Document No. LEC-OM02201

Operation Manual

Product name

LEC Serial Communication Information

Model/ Series

LEC□6 Series

SMC Corporation

Contents

LEC□6 Series/ Serial Communication
1. Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution", "Warning" or "Danger". They are all important notes for safety and must be followed in addition to International standards (ISO/IEC), Japan Industrial Standards (JIS)[*1)] and other safety regulations[*2)].

*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems
ISO 4413: Hydraulic fluid power -- General rules relating to systems
IEC 60204-1: Safety of machinery -- Electrical equipment of machines (Part 1: General requirements)
ISO 10218-1992: Manipulating industrial robots -- Safety
JIS B 8370: General rules for pneumatic equipment
JIS B 8361: General rules for hydraulic equipment
JIS B 9960-1: Safety of machinery - Electrical equipment of machines. (Part 1: General requirements)
JIS B 8433-1993: Manipulating industrial robots - Safety.
*2) Labor Safety and Sanitation Law, etc.

Caution	indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
Warning	indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury
Danger	indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Warning

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results. The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product. This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly. The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed

to direct sunlight.
2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.
3. An application which could have negative effects on people, property, or animals requiring special safety analysis.
4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

1. Safety Instructions

⚠Caution

Our products are provided for use in manufacturing industries.
The product herein described is basically provided for peaceful use in manufacturing industries. If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary. If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer/Compliance Requirements

The product used is subject to the following "Limited warranty and Disclaimer" and "Compliance Requirements".
Read and accept them before using the product.

Limited warranty and Disclaimer

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered. *3)
Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided. This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

***3) Vacuum pads are excluded from this 1 year warranty.**
A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.
Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

Compliance Requirements

When the product is exported, strictly follow the laws required by the Ministry of Economy, Trade and Industry (Foreign Exchange and Foreign Trade Control Law).

2. Outline

The electrical actuator controller LEC□6 series has a serial communication port with transmission line (physical layer) corresponding to RS485.

With this serial communication, the following operations can be performed using the controller LEC□6

(1) Movement instruction of registered step data.

(2) Editing of step data.

(3) Reading of position and speed data.

(4) Direct instruction of position, speed and thrust force and operation

This document explains the use of LEC serial communication.

Please use it together with the operation manual of the electrical actuator LEC□6 series.

3. What is LEC serial communication?

It is serial communication performed by a protocol equivalent to Modbus RTU with a transmission line corresponding to RS485.

With serial communication, internal relays, data memory and so on can be operated.

Within the controller there are internal relay's and data memory that can change and check the data inside controller, operate actuator by accessing these.

The table below shows an outline of the memory that can be accessed by ~~this~~ serial communication.

Name	Address	Contents
Internal relay area	X40～X4F Y0～Y1F, Y30	Internal relay that shows input/ output status of parallel I/O and internal status of controller. By operating the internal relays, the controller can be operated as if it was instructed from the parallel I/O.
Step data area	D0400～D043F	Memory area where contents of step data are saved. If data is written here, the contents of the step data will ~~be~~ change~~d.~~
Status data area	D9000～D9006	Current Position and speed data etc. are saved. By reading this data, it is possible to confirm ~~present~~ current position and speed etc.

⚠ Caution

- Settings inherent to the controller are saved in the addresses other than the ranges above. Please do not access this area.
- The step data area (D0400～D043F) is EEPROM. The guideline for the number of times it is possible to write to EEPROM is 100,000 times, please avoid frequent writing to EEPROM.
- The internal relay area and status data area are RAM access. When the control power supply is turned off, the set values will be reset.

The serial communication frame is shown below. Reading and writing of data is specified by "Function", address and data are specified by "Data". Please refer to Chapter 9 onwards for details of "Function".

ID	Function	Data	CRC Check
1 byte	1 byte	N bytes	2 bytes

ID specifies the controller for communication. The initial default setting of the controller is 1.

CRC Check is a 16 bit CRC Check code for the communication data. The receiving device confirms the received data and CRC Check code, if communication is normal (error free), initiates the processing. For details please refer to the communication specification in Chapter 7.

4. Operation example 1: Running with specified step data

Examples shown below are for operating the internal relay's to specify step data using serial communication. This is the same as parallel I/O. For details of communication specifications, function details and internal relay's, please refer to Chapter 7 onwards. Sent data examples are given for when the controller ID = 01. The CRC codes are values calculated to fit the sent data examples. They depend on the sent data.

The status of the flags for each operation example will depend on the operation process after the power is turned "ON". It is possible that they could be different from the operation examples.

4.1 Operation preparation

4.1.1 Write 1 to the flag (Y30) that enables operating instructions by serial communication.

【Sent data example】 【CRC calculation example】

01 05 00 30 FF 00 8C 35 35 8C

4.1.2 Write 1 to SVON (Y19) to turn the servo on.

【Sent data example】 【CRC calculation example】

01 05 00 19 FF 00 5D FD FD 5D

4.1.3 Confirm that SVRE (X49) has become 1.

【Sent data example】 Read (X40-X4F) 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Reply data example】

01 02 02 00 02 38 79

↑ X49 is the 2nd bit.

4.2 Return to origin position

4.2.1 Write 1 to SETUP (Y1C) to start return to origin position operation.

【Sent data example】 【CRC calculation example】

01 05 00 1C FF 00 4D FC FC 4D

4.2.2 When return to origin position operation is completed, SETON (X4A) becomes 1. Confirm that SETON (X4A) has become 1.

【Sent data example】 Read (X40-X4FP) 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Reply data example】

01 02 02 00 0E 38 7C

↑ X4A is the 3rd bit.

4.2.3 When operation is complete, set SETUP (Y1C) to 0.

【Sent data example】 【CRC calculation example】

01 05 00 1C 00 00 0C 0C 0C 0C

4.3 Operation

Write step data numbers to Y10～Y17.

【Sent data example】 Select step data No.2 【CRC calculation example】

01 0F 00 10 00 08 01 02 BE 97 97 BE

【Sent data example】 Write 1 to DRIVE (Y1A) to start operation. 【CRC calculation example】

01 05 00 1A FF 00 AD FD FD AD

4.4 Operation completion

Read the sent data example (X40-X4F) and if INP (X4B) is 1, it is possible to confirm operation completion (it has reached within the “In position”). When operation is completed, please write 0 to DRIVE (Y1A).

【Sent data example】 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Reply data example】

01 02 02 00 0E 38 7C

↑ X4B is the 4th bit.

【Sent data example】 Write 0 to DRIVE (Y1A). 【CRC calculation example】

01 05 00 1A 00 00 EC 0D 0D ED

5. Operation example 2: Editing step data

Step data is saved in D0400 onwards. To edit step data, please write data to these addresses.

【Sent data example】 Set step data No.1 “position” to 150.00 【CRC calculation example】

01 10 04 12 00 02 04 00 00 3A 98 52 B0 B0 52

↑(1) ↑(2)

(1) Destination address for writing: 0400h + 10h x 1【Step data No】+ 02h = 0412h

(2) Writing data: 150.00 x 100＝15000＝3A98h

6. Operation example 3: Reading position and speed data

Current position and current speed are saved in D9000 onwards. This data can be confirmed by reading these addresses.

【Sent data example】 Read position data (D9000) 【CRC calculation example】

01 03 90 00 00 02 E9 0B 0B E9

【Reply data example】

01 03 04 00 00 3A 98 E9 39

3A98h ＝ 15000 → 150.00mm

7. Operation example 4: Direct instruction of position and speed and operation

7.1 Operation preparation

7.1.1. Write 1 to the flag (Y30) that enables operating instructions by serial.

【Sent data example】 【CRC calculation example】

01 05 00 30 FF 00 8C 35 35 8C

7.1.2 Write 1 to SVON (Y19) to turn the servo on.

【Sent data example】 【CRC calculation example】

01 05 00 19 FF 00 5D FD FD 5D

7.1.3 Confirm that SVRE (X49) has become 1.

【Sent data example】 Read (X40-X4F) 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Reply data example】

01 02 02 00 02 38 79

↑ X49 is the 2nd bit.

7.2 Return to home position

7.2.1 Write 1 to SETUP (Y1C) to start return to home position operation.

【Sent data example】 【CRC calculation example】

01 05 00 1C FF 00 4D FC FC 4D

7.2.2 When return to home position operation is completed, SETON (X4A) becomes 1.

(Confirm that SETON (X4A) has become 1.)

【Sent data example】 Read (X40-X4F) 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Reply data example】

01 02 02 00 0E 38 7C

↑ X4A is the 3rd bit.

7.2.3 When operation is complete, set SETUP (Y1C) to 0.

【Sent data example】 【CRC calculation example】

01 05 00 1C 00 00 0C 0C 0C 0C

7.3 Operation

When you write “1” to D9100 after writing step data to D9102 to D9110, operation starts according to the contents of D9102 to D9110. (Refer to “10. 2 Running with specified data” for details of each address.)

An example of shift to 300mm position is shown below.

7. 3. 1 Writing step data

【Sent data example】 【CRC calculation example】

Write step data showing the operation content to D9102 to D9111. 48 72

01 10 91 02 00 10 20 00 01 01 F4 00 00 75 30 13 88 13 88 00 00 00 00 00 14

(1) (2) (3) (4) (5) (6) (7) (8)

00 64 00 00 00 00 00 00 00 00 00 00 00 64 72 48

(9) (10) (11) (12)

The content of the above sent data will be as follows:

(1) Movement Mode :Absolute
(2) Speed :500
(3) Position :300.00
(4) Acceleration :5000
(5) Deceleration :5000
(6) Pushing force :0
(7) Trigger Level :0
(8) Pushing speed :20
(9) Moving force :100
(10) Area output end 1 (area 1) :0.00
(11) Area output end 2 (area 2) :0.00
(12) In position :1.00

7. 3. 2 Start operation

When writing 0100h to D9100, operation will start.

【Sent data example】 【CRC calculation example】

01 10 91 00 00 01 02 01 00 27 09 09 27

7. 3. 3 Confirm operation is completed

If reading sent data example (X40-X4F) and INP(X4B) is 0, it is possible to confirm that operation is completed (the positioning width has been reached).

【Sent data example】 【CRC calculation example】

01 02 00 40 00 10 78 12 12 78

【Sent data example】

01 02 02 00 0E 38 7C

↑ X4B is the 4th bit.

8. Communication specifications

Serial communication with higher-level equipment is by Modbus Protocol compatible single master/ multi slave method. The higher-level equipment is the master and this controller is the slave.

When a query is issued from the master (higher-level equipment), the slave (controller) receives the query and returns a response. (The slave does not issue queries.)

But if a query is issued with broadcast specification, there is no response from the slave.

Item	Method/ condition
Interface	RS485
Communication method	Half duplex communication
Synchronization method	Start stop synchronization
Transmission mode	Modbus Protocol RTU mode
Communication speed (bps)	Can be selected from the speeds below, by parameter setting of the controller 9600 / 19200 / 38400 / 57600 / 115200 / 230400 (Initial value 38400)
Bit length	8 bit
Stop bit	1 bit
Parity	None

⚠ Caution

If using a Teaching Box (LEC-T1), set the communication speed to 115200 (bps) or less. If it is set to a value over 115200 (bps), the Teaching Box will not be able to communicate with the controller.

8.1 Communication frame

The communication frame is shown below.

Address	Function	Data	CRC Check
1Byte	1Byte	N Bytes	2 Bytes

8.1.1 Address

Sets the address of the slave.

When this value corresponds to the "Controller ID" in the "basic parameters", the comunication data is judged to be sent to itself.

But if the value is 0 (zero), it becomes broadcast specification (sent to all stations).

(In this case, no response is returned.)

The “Address” values and meanings are as follows.

0(00) : Broadcast specification (no response from slave)

1(01h) to 255(FFh) : Controller ID

8.1.2 Function

The table below shows the function codes and functions that can be used with this controller.

(For details of each code, refer to “8. Function details”.)

Code (Hex)	Name	Function	Broadcast specification
01h	Read output signal (Y)	Read Y contact	Not possible
02h	Read input signal (X)	Read X contact	Not possible
03h	Read data (D)	Read parameters and other data	Cannot read X, Y contacts
05h	Forced signal output (Y)	Write one Y contact	Possible (*1)
08h	Echo back	Communication test by echo back	Not possible
0Fh	Output signal batch write	Write all Y contacts	Possible (*1)
10h	Write data (D)	Write parameters and other data	Cannot write Y contact

(*1) When in broadcast specification, the motor controller does not return a response.

8.1.3 Data

Data corresponding to each function code. Maximum 256 Bytes.

8.1.4 CRC Check

16 bit CRC Check code for communication data. The motor controller communication specification is “Modbus Protocol compatible”, so the CRC check method also conforms to the RTU mode of the Modbus Protocol. (The CRC check of the RTU mode is CRC-16 (polynomial data = A001h).

When sending, CRC data is calculated and added to the transmission frame.

When receiving, the CRC of the received data is calculated and compared with the CRC data attached to the received frame. If the CRC does not match, there will be no response.

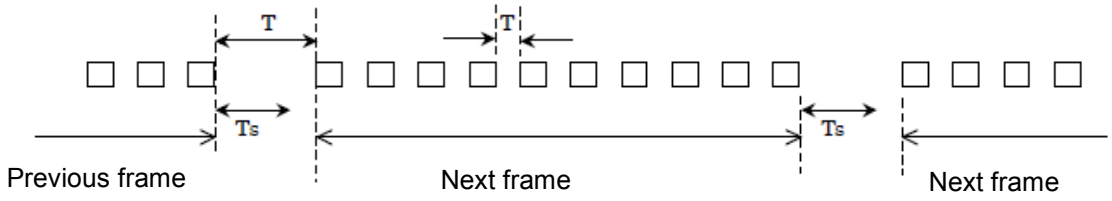
8.2 Silent interval

In RTU mode of the Modbus Protocol, delimiter judgment of the communication frame is done by time (silent interval).

In other words, the interval between characters in the communication frame (T) is compared to the silent interval (Ts) and judged as follows.

When T ≧ Ts : Delimiter (end of communication frame)

When T ＜ Ts : Part of communication frame



The silent interval (Ts) is specified in “Motor parameters”. Note that the unit of the parameter is a multiple of the basic interval (=3.5 Char). 1 Char is 10 bits.

The initial value of "Motor parameters" "Silent interval” is 1.

8.3 Communication delay time

It is possible to set a delay time after receiving a query (transmission frame from the master) before starting to send the response. This time is specified in “Motor parameters” “Minimum communication delay time”.

The initial value of "Motor parameters" “Minimum communication delay time” is “5ms”.

8.4 Response time

The time Tx from when the master sends the query to when this controller finishes sending the response is as follows. If the master re-sends the query, please wait for at least time Tx from the previous transmission before resending. (Tx does not include the query communication time)

Tx ＝ Ts + T0 + Td + (10 x Br / Kbr) ［ms］

Ts : Silent interval time

(1 / communication speed bps x (silent interval set value x 3.5 Char x 10 bit))

T0 : Internal processing time (4ms) x 1.5 (safety factor)

Td : Communication delay time

Br : Number of Bytes of response messages

Kbr : Communication speed [kbps]

8.5 Wiring of serial IO connector (CN4) for LEC

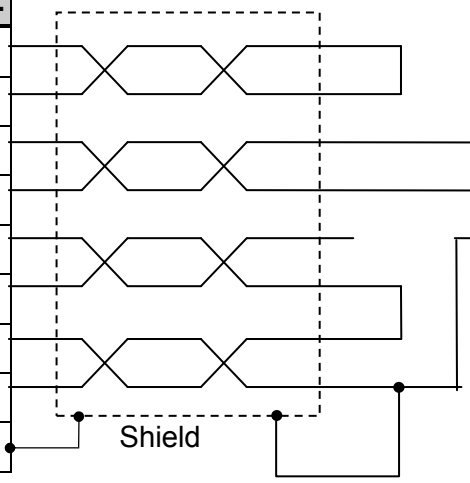
A controller wiring example when one controller is connected to the higher-level communication device is shown below.

LEC controller

Plug for CN4 (modular connector 8P)

Recommended plug: TM21-88P(04) [Hirose Electric]

Name	Pin No.
EMG+	1
EMG-	2
SD+	3
SD-	4
EN_SW+	5
CON	6
DC24V	7
GND	8
Case shield	



Communication device

Communication method: RS485

Name
SD+ (Transmission data +)
SD- (Transmission data -)
SG (Signal ground)

⚠ Caution

・If CON(6) and DC24V(7) are short circuited, movement instruction from serial IO becomes possible. Also, stop signal "EMG+(1), EMG-(2)" becomes effective at this time. If necessary, connect a stop switch to EMG+(1), EMG-(2).

・EN_SW+ is a signal for the teaching box (LEC-T1). Do not connect it.

・For details of the connection with the higher-level equipment, please refer to the operation manual of the higher-level communication equipment.

⚠ Warning

・Enquire to SMC separately if connecting multiple controllers to the higher-level equipment.

・Power supply 0V of all controllers for communication and power supply 0V of the higher-level equipment should have the same potential.

・Be sure to turn power “off” before removing connectors, otherwise the controller may be damaged.

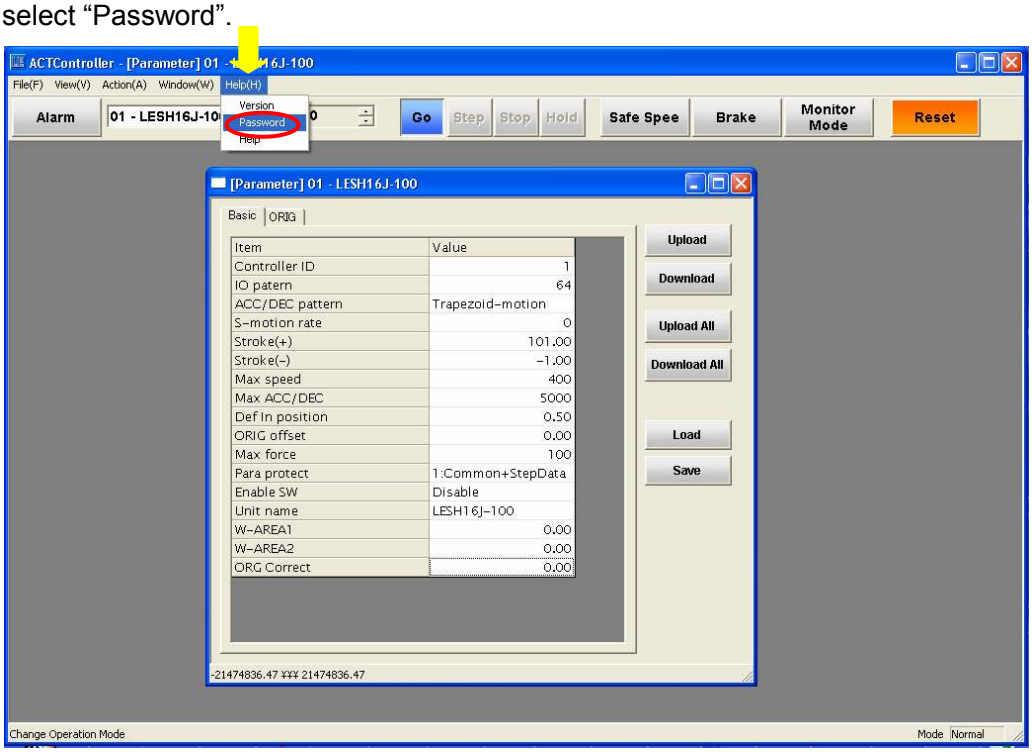
8.6 How to change parameters (example)

The procedure for changing “Communication speed”, “Silent interval” and “Minimum delay time” is shown below. Please follow steps 1 to 9.

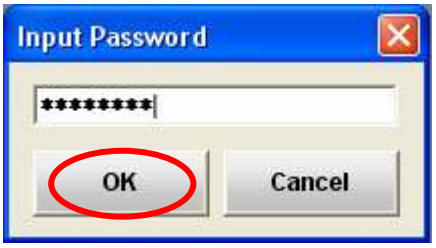
(Example)

Communication speed	38400		57600
Silent interval	1	⇒	10
Minimum delay time	5		50

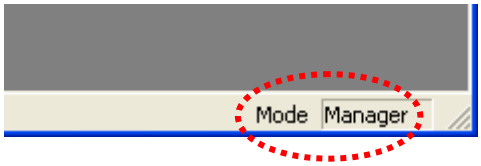
① Start up the controller setting software in normal mode, click on “Help” (circled in red below) and select “Password”.



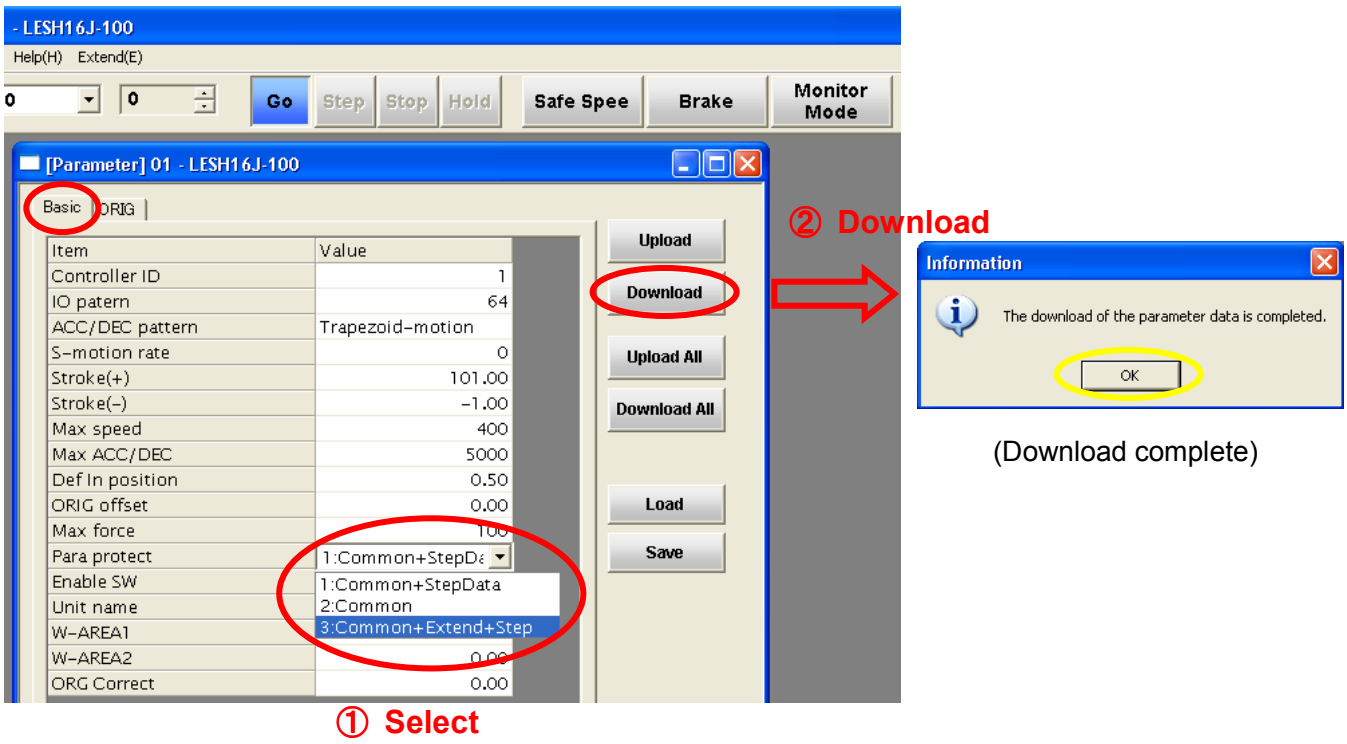
② The password input screen is displayed. Input **password** and click on “OK”.



If the input is successful, “Manager” is displayed on the lower right of the screen.

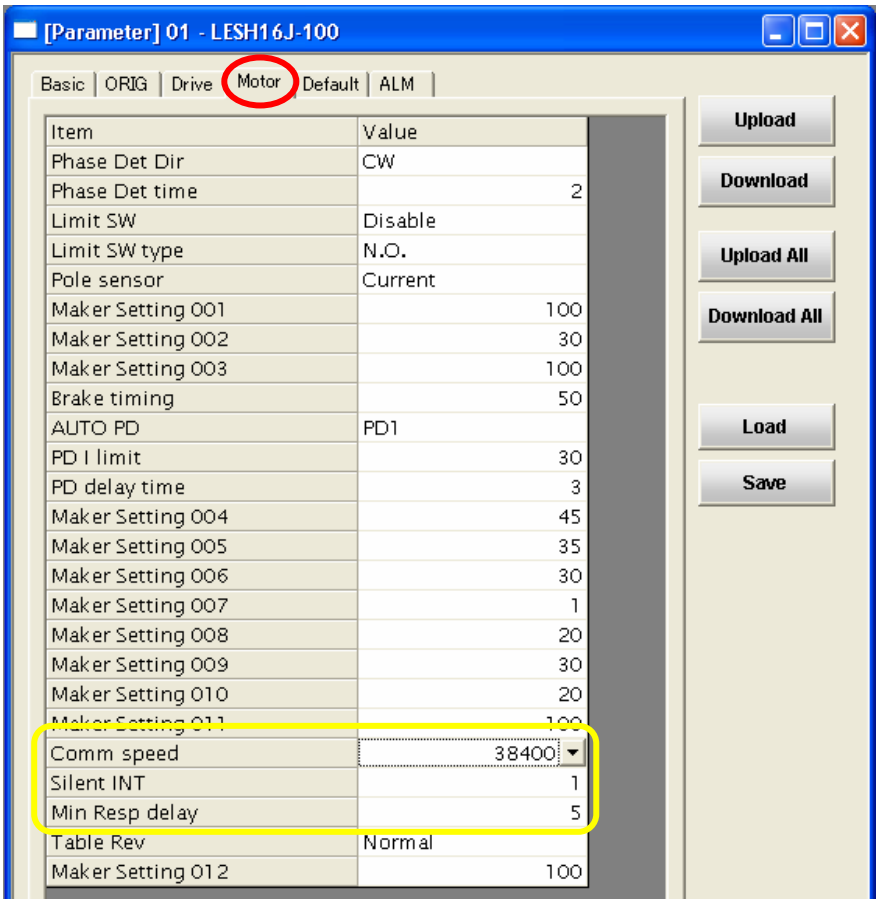


③ “3: Basic + extended + step” is added to the Parameter Protect of the basic parameters. Select “3: Basic + extended + step” and click on “Download”.



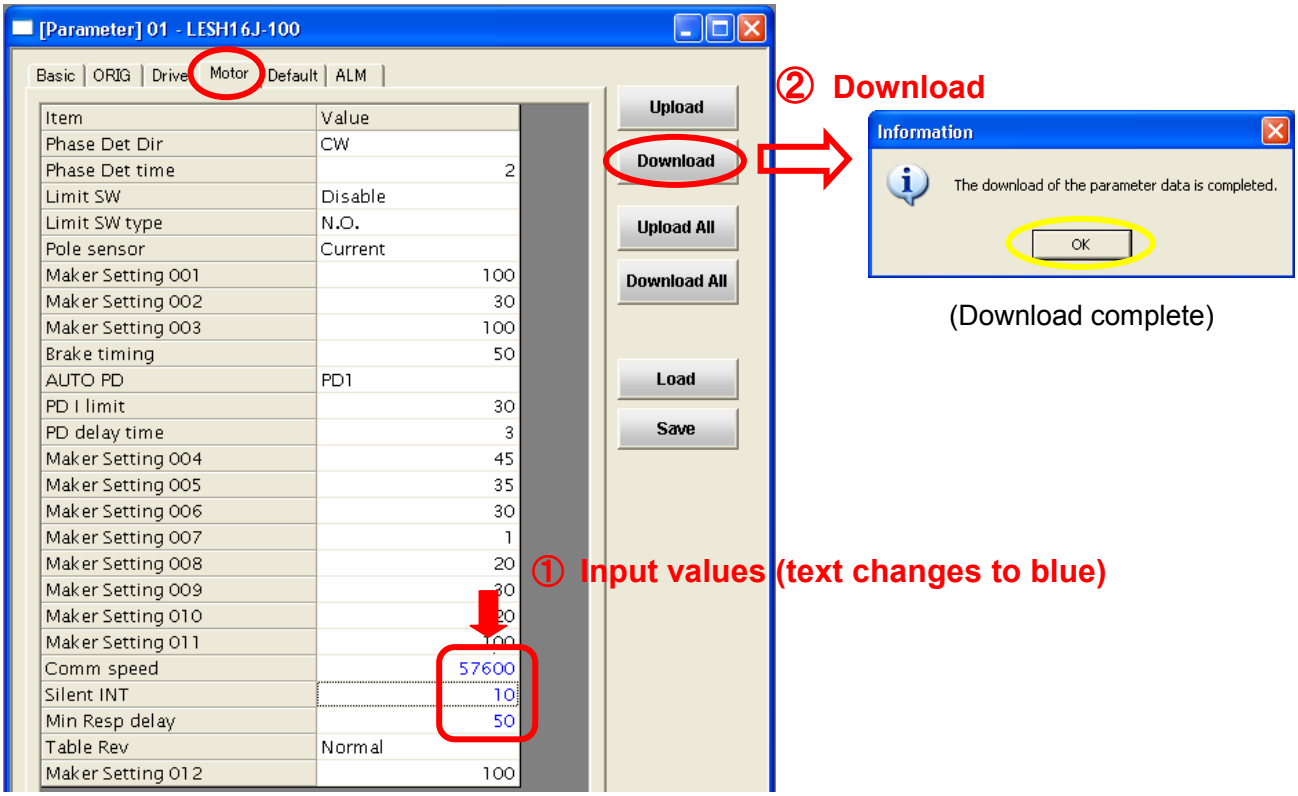
(Download complete)

④ The extended parameters are displayed. Select the motor parameter.
(It is possible to change “Communication speed”, “Silent interval” and “Minimum delay time”.)



⑤ Change the “Communication speed”, “Silent interval” and “Minimum delay time” values and click on “Download”. The values will be reflected by the controller.

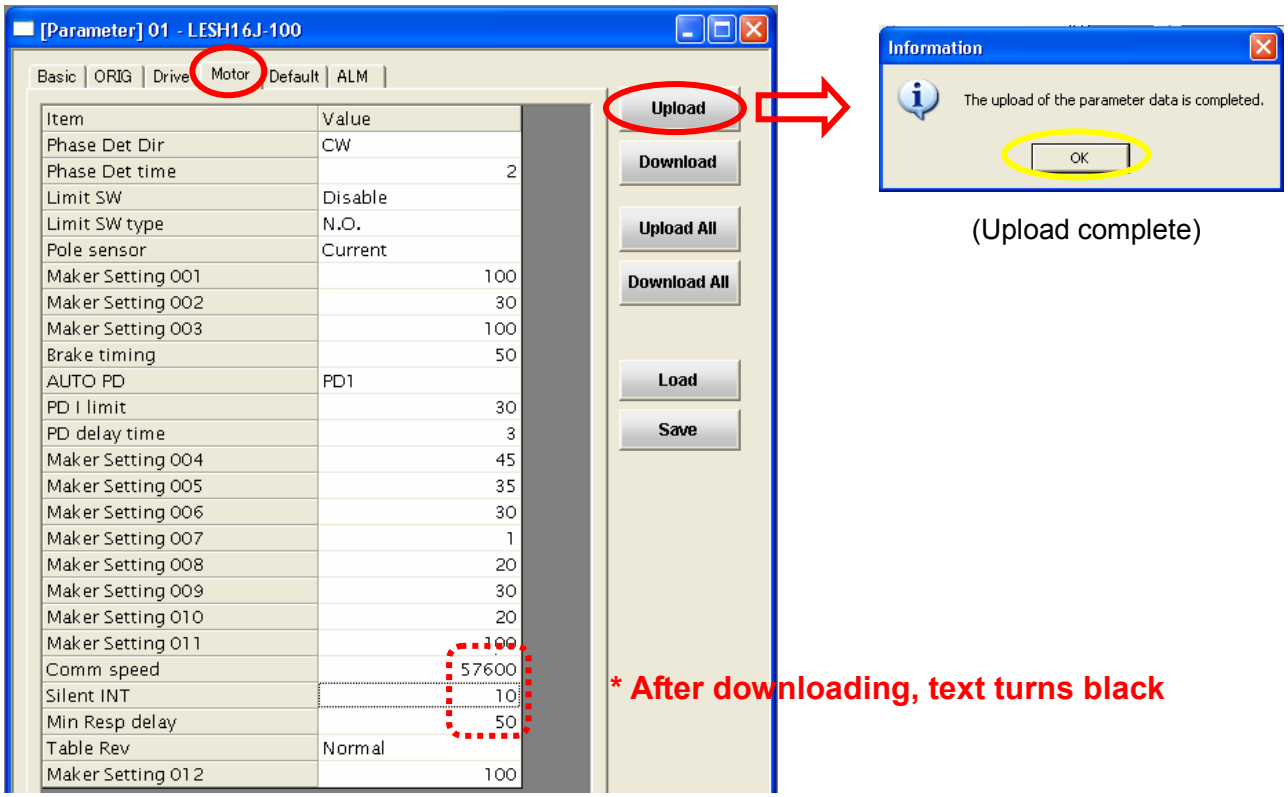
(*When the values are changed the text changes to blue. When downloaded, the changed values turn black.)



(Download complete)

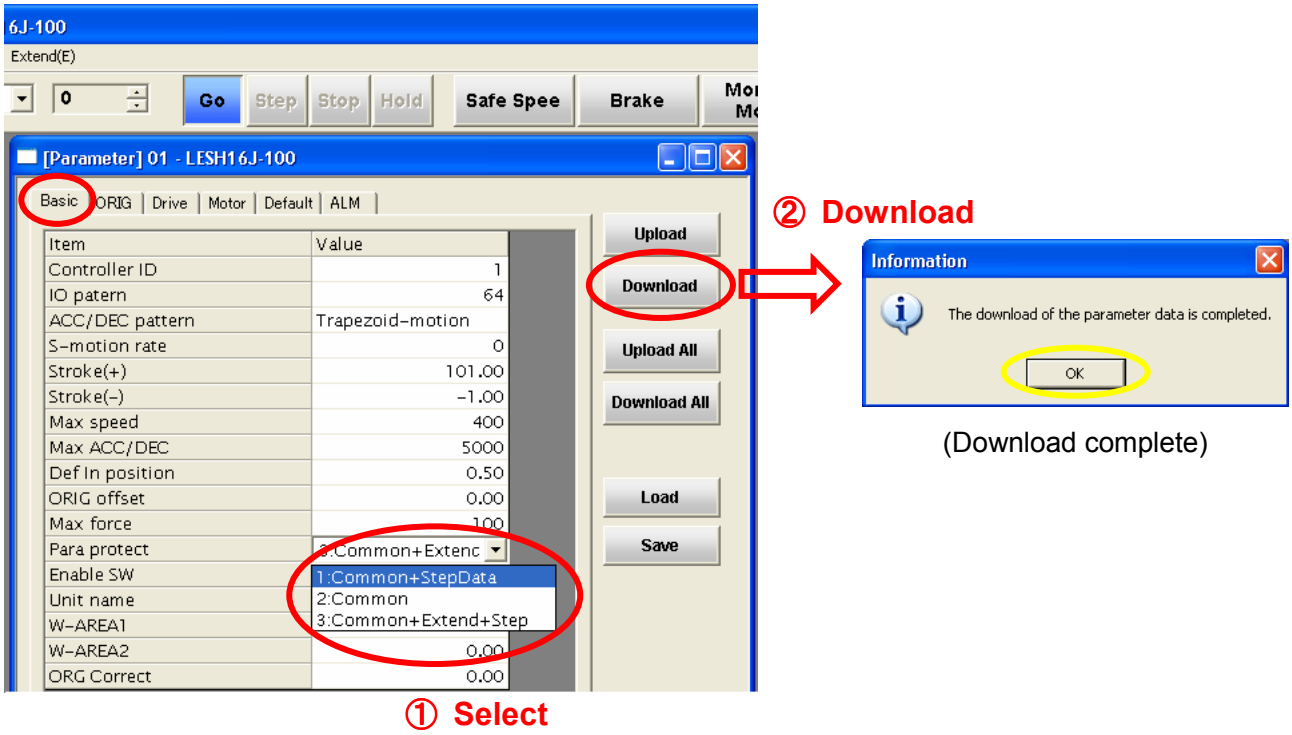
⑥ To confirm, after “download” click on “upload”.

Confirm that the values you set have been recorded.



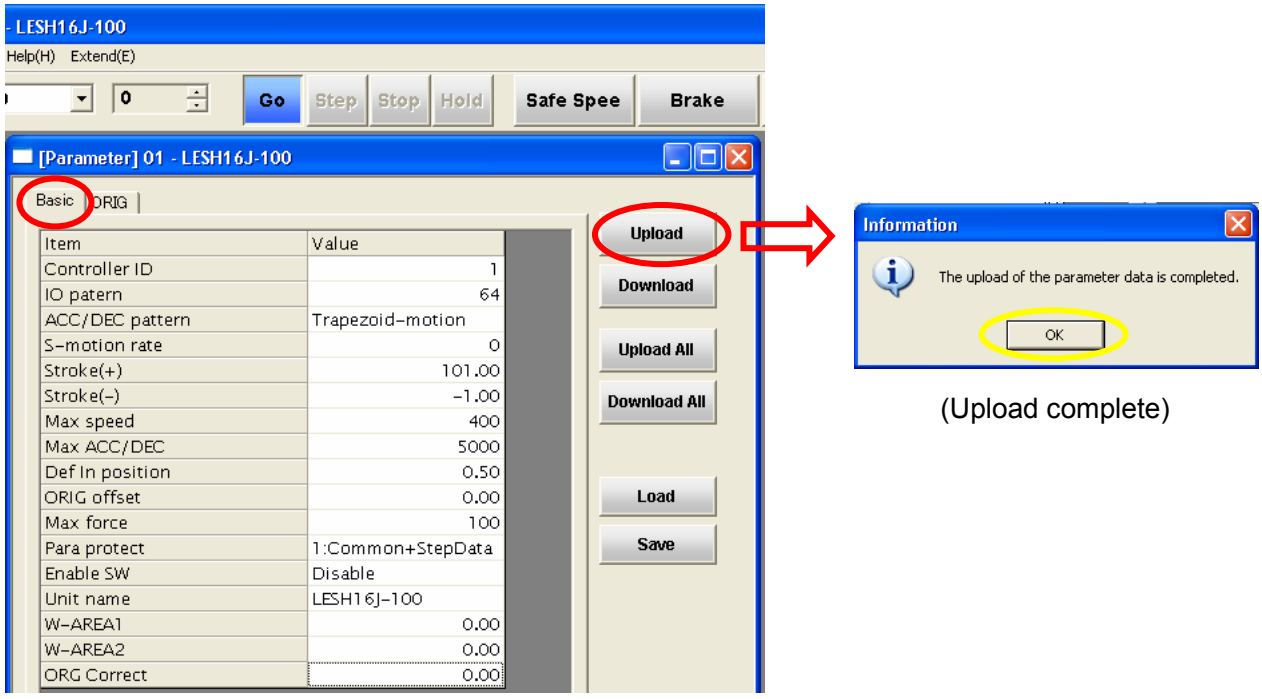
(Upload complete)

⑦ If the set values are recorded, select [1: Basic + step data] of the Parameter Protect of basic parameters, and click on “Download”.



⑧ To confirm, after “download” click on “upload”.

If [1: Basic + step data] of the Parameter Protect of basic parameters is registered, the parameter change work is completed.



⚠ Warning

- This change involves changing extended parameters. Do not change parameters that are not mentioned in the procedure.
- Do not click on [Download All]. Other parameters will be changed as a batch, so parameters that cannot be changed may be changed, causing ignition, malfunction and damage to the actuator and controller.

9. Function details

9.1 Read output signal (01h)　* Broadcast not possible

Performs reading of Y contact.

(Example) Read 16 bits of Y10(h)～Y1F(h) from controller with ID=3.

●Query

			Example
1	**Address**		03
2	**Function**		01
3	**DATA**	**Read start number (H)**	00
4		**Read start number (L)**	10
5		**Read points (H)**	00
6		**Read points (L)**	10
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

●Normal response

			Example
1	**Address**		03
2	**Function**		01
3	**DATA**	**Data bytes**	02
4		**Data 1**	00
5		**Data 2**	12
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

	bit7							bit0
Data 1 →	Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10
Data 2 →	Y1F	Y1E	Y1D	Y1C	Y1B	Y1A	Y19	Y18

The examples of data 1 to 3 above are when Y1F～Y10 = 0001 0010 0000 0000.

●Abnormal response

		Example
1	**Address**	03
2	**Function (*1)**	81
3	**Error code (*2)**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

(*1) The function code of the abnormal response is the value when MSB(Most Significant Bit) of the function code of the query is 1.

(*2) Refer to “8.8 Error Codes” for details of error codes.

9.2 Read input signal (02h)　* Broadcast not possible

Performs reading of X contact. (Format is the same as reading output signal (01h)).

(Example) Read 16 bits of X40～X4F(h) from controller with ID=3.

●Query

			Example
1	**Address**		03
2	**Function**		02
3	**DATA**	**Read start number (H)**	00
4		**Read start number (L)**	40
5		**Read points (H)**	00
6		**Read points (L)**	10
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

●Normal response

			Example
1	**Address**		03
2	**Function**		02
3	**DATA**	**Data bytes**	02
4		**Data 1**	04
5		**Data 2**	8E
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

	bit7							bit0
→	X47	X46	X45	X44	X43	X42	X41	X40
→	X4F	X4E	X4D	X4C	X4B	X4A	X49	X48

The examples of data 1 to 2 above are when X4F～X40 = 1000 1110 0000 0100.

●Abnormal response

		Example
1	**Address**	03
2	**Function**	82
3	**Error code**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

9.3 Read data (03h)　* Broadcast not possible

Performs reading of parameters and other data.

(Example) Read 4 words of D0400～D0403 from controller with ID=3.　(2 bytes = 1 word)

●**Query**

			Example
1	**Address**		03
2	**Function**		03
3	**DATA**	**Read start number (H)**	04
4		**Read start number (L)**	00
5		**Read words (H)**	00
6		**Read words (L)**	04
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

●**Normal response**

			Example		
1	**Address**		03		
2	**Function**		03		
3	**DATA**	**Data bytes**	08		
4		**word1 (H)**	00	D0400	Operation method
5		**word1 (L)**	01	D0400	(For 1h)
6		**word2 (H)**	00	D0401	Speed
7		**word2 (L)**	28	D0401	(For 28h)
8		**word3 (H)**	00	D0402	
9		**word3 (L)**	00	D0402	Position
10		**word4 (H)**	06	D0403	(For 640h)
11		**word4 (L)**	40	D0403	
12	**CRC16 (L)**		Calculated value		
13	**CRC16 (H)**		Calculated value		

●**Abnormal response**

		Example
1	**Address**	03
2	**Function**	83
3	**Error code**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

9.4 Forced signal output (05h)　* Broadcast possible

Performs writing of 1 point of Y contact.

(Example) Turn ON Y19 (SVON) of controller with ID=3.

●Query

			Example	
1	Address		03	
2	Function		05	
3	DATA	Contact number (H)	00	
4		Contact number (L)	19	
5		Contact state (H)	FF	ON : FF00h OFF: 0000h
6		Contact state (L)	00	
7	CRC16 (L)		Calculated value	
8	CRC16 (H)		Calculated value	

●Normal response

			Example
1	Address		03
2	Function		05
3	DATA	Contact number (H)	00
4		Contact number (L)	19
5		Contact state (H)	FF
6		Contact state (L)	00
7	CRC16 (L)		Calculated value
8	CRC16 (H)		Calculated value

●Abnormal response

		Example
1	Address	03
2	Function	85
3	Error code	01
7	CRC16 (L)	Calculated value
8	CRC16 (H)	Calculated value

9.5 Echo back (08h)　* Broadcast not possible

Performs communication test by echo back.

(Example) Perform echo back test for controller with ID=3.

●Query

			Example	
1	**Address**		03	
2	**Function**		08	
3	**DATA**	**Test code (H)**	00	Specify 0000h
4		**Test code (L)**	00	
5		**Data (H)**	12	Arbitrary
6		**Data (L)**	34	
7	**CRC16 (L)**		Calculated value	
8	**CRC16 (H)**		Calculated value	

●Normal response

			Example	
1	**Address**		03	
2	**Function**		08	
3	**DATA**	**Test code (H)**	00	
4		**Test code (L)**	00	
5		**Data (H)**	12	Received data is returned
6		**Data (L)**	34	
7	**CRC16 (L)**		Calculated value	
8	**CRC16 (H)**		Calculated value	

●Abnormal response

		Example
1	**Address**	03
2	**Function**	88
3	**Error code**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

9.6 Output signals batch writing (0Fh)　* Broadcast possible

Performs batch writing of Y contacts. (Writing data format is the same as the reading data format of output signal (01h).

(Example) Batch write to Y10～Y1F of controller with ID=3.

●**Query**

			Example
1	**Address**		03
2	**Function**		0F
2	**DATA**	**Write start number (H)**	00
3		**Write start number (L)**	10
4		**Write points (H)**	00
5		**Write points (L)**	10
6		**Number of data**	02
7		**Set data 1**	0F
8		**Set data 2**	12
9	**CRC16 (L)**		Calculated value
10	**CRC16 (H)**		Calculated value

bit7							bit0
Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10
Y1F	Y1E	Y1D	Y1C	Y1B	Y1A	Y19	Y18

* Set contacts Y16, Y17, Y1D, Y1E, Y1F to “0”.

The examples of data 1 to 2 above are when Y1F～Y10 = 0001 0010 0000 1111.

●**Normal response**

			Example
1	**Address**		03
2	**Function**		0F
3	**DATA**	**Write start number (H)**	00
4		**Write start number (L)**	00
5		**Write points (H)**	00
6		**Write points (L)**	0E
7	**CRC16　(L)**		Calculated value
8	**CRC16　(H)**		Calculated value

●**Abnormal response**

		Example
1	**Address**	03
2	**Function**	8F
3	**Error code**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

9.7 Write data (10h)　* Broadcast possible

Performs writing of data.

(Format of writing data is the same as reading data format of data reading (03h).)

(Example)　Write 4 words of D0410～D0413 to controller with ID=3.　(2 Bytes = 1 word)

●Query

			Example		
1	**Address**		03		
2	**Function**		10		
3	**DATA**	**Write start number (H)**	04		
4		**Write start number (L)**	10		
5		**Words written (H)**	00		
6		**Words written (L)**	04		
7		**Number of data**	08		
8		**word1 (H)**	00	D0410	Operation method
9		**word1 (L)**	01	D0410	(For 1h)
10		**word2 (H)**	00	D0411	Speed
11		**word2 (L)**	28	D0411	(For 28h)
		word3 (H)	00	D0412	
		word3 (L)	00	D0412	Position
12		**word4 (H)**	06	D0413	(For 640h)
13		**word4 (L)**	40	D0413	
14	**CRC16 (L)**		Calculated value		
15	**CRC16 (H)**		Calculated value		

●Normal response

			Example
1	**Address**		03
2	**Function**		10
3	**DATA**	**Write start number (H)**	04
4		**Write start number (L)**	10
5		**Words written (H)**	00
6		**Words written (L)**	04
7	**CRC16 (L)**		Calculated value
8	**CRC16 (H)**		Calculated value

●**Abnormal response**

		Example
1	**Address**	03
2	**Function**	90
3	**Error code**	01
7	**CRC16 (L)**	Calculated value
8	**CRC16 (H)**	Calculated value

8.8 Error codes

Error codes and the factors causing them to be generated are shown below.

Error code	Name	Factors
01	Illegal function	An undefined function code was specified.
02	Outside address range	1) An address outside the range was set in the read or write start address. 2) In echo back, the test code was not 0000h. ・ Writing was attempted to a number (address) not permitted for writing. ・ Writing was attempted of a parameter not permitted in the Parameter Protect setting. ・ Writing was attempted of a parameter not permitted due to the operation mode (parallel/ serial). **⚠Warning** Use only the range whose use is permitted in this document. Other addresses are in the manufacturer's setting range. If the manufacturer's setting range is changed, it could cause damage to the controller and actuator.
03	Outside access point range	1) The number of points set meant that the read or write last number was outside the range. 2) There was an instruction meaning that the size of "Data" in the communication frame exceeded 256 Bytes. 3) In Function 05 (Forced signal output), the data of the specified "terminal state" was not FF00h(ON) or 0000h (OFF). 4) In Function 0F (Output signals batch writing), the specified "Write points" exceeded 256. 5) The read or write specified size was 0.

10. Memory map

The memory map of the LEC controller is shown below.

Only use the valid addresses and flags. Do not use any others (including undefined and unused).

10.1 State data

The state of the electrical actuator (current location, current speed, and current thrust) is located in address D9000-D9006.

Address	Parameter name	Byte	Setting range	Data type	Contents
D9000	Current position	4	± 2147483647	Integer	Displays the current position (Units: 0.01mm)
D9002	Current speed	2	0～65535		Displays the current speed (Units: mm/sec)
D9003	Current thrust	2	0～300		Displays the current thrust (Units: %)
D9004	Target position	4	± 2147483647		Displays the target position (Units: 0.01mm)
D9006	Driving data No.	2	0～63		Displays the step data no. that is completed or driving

② "Equipment name"(basic parameter "Equipment name") is stored in Address D000e.

Address	Parameter name	Byte	Setting range	Data type	Contents
D000e	Equipment name	16	14 letters	Letter	Registered by ASCII code

10.2 Running with specified data

Electric actuator is run with specified data using addresses D9100 to D9110. This operation changes the internal flag (Area D9084) depending on the operating conditions.

【Procedure for running with specified data】

① Set internal flag Y30(input invalid flag) to "1:Serial input operation mode".

② Write "1" to internal flag Y19(SVON) and confirm that internal flag X49(SVRE) has become "1".

③ Write "1" to internal flag Y1C(SETUP) and confirm that internal flag X4A(SETON) has become "1".

④ Write data in addresses D9102 to D9110 to controller.

⑤ Write Operation Start instruction from address D9100.

Address	Operation start instruction	byte	Setting
D9100	Data specified mode	1	1: Starts operation according to operation data (D9102 to D9110). (Returns to 0 after operation start was processed.)
	Not defined	1	-

Address	Virtual operation data	byte	Setting range	Unit	Data type
D9102	Movement Mode	2	1:absolute coordinate movement 2:relative coordinate movement	- -	Integer
D9103	Speed	2	1 to 65535	mm/s	
D9104	Position	4	±2147483647	0.01mm	
D9106	Acceleration	2	1 to 65535	mm/s^2	
D9107	Deceleration	2	1 to 65535	mm/s^2	
D9108	Pushing force	2	0 to 100 (Positioning operation for "0")	%	
D9109	Trigger Level	2	0 to 100	%	
D910a	Pushing speed	2	1 to 65535	mm/s	
D910b	Moving force	2	0 to 300	%	
D910c	Area output end 1 (Area 1)	4	±2147483647	0.01mm	
D910e	Area output end 2 (Area 2)	4	±2147483647	0.01mm	
D9110	In position	4	1～2147483647	0.01mm	

⚠ Warning

The setting range differs depending on the actuator. Avoid using the actuator outside the setting range. Please refer to the instruction manual of each actuator for the setting range.

10.3 Internal flags

The status information of the motor controller can be confirmed by using address D9084 (X40 to X4F). The internal flags of the electrical actuator are operated using address D90c1 (Y10～Y1F) and D90c2 (Y30～Y3F).

● **Internal flags (status flags)**

Flag name		Read	Write	Contents
X40	OUT0	○	×	As internal processing of controller (regardless of parallel/ serial), ON when the functions on the left are output
X41	OUT1	○	×	
X42	OUT2	○	×	
X43	OUT3	○	×	
X44	OUT4	○	×	
X45	OUT5	○	×	
X46	—	○	×	Cannot be used
X47				
X48	BUSY	○	×	As internal processing of controller (regardless of parallel/ serial), ON when the functions on the left are output But unlike parallel I/O driving, ESTOP and ALARM signals have positive logic. E-STOP: ON when EMG stops. ALARM: ON when alarm is generated.
X49	SVRE	○	×	
X4A	SETON	○	×	
X4B	INP	○	×	
X4C	AREA	○	×	
X4D	WAREA	○	×	
X4E	ESTOP	○	×	
X4F	ALARM	○	×	

● **Internal flags (state change flags)**

Flag name		Read	Write	Contents
Y10	IN0	○	○	●When Read Displays the instruction state when in serial driving mode. (ON: 1, OFF: 0) ●When Write Gives instructions to controller. Only valid when in serial driving mode. (ON: 1, OFF: 0)
Y11	IN1	○	○	
Y12	IN2	○	○	
Y13	IN3	○	○	
Y14	IN4	○	○	
Y15	IN5	○	○	
Y16	—	○	○	Cannot be used
Y17		○	○	
Y18	HOLD	○	○	●When Read Displays the instruction state when in serial driving mode. (ON: 1, OFF: 0) ●When Write Gives instructions to controller. Only valid when in serial driving mode. (ON: 1, OFF: 0)
Y19	SVON	○	○	
Y1A	DRIVE	○	○	
Y1B	RESET	○	○	
Y1C	SETUP	○	○	
Y1D	JOG-	○	○	Move to – direction by JOG operation. (1: move, 2: stop)
Y1E	JOG+	○	○	Move to + direction by JOG operation. (1: move, 2: stop)
Y1F	—	○	○	Cannot be used
Y30	Input invalid flag (*1) (*2)	○	○	0: Parallel input driving mode (parallel output end normal operation) 1: Serial input driving mode (parallel output end output prohibited)
Y31 ～Y3F	—	○	×	Cannot be used (cannot be changed)

(*1) The driving input mode (parallel/ serial) is switched in Y30.

(*2) When Y30 is specified from 0 to 1, the parallel input state before the instruction is continued. Conversely, when Y30 is specified from 1 to 0, the state of the parallel input terminal is reflected immediately.

10.4 Step data

Address	Parameter name	Byte	Input range	Data type	Contents
D0400 to D07FF	Step data (No.0～63) 32byte x 64	2048	-	-	-

(Example)
When address is Step data No.0

Address	Parameter name	Byte	Input range	Data type	Contents
D0400	Movement mode	2	0～255	Integer	1: Absolute co-ordinate movement (ABS) 2: Relative co-ordinate movement (INC)
D0401	Speed	2	1～65535		Sets the speed of movement to the target position or pushing start position. (Units: mm/s)
D0402	Position	4	±21474 83647		Sets the target position or pushing start position. (Units: 0.01mm)
D0404	Acceleration	2	1～65535		Sets the acceleration to the movement speed. (Units: mm/s^2)
D0405	Deceleration	2	1～65535		Sets the deceleration to the movement speed. (Units: mm/s^2)
D0406	Pushing force	2	0～100		Selects pushing operation or positioning operation from the set value. 0: Positioning operation 1 to 100: Pushing operation torque setting (unit 1%)
D0407	Trigger LV	2	0～100		When in pushing operation, if thrust above this value is generated, INP output becomes ON. This parameter is set to a value below the pushing thrust. (Units: %)
D0408	Pushing speed	2	1～65535		Movement speed when pushing. (Units: mm/s)
D0409	Moving force	2	0～300		Maximum thrust when positioning. (Units: %)
D040a	Area output end 1 (Area 1)	4	±21474 83647		Condition for AREA output to be ON. (Units: 0.01mm) If the position is in the range between Area output end 1 (Area 1) and Area output end 2 (Area 2), the AREA output turns ON.
D040c	Area output end 2 (Area 2)	4	±21474 83647		
D040e	In position	4	1～21474 83647		The functions are different for pushing driving and positioning driving. ●Positioning driving: Positioning width (Units: 0.01mm) ●Pushing driving: Pushing width (Units: 0.01mm)

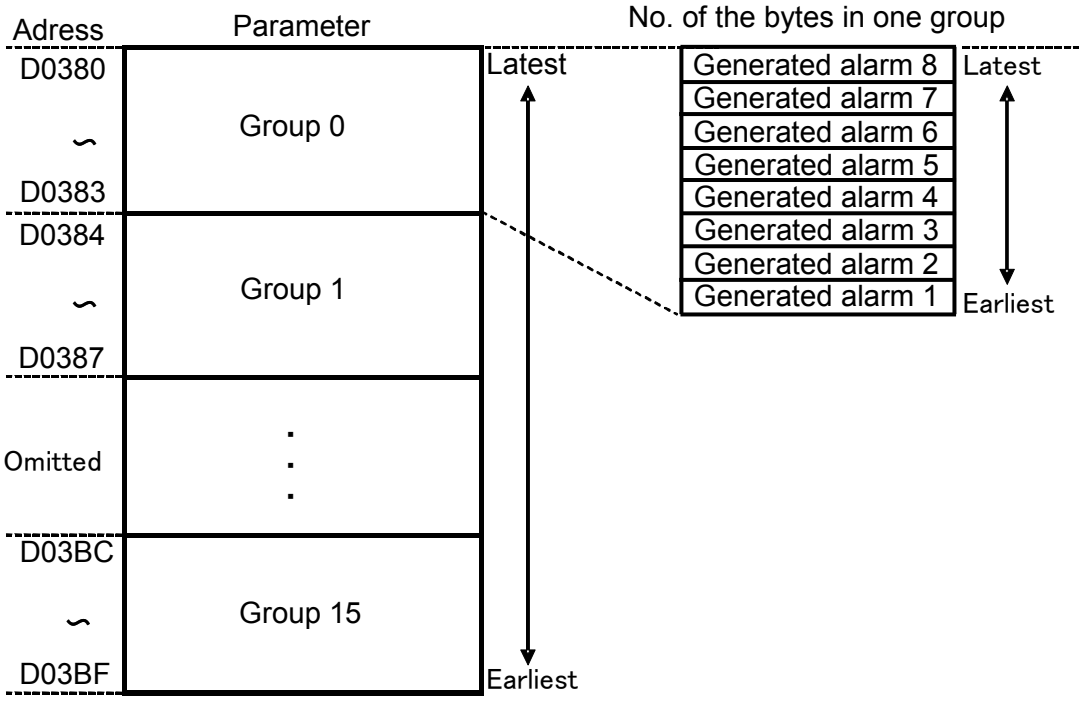
10.5 Alarm data

Alarm history is controlled on a group basis classifying 8 generated alarms （8byte） as one group and stores 16 groups of alarms from Group 0 to Group 15.

Address	Parameter name	Byte	Input range	Data type	Contents
D0380 to D03BF	Alarm history Group 0 to 15	128	0 to 255	Integer	Stores alarm history (＊1)

(＊1) Group 0 of alarm history shows the latest alarm (being generated) and as the group No. increases, the generated alarm history goes back.

10.6 Data format for alarm history



11. CRC calculation method

Data for calculation is all message data. Data is calculated in units of 2 Bytes (16 bits).

Step	Calculation method
【I】	Preload ”FFFFh”.
【II】	ExOR the 1 Byte value from the start of the message data (1st value) and the value of 【I】.
【III】	Shift the result of 【II】 by 1 bit in the lowest bit direction, and set 0 to the highest bit.
【IV】	As a result of 【III】, if the bit obtained is 1, then ExOR ”A001h” to the value of 【III】. (If the bit obtained is 0, do not ExOR.)
【V】	Repeat the contents of 【III】 to 【IV】 above until 8 bit shift.
【VI】	ExOR the result of 【V】 and the value of the next 1 Byte of the message data (2nd value).
【VII】	Repeat the contents of 【III】 to 【VI】 for the remainder of the message (3rd value to last value).
【VIII】	The 2 Byte data of the result of 【VII】 becomes the CRC data.

⚠ Caution

When adding CRC to the message, be careful of the order of High Byte “CRC16(H)” and Low Byte ”CRC16(L)” of the result of ⑧.

【Calculation example】

Calculate the CRC check data when communication test is done by echo back (Function 08: test code 0000h, test data 5AA5h) for Address 20.

Address	20	→	1st value
Function	08	→	2nd value
Data	00	→	3rd value
	00	→	4th value
	5A	→	5th value
	A5	→	6th value (final value)

		High Byte “CRC16(H)”								Low Byte “CRC16(L)”									Step
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	flag	
1	FFFFh load	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		【I】
2	1st value(20h)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		【II】
3	No.1 xor No.2	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1		【II】
4	Shift>>1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	【III】
5	No.4 xor a001h	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0		【IV】
6	Shift>>2	0	0	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	【V】
7	No.6 xor a001h	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0		【V】

8	Shift>>2	0	0	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	【V】
9	No.8 xor a001h	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1		【V】
10	shift>>1	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	【V】
11	No.10 xor a001h	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	0		【V】
12	shift>>2	0	0	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	【V】
13	No.12 xor a001h	1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	0		【V】
14	2nd value(08h)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		【VI】
15	No.13 xor No.15	1	0	0	1	1	0	0	0	1	0	1	1	0	1	1	0		【VI】
16	shift>>2	0	0	1	0	0	1	1	0	0	0	1	0	1	1	0	1	1	【VI】
17	No.16 xor a001h	1	0	0	0	0	1	1	0	0	0	1	0	1	1	0	0		【VI】
18	shift>>3	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	1	1	【VI】
19	No.18 xor a001h	1	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0		【VI】
20	shift>>3	0	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	1	【VI】
21	No.20 xor a001h	1	0	1	1	0	1	1	0	0	0	0	1	1	0	0	1		【VI】
22	3rd value(00h)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		【VII】
23	No.21 xor No.22	1	0	1	1	0	1	1	0	0	0	0	1	1	0	0	1		【VII】
24	shift>>1	0	1	0	1	1	0	1	1	0	0	0	0	1	1	0	0	1	【VII】
25	No.24 xor a001h	1	1	1	1	1	0	1	1	0	0	0	0	1	1	0	1		【VII】
26	shift>>1	0	1	1	1	1	1	0	1	1	0	0	0	0	1	1	0	1	【VII】
27	No.26 xor a001h	1	1	0	1	1	1	0	1	1	0	0	0	0	1	1	1		【VII】
28	shift>>1	0	1	1	0	1	1	1	0	1	1	0	0	0	0	1	1	1	【VII】
29	No.28 xor a001h	1	1	0	0	1	1	1	0	1	1	0	0	0	0	1	0		【VII】
30	shift>>2	0	0	1	1	0	0	1	1	1	0	1	1	0	0	0	0	1	【VII】
31	No.30 xor a001h	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	1		【VII】
32	shift>>1	0	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	1	【VII】
33	No.32 xor a001h	1	1	1	0	1	0	0	1	1	1	0	1	1	0	0	1		【VII】
34	shift>>1	0	1	1	1	0	1	0	0	1	1	1	0	1	1	0	0	1	【VII】
35	No.34 xor a001h	1	1	0	1	0	1	0	0	1	1	1	0	1	1	0	1		【VII】
36	shift>>1	0	1	1	0	1	0	1	0	0	1	1	1	0	1	1	0	1	【VII】
37	No.36 xor a001h	1	1	0	0	1	0	1	0	0	1	1	1	0	1	1	1		【VII】
38	4th value(00h)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		【VII】
39	No.37 xor No.38	1	1	0	0	1	0	1	0	0	1	1	1	0	1	1	1		【VII】
40	shift>>1	0	1	1	0	0	1	0	1	0	0	1	1	1	0	1	1	1	【VII】
41	No.40 xor a001h	1	1	0	0	0	1	0	1	0	0	1	1	1	0	1	0		【VII】
42	shift>>2	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	0	1	【VII】
43	No.42 xor a001h	1	0	0	1	0	0	0	1	0	1	0	0	1	1	1	1		【VII】
44	shift>>1	0	1	0	0	1	0	0	0	1	0	1	0	0	1	1	1	1	【VII】
45	No.44 xor a001h	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0		【VII】
46	shift >>2	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	【VII】

47	No.46 xor a001h	1	0	0	1	1	0	1	0	0	0	1	0	1	0	0	0		【VII】
48	shift>>2	0	0	1	0	0	1	1	0	1	0	0	0	1	0	1	0		【VII】
49	5^{th} value(5Ah)	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0		【VII】
50	No.48 xor No.49	0	0	1	0	0	1	1	0	1	1	0	1	0	0	0	0		【VII】
51	shift>>5	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	0	1	【VII】
52	No.51 xor a001h	1	0	1	0	0	0	0	1	0	0	1	1	0	1	1	1		【VII】
53	shift>>1	0	1	0	1	0	0	0	0	1	0	0	1	1	0	1	1	1	【VII】
54	No.53 xor a001h	1	1	1	1	0	0	0	0	1	0	0	1	1	0	1	0		【VII】
55	shift>>2	0	0	1	1	1	1	0	0	0	0	1	0	0	1	1	0	1	【VII】
56	No.55 xor a001h	1	0	0	1	1	1	0	0	0	0	1	0	0	1	1	1		【VII】
57	6^{th} value(A5h)	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1		【VII】
58	No.56 xor No.57	1	0	0	1	1	1	0	0	1	0	0	0	0	0	1	0		【VII】
59	shift>>2	0	0	1	0	0	1	1	1	0	0	1	0	0	0	0	0	1	【VII】
60	No.59 xor a001h	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1		【VII】
61	shift>>1	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	【VII】
62	No.61 xor a001h	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0	1		【VII】
63	shift>>1	0	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0	1	【VII】
64	No.63 xor a001h	1	1	0	1	0	0	0	1	1	1	0	0	1	0	0	1		【VII】
65	shift>>1	0	1	1	0	1	0	0	0	1	1	1	0	0	1	0	0	1	【VII】
66	No.65 xor a001h	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	1		【VII】
67	shift>>1	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	0	1	【VII】
68	No.67 xor a001h	1	1	0	0	0	1	0	0	0	1	1	1	0	0	1	1		【VII】
69	shift>>1	0	1	1	0	0	0	1	0	0	0	1	1	1	0	0	1	1	【VII】
70	No.69 xor a001h	1	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0		【VII】
71	shift>>1	0	1	1	0	0	0	0	1	0	0	0	1	1	1	0	0		【VII】
	Convert to hexadecimal	**6**				**1**				**1**				**C**					【VIII】

Revision history
2011.12.12： Addition “Operation example 4”

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