to 247, but MASTER-K120S supports from 0 to 31.
- (2) Address 0 is used for broadcast address. Broadcast address is all slave device recognize and respond to like the self-address, which can't be supported by MASTER-K120S.

4) Function code area

- (1) MASTER-K120S supports only 01, 02, 03, 04, 05, 06, 15, and 16 among Modicon products' function codes.
- (2) If the response format is confirm+(ACK), it uses the same function code.
- (3) If the response format is confirm-(NCK), it returns as it sets the 8th bit of function code as 1.

Ex) If function code is 03, (we write here only function code part. Because only function codes are different.)

[Request]	0000 0011 (H03)
[Confirm+]	0000 0011 (H03)
[Confirm-]	1 000 0011 (H83)

It returns as it sets the 8th bit of function code of request frame.

5) Data area

- (1) It sends data, using ASCII data(ASCII mode) or hex (RTU mode).
- (2) Data is changed according to each function code.
- (3) Response frame uses data area as response data or error code.

6) LRC Check/CRC Check area

- (1) LRC (Longitudinal Redundancy Check) : It works in ASCII mode. It takes 2' complement from sum of frame except header or tail to change into ASCII code,
- (2) CRC (Cyclical Redundancy Check): It works in RTU mode. It uses 2-byte CRC check rules.

REMARK

- 1) All numerical data can use hexadecimal, decimal, and binary type. If we convert decimal 7 and 10 into each type:
Hexadecimal : H07, H0A or 16#07, 16#0A
Decimal : 7, 10
Binary : 2#0111, 2#1010

7) Function code types and memory mapping

Code	Function code name	Modicon PLC Data address	Remark
01	Read Coil Status	0XXXX(bit-output)	Read bits
02	Read Input Status	1XXXX(bit-input)	Read bits
03	Read Holding Registers	4XXXX(word-output)	Read words
04	Read Input Registers	3XXXX(word-input)	Read words
05	Force Single Coil	0XXXX(bit-output)	Write bit
06	Preset Single Register	4XXXX(word-output)	Write word
15	Force Multiple Coils	0XXXX(bit-output)	Write bits
16	Preset Multiple Registers	4XXXX(word-output)	Write words

• MASTER-K120S Mapping

Bit area		Word area	
Address	Data area	Address	Data area
h0000	P area	h0000	P area
h1000	M area	h1000	M area
h2000	L area	h2000	L area
h3000	K area	h3000	K area
h4000	F area	h4000	F area
h5000	T area	h5000	T area(current value area)
h6000	C area	h6000	C area(current value area)
		h7000	S area
		h8000	D area

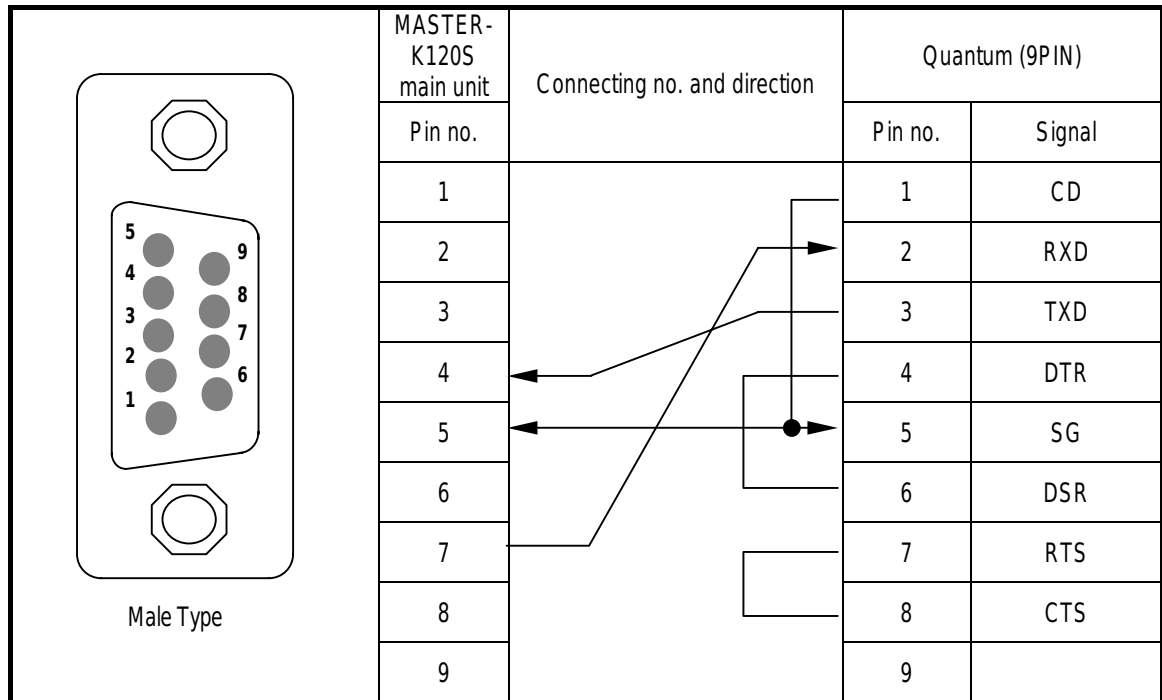
8) Modbus addressing rules

MASTER-K120S main unit starts its address from 0 and matches with 1 of Modicon products' data address. So MASTER-K120S's address n matches $n+1$ of Modicon products' address. This means that the output contact point 1 (0001) of Modicon products is marked as communication address 0 and the input contact point 1 (0001) of Modicon products is marked as communication address 0 in MASTER-K120S.

9) The size of using data

As for data size, MASTER-K120S main unit supports 128 bytes in ASCII mode and 256 bytes in RTU mode. The maximum size of the Modicon products is different from each other kind. So refer to "Modicon Modbus Protocol Reference Guide."

10) Map of wiring



- Use RS-485 connector when using channel 2.

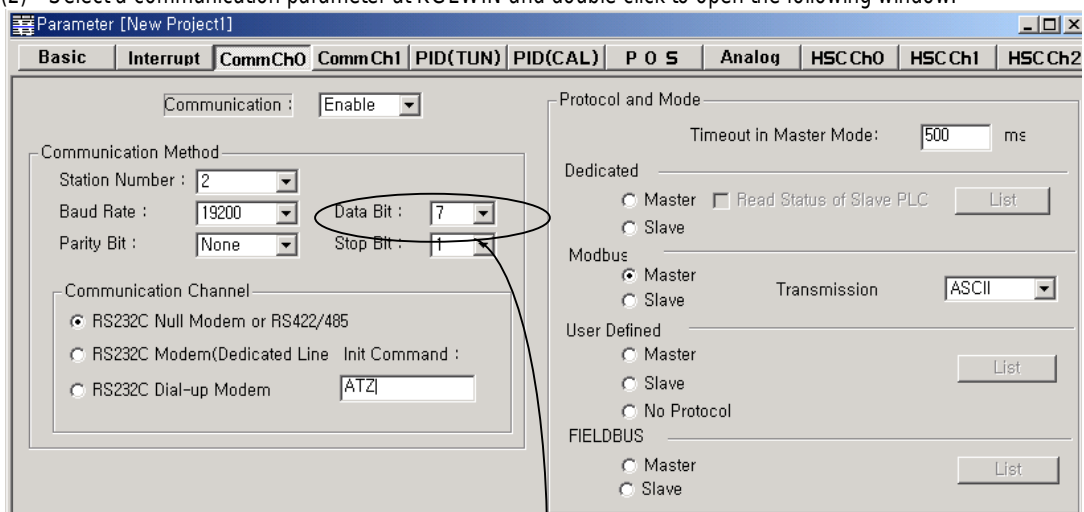
8.3.3 Parameters Setting

1) Setting communication parameter

(1) Open a new project file at KGLWIN.

- K120S should be selected in PLC types.
- Open a new project file for each of the master and the slave.

(2) Select a communication parameter at KGLWIN and double click to open the following window.



If communication mode is ASCII, Be sure to set 7bit

(3) Set the contents as follows.

Item	Setting contents
Station No.	Set a number between 0 to 31 (Don't assign no. 0 as broadcasting station lest it may be a cause for mistaken operation)
Baud Rate	Set one from 1200, 2400, 4800, 9600, 19200, 38400, or 57600 bps.
Data Bit	Set 7 or 8. ASCII mode: Set as 7 bits. RTU mode: Set as 8 bits.
Parity Bit	Set as one of None, Even, or Odd.
Stop Bit	Set 1 or 2 bit(s). When parity bit is set: Set as 1 bit. When parity bit isn't set: Set as 2 bits.
Communication Channel	<ul style="list-style-type: none"> • RS232C Null Modem or RS422/485 : It's a communication channel for the communication, using MASTER-K120S main unit's built-in communication and Cnet I/F module (G7L-CUEC). • RS232C Modem (Dedicated Line) : It's to be selected for the communication, using an dedicated modem with Cnet I/F module (G7L-CUEB). • S232C Dial Up Modem : It's to be selected for the general communication connecting through the telephone line by dial up modem and Cnet I/F module (G7L-CUEB). • Note : Using Cnet I/F module (G7L-CUEB) supporting RS232C, RS232C dedicated or dial-up modem communication can be done, but not through Cnet I/F module (G7L-CUEC) supporting RS422/485.
Time out in Master Mode	<ul style="list-style-type: none"> • It's the time waiting a responding frame since the master MK80S main unit sends a request frame. • The default value is 500ms. • It must be set in consideration of the max. periodical time for sending/receiving of the master PLC. • If it's set smaller than the max. send/receive periodical time, it may cause communication error.
Modbus Master/ Slave	If it is set as the master, it's the subject in the communication system. If it's set as the slave, it only responds to the request frame of the master.
Transmission Mode	Select ASCII mode or RTU mode.

8.3.4 Instruction and example

1) MODBUS communication instruction(MODCOM)

MODCOM	MODBUS communication
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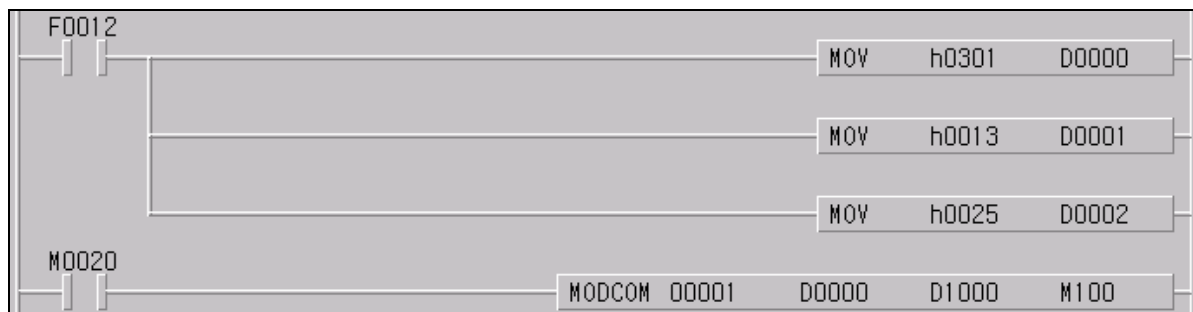
Instruction	Available device											No. of steps	Flag		
	M	P	K	L	F	T	C	S	D	#D	integer		Error (F110)	Zero (F111)	Carry (F112)
Ch											○	7	○		
S1	○	○	○	○	○	○	○		○	○					
S2	○	○	○	○		○	○		○	○					
S3	○	○	○	○		○	○		○	○					

Input Condition		MODBUS Communication Channel		SND/RCV Parameter	SND/RCV Data	Status
		MODCOM	Ch	S1	S2	S3
Flag		Designation				
Error (F110)	Error flag turns on when designating area is over and the instruction isn't executed	Ch	Designated communication channel			
		S1	Device which is registered communication parameter			
		S2	Device which stored communication data			
		S3	Device which stored communication status			

■ MODCOM Ch S1 S2 S3

(1) Example program

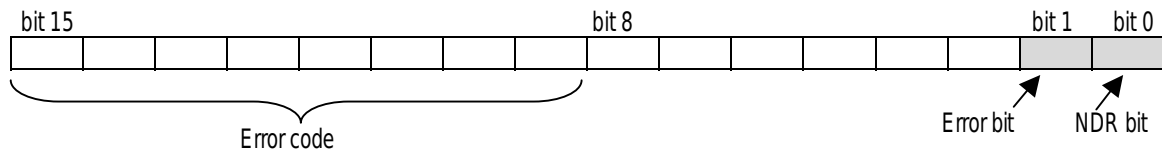
- Designate slave station No. , function code, address, No. of reading
- When input condition(M0020) turns on, MODBUS communication starts.
- Receiving data are stored D1000, and communication status is stored to M100



- When operates as slave, MASTER-K120S responses to master station without commands. And When operates as master, MASTER-K120S sends data in S1 with MODBUS protocol at rising edges of execution condition.

Chapter 8 Communication Functions

- S3 format is as below.



- NDR : when the communication ends normally, this bit turns on during 1 scan.
- Error bit : when communication error occurs, this bit turns on during 1 scan. At that time error code stores bit 8 ~ bit 15.
- Error code is as follow

Code	Error type	Meaning
01	Illegal Function	Error in inputting function code in instruction.
02	Illegal Address	Error of exceeding the area limit of reading/writing on the slave station.
03	Illegal Data Value	Error when the data value to be read from or write on the slave station isn't allowed.
04	Slave Device Failure	Error status of the slave station.
05	Acknowledge	It's a responding code of the slave station for the master station to prevent the master station time-out error, when request command processing takes time. The master station marks an error code and waits for a certain time without making any second request.
06	Slave Device Busy	Error when request command processing takes too much time. The master should request again.
07	Time Out	Error when exceeds the time limit of the communication parameter as it communicates.
08	Number Error	Errors when data is 0 or more than 256 bytes
09	Parameter Error	Error of setting parameters (mode, master/ slave)
10	Station Error	Error when the station number of itself and the station number set by the S1 of instruction are the same.

Remark

-. In MASTER-K120S series, the 'MODBUS' command which has been used in MK80S series can be used.
In this case, communication channel is fixed to channel 0.

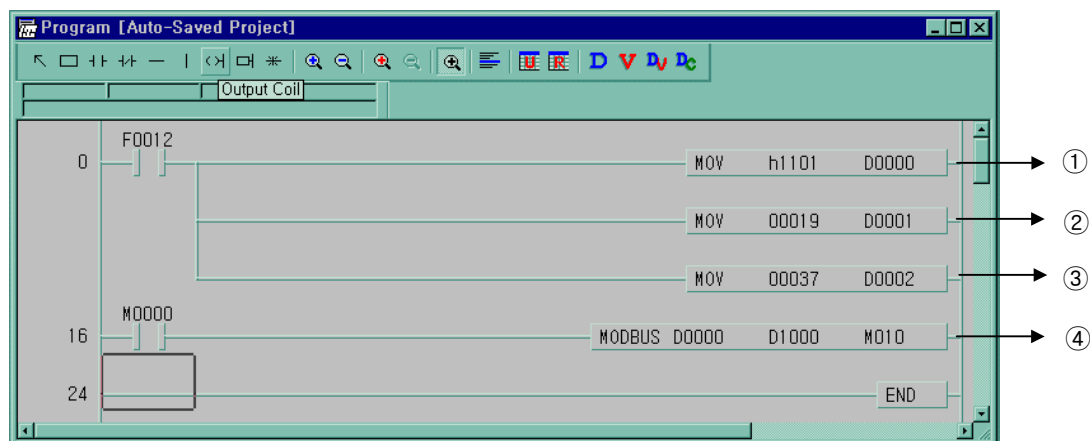
2) Example program 1

It's supposed that MASTER-K120S main unit is the master and it reads Coil Status of the station no. 17, a Modicon product. The master reads status of the Coil 00020 ~ 00056 of the slave station no. 17. The Coil of the slave station is supposed to be as follows and the data that are read is saved in D1000

Coil	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40
Status	X	X	X	1	1	0	1	1	0	0	0	0	1	1	1	0	1	0	1	1
Hex	1				B				0				E				B			
Coil	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20
Status	0	0	1	0	0	1	1	0	1	0	1	1	1	1	0	0	1	1	0	1
Hex	2				6				B				C				D			

- The status of Coil 57, 58, 59 are redundancy.
- Data is sent starting from the low bit by byte unit. If the deficient bit of a byte is filled with 0. An example of sending the above data is as Following example 1.

Example 1) CD B2 0E 1B



- ① It designates slave station and function code (No. of station : h11(17) , function code : h01)
- ② Address setting
 - Address '0' at MODBUS protocol means address '1' actually .So if you want to designate address '20' , write address '19'
- ③ Reading number setting (Reading number is 37 from 20 to 56.)
- ④ This is MODBUS Communication instruction.
 - Data is sent starting from the low bit by byte unit. If the deficient bit of a byte is filled with 0. An example of sending the above data is as follows.
 - The data transmission starts lower byte. The remnant part of byte is filled with '0'
- ⑤ Stored data at D1000,D1001,D1002 are :

Device	Stored data
D1000	h CD 6B
D1001	h B2 CE
D1002	h 00 1B

3) Example program 2

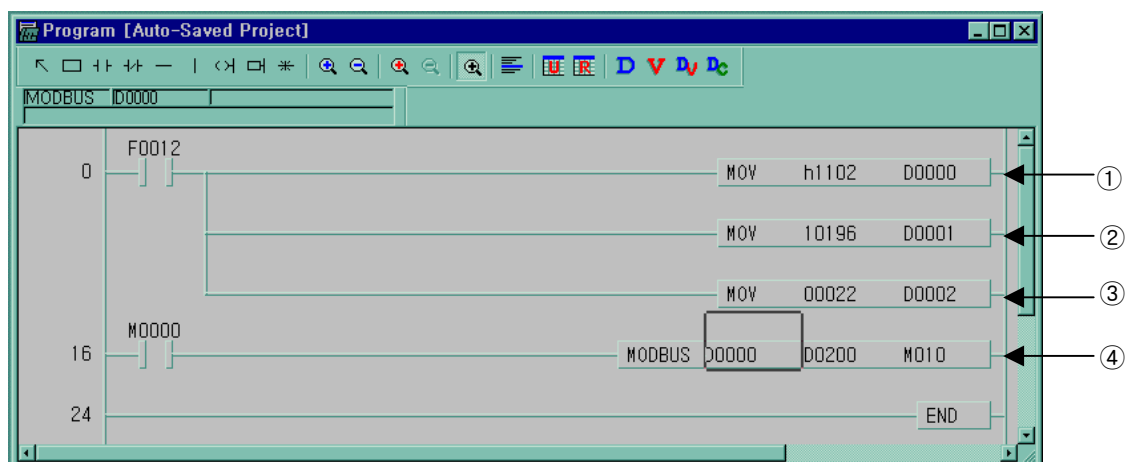
It's supposed that MASTER-K120S main unit is the master and it reads Coil Status of the station no. 17, a Modicon product. The master reads status of the input contact 10197 ~ 10218 of the slave station no. 17.

The input contact of the slave station is supposed to be as follows and the data that are read is saved in M015.

Input	10220	10219	10218	10217	10216	10215	10214	10213	10212	10211	10210	10209
Status	X	X	1	1	0	1	0	1	1	1	0	1
Hex	3				5				D			
Input	10208	10207	10206	10205	10204	10203	10202	10201	10200	10199	10198	10197
Status	1	0	1	1	1	0	1	0	1	1	0	0
Hex	B				A				C			

- The status of input contact 10219,10220 are redundancy.
- Data is sent starting from the low bit by byte unit. If the deficient bit of a byte is filled with 0. An example of sending the above data is as follows.

Example 2) AC DB 35

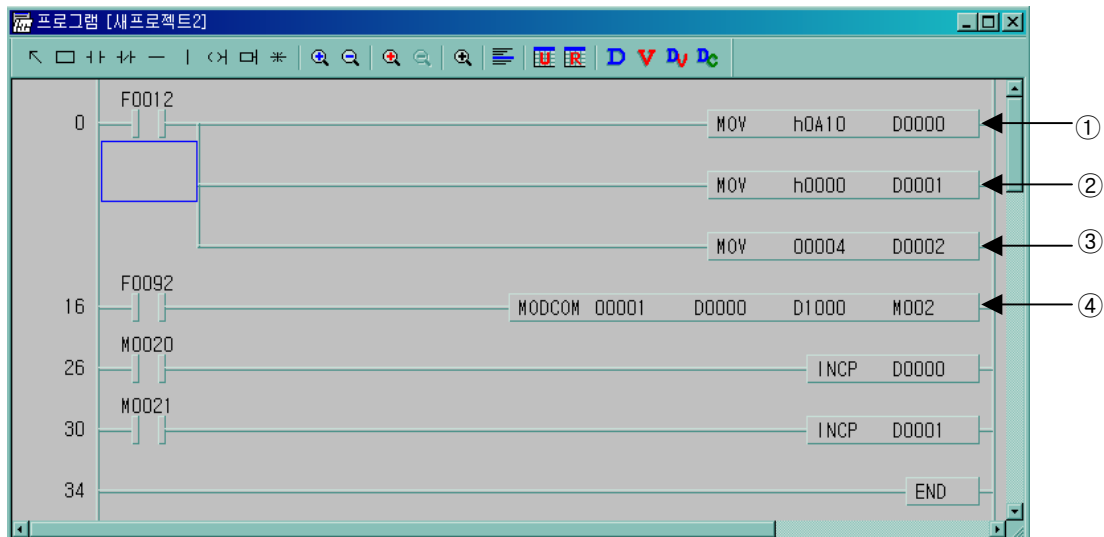


- ① : It designates slave station and function code (No. of station : h11(17) , function code : h02)
- ② : Address setting
Address '0' at MODBUS protocol means address '1' actually .So if you want to designate address '10197' , write address '10196'
- ③ : Reading number setting (Reading number is 22 from 10197 to 10220.)
- ④ : This is MODBUS Communication instruction.
The data transmission starts lower byte. The remnant part of byte is filled with '0'
- ⑤ Stored data at D200,D201 are :

Device	Stored data
D200	h AC DB
D201	h 00 35

4) Example program 3

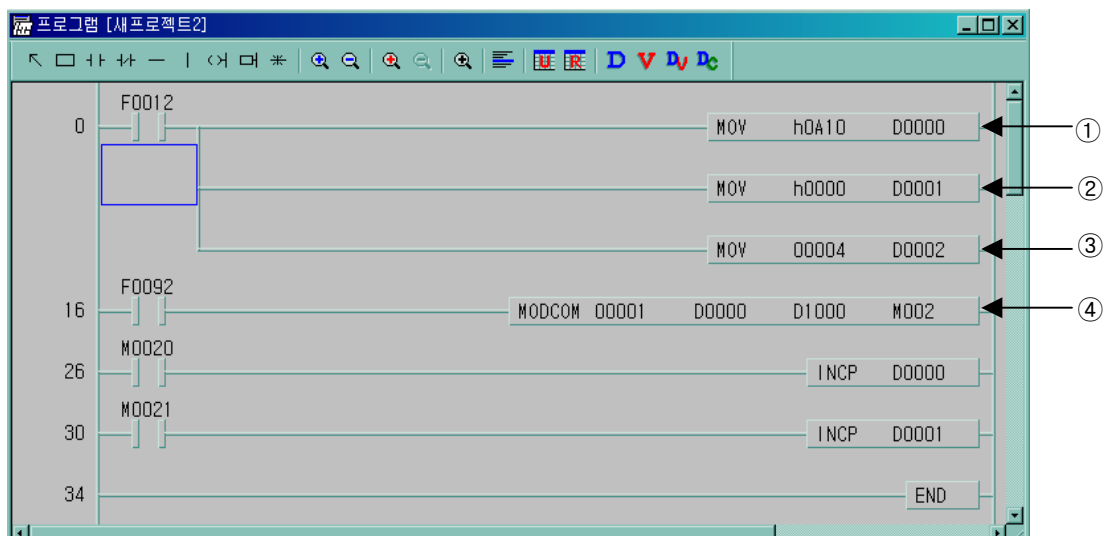
The master writes data D1000 ~ D1003 to contact 40000 of the slave station no. 10.



- ① : It designates slave station and function code (No. of station : h0A(10) , function code : h10)
- ② : Address setting
Address '0' of function code '16' at MODBUS protocol means address '40000' actually.
- ③ : Writing number setting (Writing number is 4)
- ④ : This is MODBUS Communication instruction.

5) Example program 4

The master writes data in D1000 to contact 40000 of the slave station no. 10.



- ① : It designates slave station and function code (No. of station : h0A(10) , function code : h06)
- ② : Address setting
Address '0' of function code '16' at MODBUS protocol means address '40000' actually.
- ③ : Writing number setting (Writing number is 1)
- ④ : This is MODBUS Communication instruction.

8.4 No Protocol Communication

8.4.1 Introduction

No protocol communication is useful when communication between MASTER-K120S main unit and other kind of devices with user defined protocol is impossible. User defined protocol is very convenient when there are enough interval between frames or a kind of frame is less than 16. But, When the kind of frame is greater than 16 or frames are continued without interval, user defined protocol is not available.

When the kinds of frame are more than 16, they can't be registered in parameter area, therefore MASTER-K120s can't transfer these frames. Also, if there are no interval between frame, MASTER-K120S can't find end of frame.

To overcome these defects of user defined protocol, MASTER-K120S provide 'No Protocol Communication'.

In the No Protocol Communication, frames are designated by commands, not by parameter setting. So Max. 128 frames can be designated when using this communication mode. This section explains No protocol Communication setting & usage.

1) Sending Data

Input Condition	No protocol Communication	Channel	No. of Sending byte	Sending Byte Area	Status
	DSND	00000	00010	D0100	M000

- Command : DSND
- Sends stored data in designated device at the rising edge of input condition.
- Data and the number of character must be stored in designated device before they are sent.
- Operands
 - (a) First operand - Designates communication channel
 - (b) Second operand - Number of data to sending (Unit of byte)
 - (c) Third operand - Starting address of devices which stores sending data
 - (d) Fourth operand - Device address which indicates communication status.

2) Receiving Data

Input Condition	No protocol Communication	Channel	Receive Format	Receiving Data Storing Area	Status
	DRCV	h0001	h0003	D0100	M010

- Command : DRCV
- Saves received data to pre-defined receiving devices when designated ending condition is occurs.
- The ending condition can be designated by following two kinds.
 - By number of character which is received.
 - By designated last byte. It is useful when there is no interval between received frames.
- Supports hexadecimal type.
- Operands
 - (a) First operand - Designates communication channel
 - (b) Second operand - Designates receiving format
 - (c) Third operand - Starting address of devices which stores receiving data
 - (d) Fourth operand - Device which indicates end of receiving

- Receiving format can be designated as below.

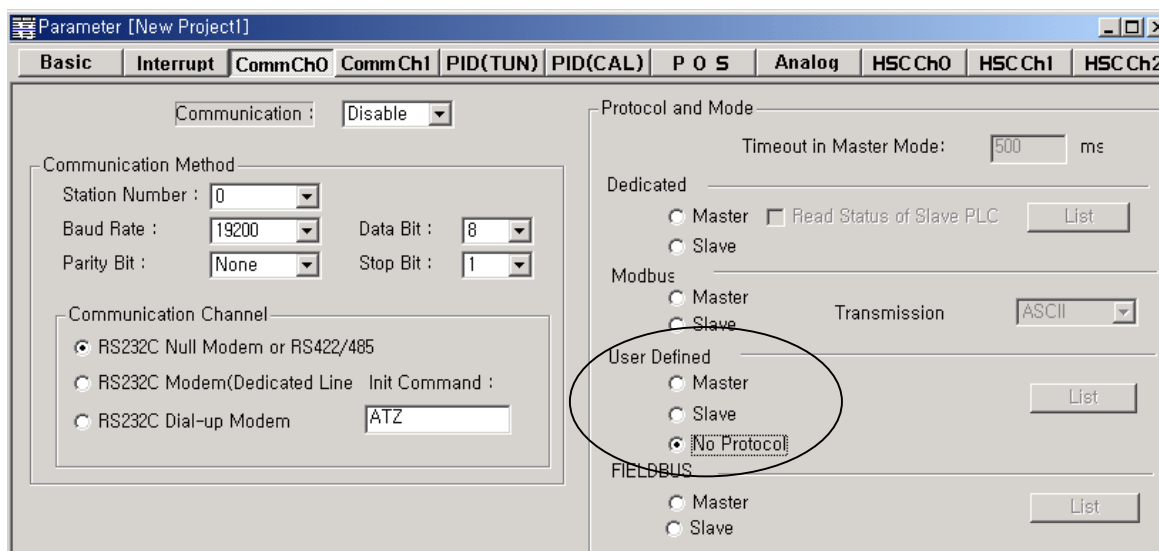
Upper byte(hex)	Lower byte(hex)
H00(Receiving by Length of frame)	H03 (R eceives when length of frame data is 3)
H01(Receiving by last byte)	H03 (Receives when last frame data is 03(ETX))

- When designated as length of frame : Stores received data to devices when number of received byte is equal to designated lower byte value of receiving format.(setting range : 1~255)
- When designated last byte : Stores received data to devices when receives designated ending byte.

8.4.2 Parameter setting

1) Setting Communications Parameter

- Open a new project file from KGLWIN and select MK120S as PLC type
- After selecting communication parameter at KGLWIN. Double click it to activate this window



- Set the communication methods and channel (Refer to Chapter 8.1.7 for details.)
- Click 'No protocol', then parameter setting is finished

8.4.3 Instructions

1) No protocol receive(DRCV)

DRCV	No protocol receive
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Instruction	Available Device											No. of step	Flag		
	M	P	K	L	F	T	C	S	D	#D	Integer		Error (F110)	Zero (F111)	Carry (F112)
Ch											○	9	○		
Cw	○	○	○	○	○	○	○		○	○	○				
D	○	○	○	○		○	○		○	○					
SS	○	○	○	○		○	○		○	○					

Input Condition	No protocol Communication	Channel	Receive Format	Receiving Data Storing Area	Status
DRCV	Ch	CW	D	SS	

Flag

Error (F110)	Error flag turns on, when designating area is over.
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Designation

Ch	Designated communication channel
CW	Designated format of receiving frame
D	Device address which is stored communication data
SS	Device address which is displayed communication status

■ DRCV Ch Cw D SS

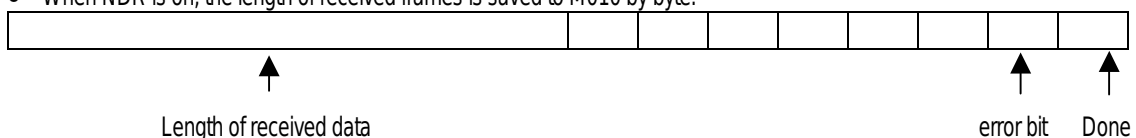
(1) Function

- When the execution condition is on, the communication starts with No protocol.
- Received data is stored in device 'D'
- If received data is not match to the designated format by 'Cw', data is not saved to 'D'
- The communication status is saved in 'SS'.

(2) Example program

M0000	DRCV	h0001	h0103	D0100	M010
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- When the execution condition M0000 is on, the communication starts with channel 1
- When 'EXT(h'03)' is received, Received frames are saved to D0100
- When NDR is on, the length of received frames is saved to M010 by byte.



Chapter 8 Communication Functions

1) No protocol send(DSND)

DSND	No protocol send
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Instruction	Available Device											No. of step	Flag		
	M	P	K	L	F	T	C	S	D	#D	Integer		Error (F110)	Zero (F111)	Carry (F112)
Ch											○	9	○		
n	○	○	○	○	○	○	○		○	○	○				
S	○	○	○	○		○	○		○	○					
SS	○	○	○	○		○	○		○	○					

Input Condition	No protocol Communication	Channel	No. of Sending byte	Sending Byte Area	Status
	DSND	Ch	n	S	SS

Flag	Designation
Error (F110)	Error flag turns on, when designating area is over.
Ch	Designated communication channel
n	Number of data to sending by bytes
S	Device address which is stored communication data
SS	Device address which is displayed communication status

■ DSND Ch n S SS

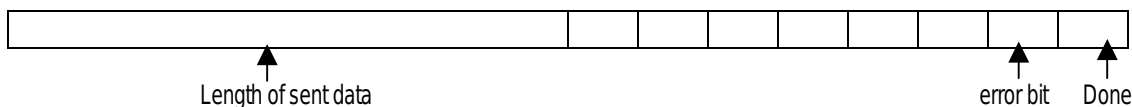
(1) Function

- When the execution condition is on, the No protocol communication starts
- 'n' represents the number of data to send (unit of byte) and Sending data is stored in device 'D'
- 'Ch' is designated communication channel and Communication status is saved in 'SS'.

(2) Example program

P0040	DSND	00000	00010	D0100	M000
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- When the execution condition P0040 is on, the communication starts with channel 1
- Length of sending data which is stored in D0100 is 10 byte and the communication status is stored in M000.

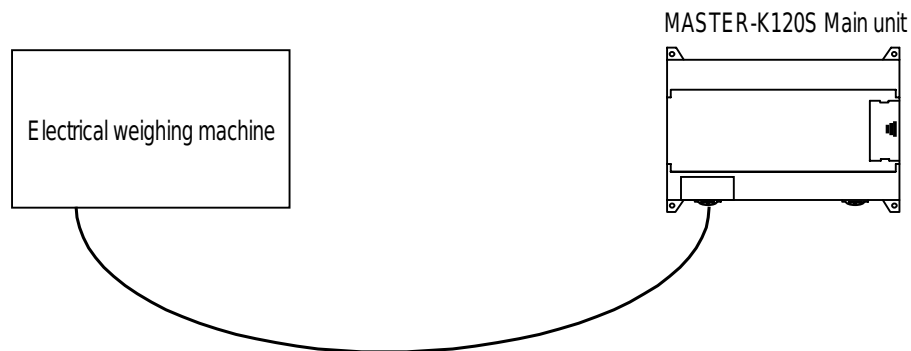


(3) Error code

Code	Error	Description
06	Parameter Error	Communication parameter setting error
08	Slave Device Busy	Slave device is busy
09	Frame Type Error	Size of sending byte is out of range

8.4.4 Examples

Assume that a electrical weighing machine sends data which has unfixed size continuously. MASTER-K120S can communicates with it using no protocol.



For no protocol communication, one of following ending condition is designated. One is size of received data and the other is whether it has some pre-defined data.

In this example, assume that received data is as following.

“ENQ(1Byte) + Station No.(1Byte) + Data(1~10 Words) + EOT(1Byte)”

When above frame is received, Received framed is saved to designated device If designated 'Receiving Format(Cw)' is h0104. and decides if use these data or not. After that, sends data which is in sending device if required.

Assume that the sending data format is as following.

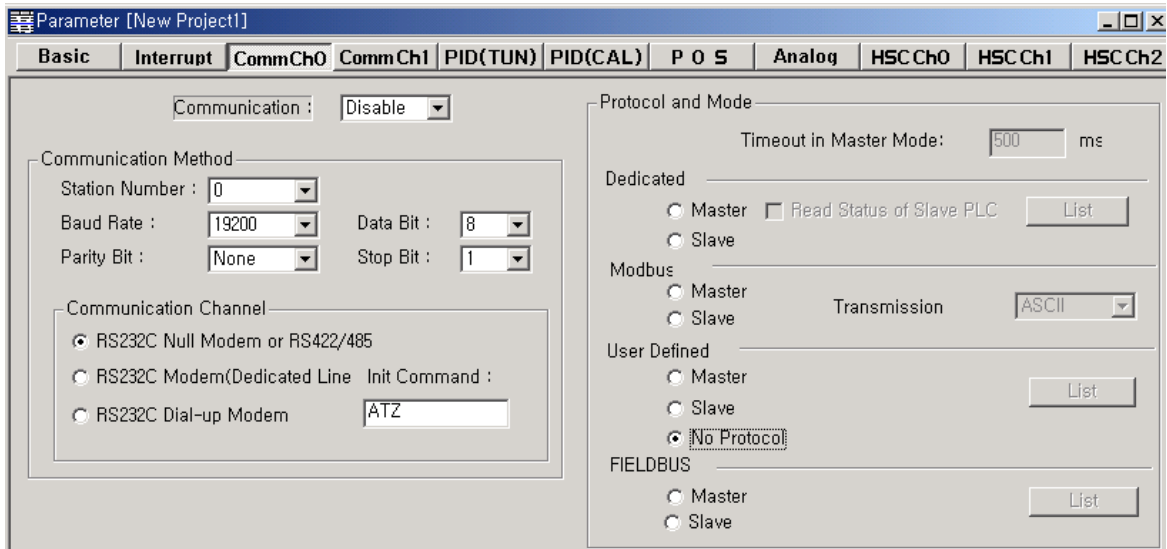
“ACK(1Byte) + Station No.(1Byte) + OK(2Bytes) + EOT(1Byte)”

In this example the size of received data is 1 word.

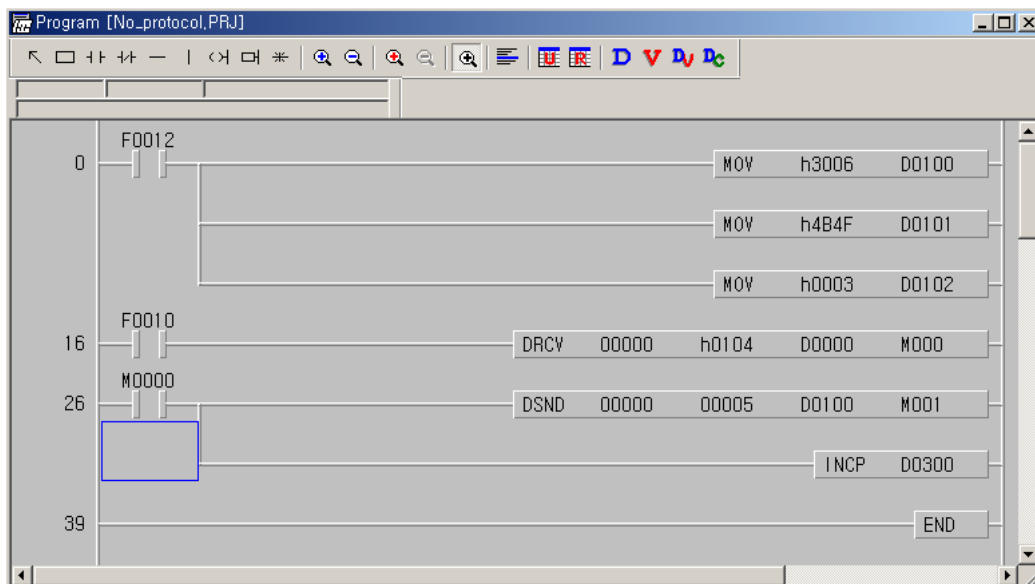
Chapter 8 Communication Functions

1) Communication Parameter Setting

- Open a new project file from KGLWIN
 - K120S must be selected as PLC type.
- After selecting communication parameter from KGLWIN and clicking twice, this window comes up.
- Designate baud rate, data bit, parity bit, stop bit, and protocol.



2) Program



- Save sending data to D0100 : "ack + 0 + OK + ETX"
 - If h'04(EOT) is received, h3004 is saved to D0000, and Weight data to D0111(1 Word)
- Sending 5bytes in D0100 using DSND instruction

8.5 Remote connection and communication I/F module

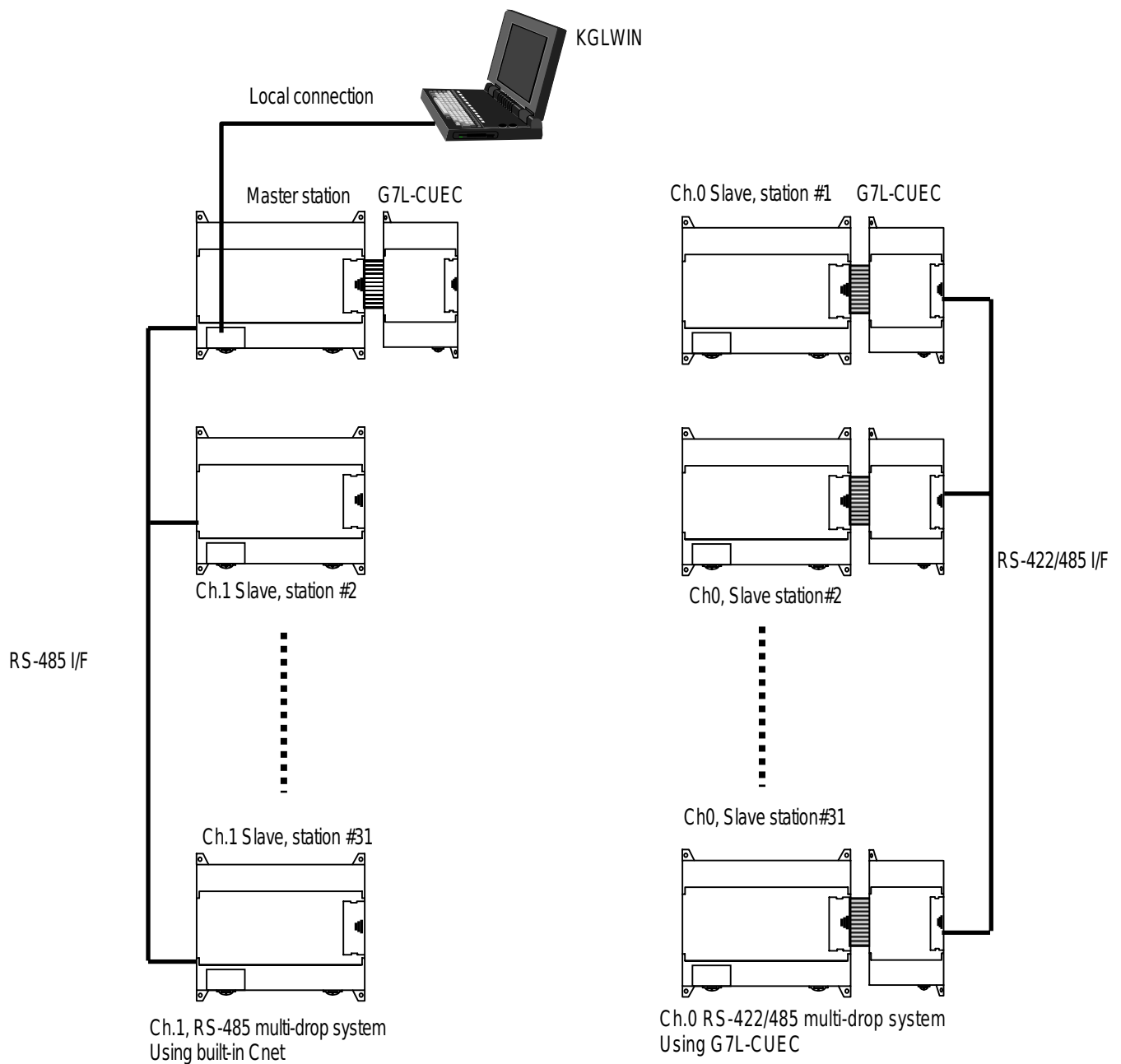
8.5.1 Remote connection

MASTER-K120S series can connect to other PLC by built-in Cnet interface or communication I/F modules.

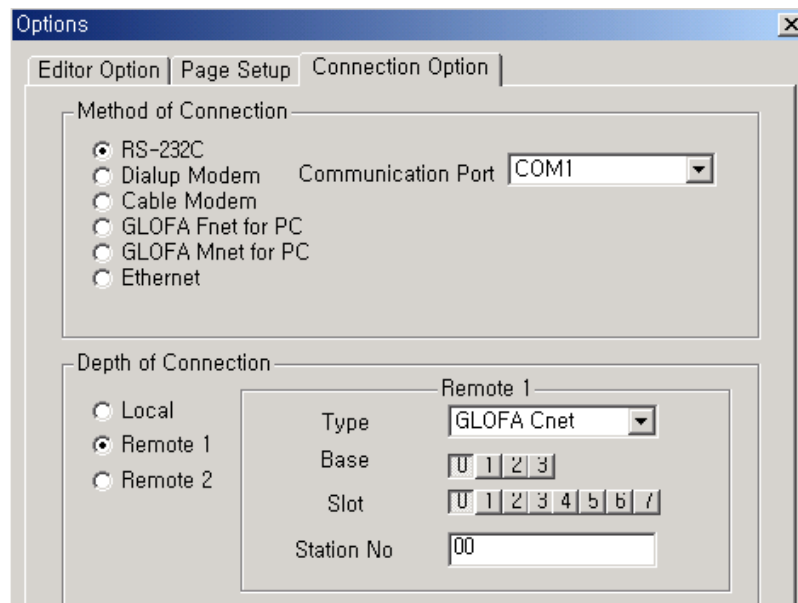
1) Remote connection by built-in Cnet I/F

Remote connection by built-in Cnet I/F is available by dedicated communication protocol only.

If KGLWIN and Master station is connected physically, it can connect to each slave station using remote connection function.



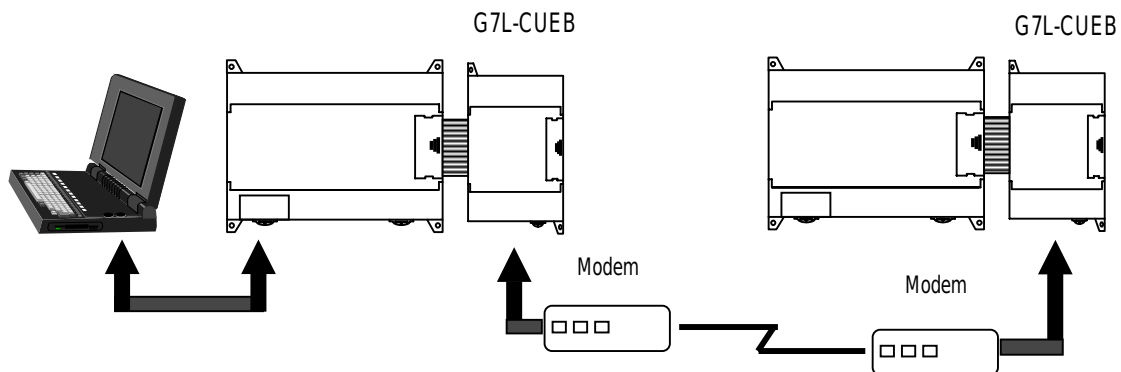
- Open a new project file from KGLWIN
- After selecting menu-project-option, click 'connection option'



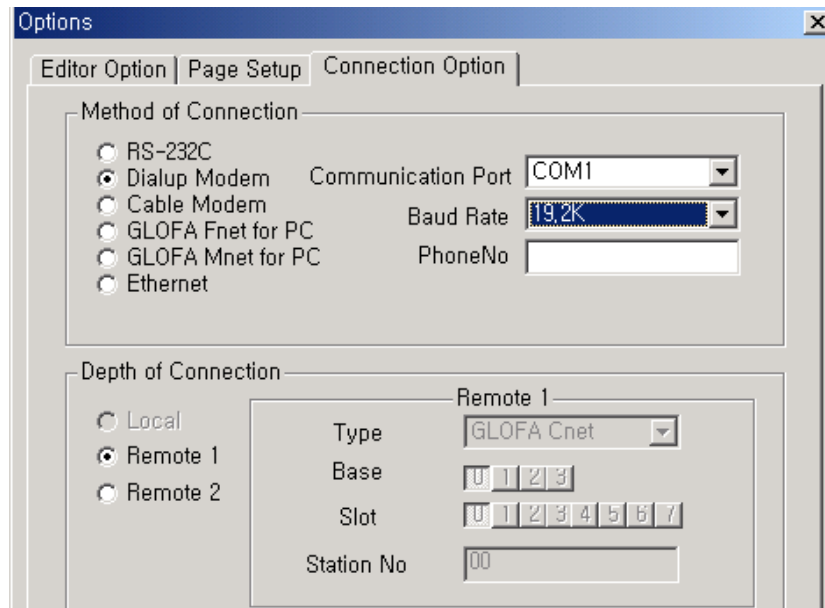
- Click 'Remote 1' in depth of connection
 - Type : Select GLOFA Cnet
 - Base : Select '0'.
 - Slot : set to 0 when uses channel 0, and '1' when uses channel 1
 - Station No. : Input slave station number to connect
- Click 'OK'
- Remote connection is available by dedicated protocol only

2) Remote connection by modem

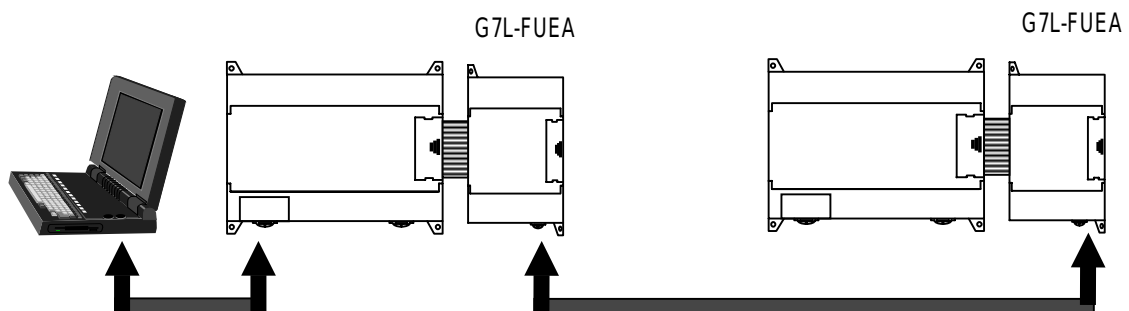
Remote connection by modem is available by G7L-CUEB I/F module.
In this time, TM/TC switch of G7L-CUEB module must be set to 'On'.



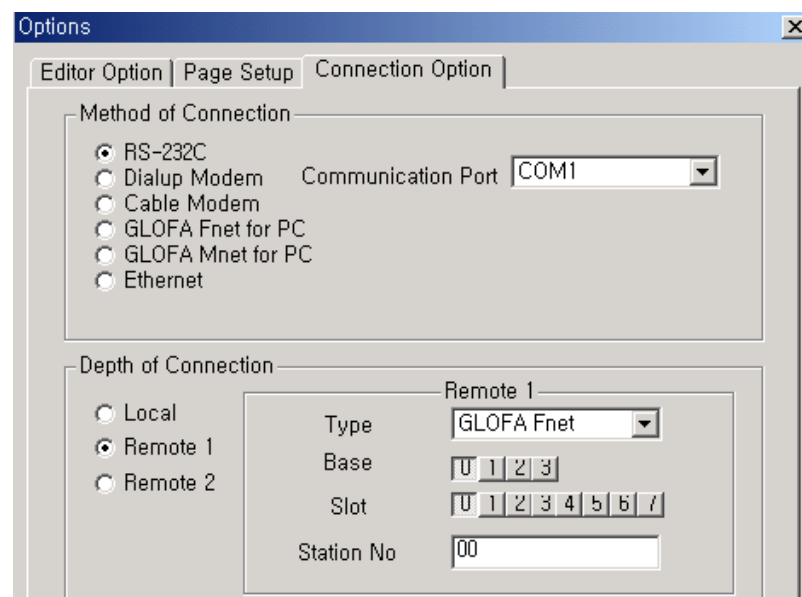
- Dedicated modem and dial-up modem are both available and Set connection option of KGLWIN as below.



3) Remote connection by Fnet I/F module



- Remote connection by Fnet interface is available by setting connection option of KGLWIN as below



8.5.2 Communication I/F module

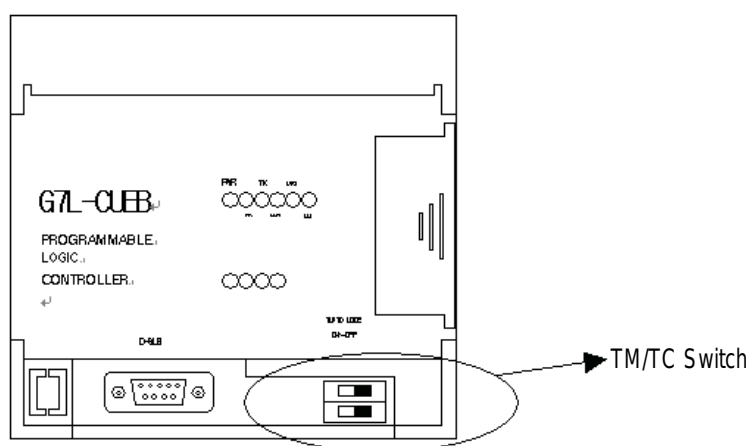
MASTER-K120S series supports various kinds of communication I/F module.

In this time, Built-In Cnet in main unit must be set to 'Off' as below and only one communication module can be extended



1) Usage of G7L-CUEB

Using G7L-CUEB, MASTER-K120S can connect to other PLC by dedicated modem or dial-up modem

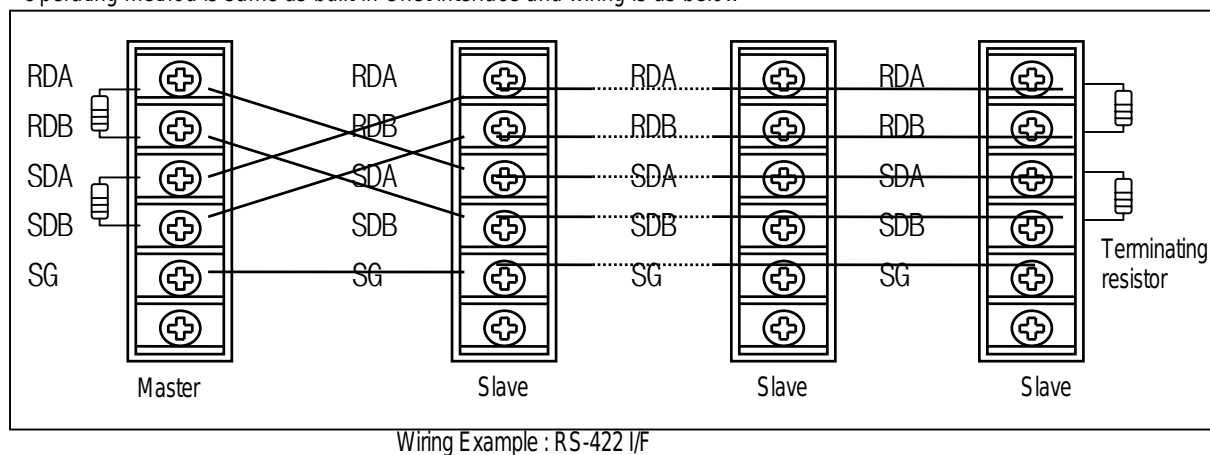


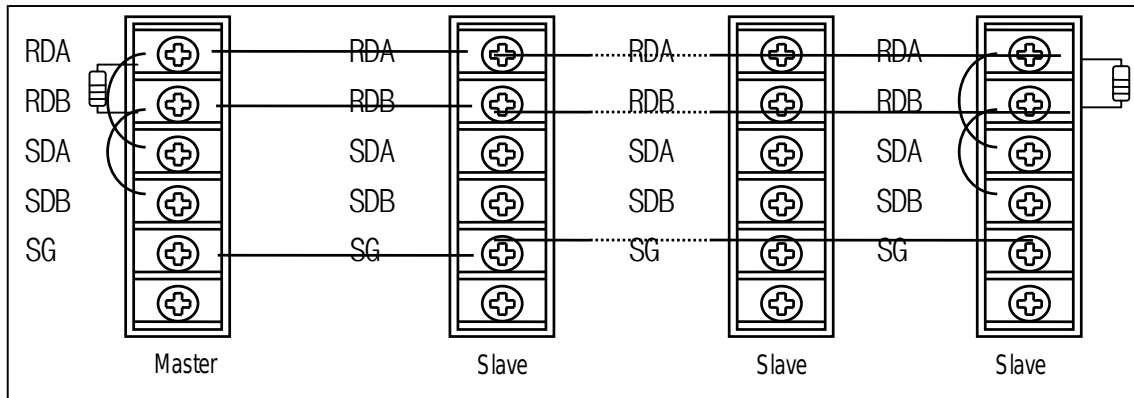
- Set TM/TC switch to 'On' when uses remote connection function
- Set TM/TC switch to 'Off' when uses data communication function
- Data communication and remote connection function are not allowed simultaneously
- Data communication mode supports every communication protocol but In remote connection function supports dedicated protocol only.

2) Usage of G7L-CUEC

Channel 0 can be used as RS-422/485 I/F by using G7L-CUEC I/F module

Operating method is same as built-in Cnet interface and wiring is as below

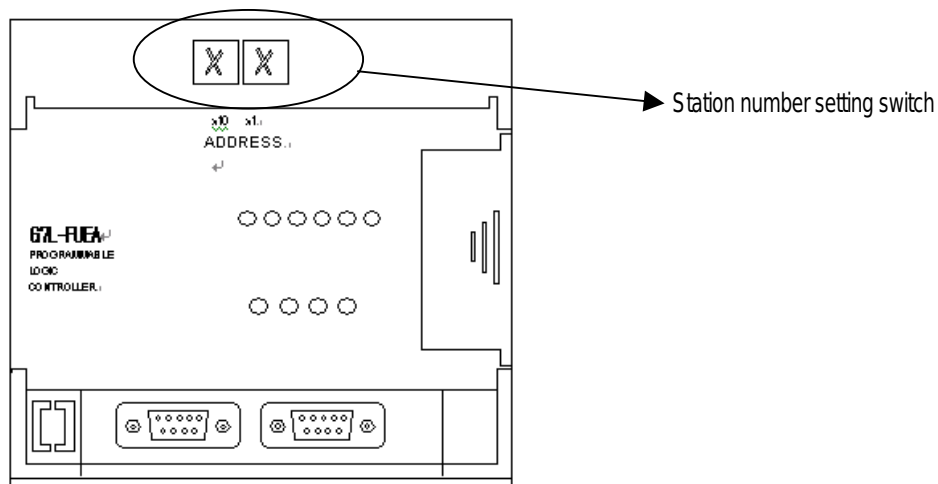




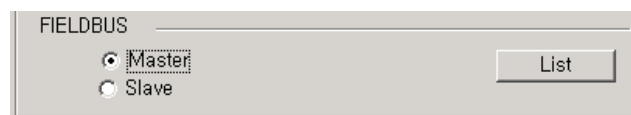
Wiring Example : RS-485 I/F

3) Usage of G7L-FUEA/RUEA

G7L-FUEA and G7L-RUEA are Field Bus Interface module of LGIS and they support High speed link communication service by parameter setting. But communication by command(Read, Write) are not available

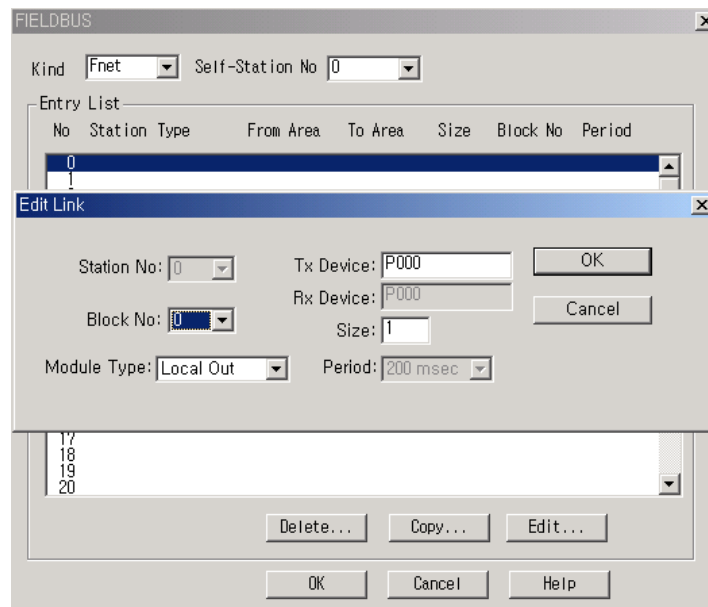


- After selecting communication parameter from KGLWIN and select FIELDBUS MASTER as below



Chapter 8 Communication Functions

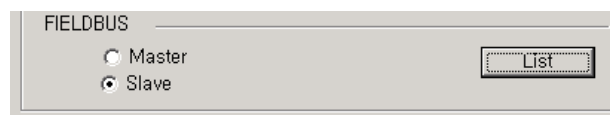
- Clicking List button then this window comes up.
- Designate self-station No. and set link items after double clicking entry list
- For the details, refer to User's manual of Fnet I/F module



4) Usage of G7L-PBEA/DBEA

G7L-PBEA support profibus slave function only and G7L-DBEA supports DeviceNet slave interface function only .

- After selecting communication parameter from KGLWIN and select FIELDBUS slave as below



- Clicking List button then this window comes up.
- After double clicking entry list 0, designate from/to area
- P net For maximum Sending/Receiving data size is 244 byte and that of DeviceNet are 30/32 byte.
- For the details, refer to corresponding User's manual

