Table of Content

1. Overview

The EV drive supports RS232 or RS485 communication
for parameter setup and motor control.
The EV drive supports three types of control commands

1. Standard Modbus: Read(03), Write(06), Multiple write(16)
2. Multi-drive: Customized protocol based on the standard Modbus protocol for encoder model servo control up to 4 drives in one command message.
3. Multi-drive lite: Customized protocol based on the standard Modbus protocol for speed control up to 4 drives in one command message.

Please set the following items before use communication. (For communication parameters please reference to" 3.4.7 Communication parameters").
NOTE: Repower is required for all the settings to be affective.
(cut off the power until PWR LED is off for more than 0.5 sec than turn on the power again).

<table>
<tr><th>Setting Items</th><th colspan="4">RS-485</th><th>RS-232</th></tr>
<tr><td>Drive slave ID</td><td colspan="4">Set by SW1 dial:
0 = Broadcast | 4 = ID 4 | 8 = ID 8 | C = ID 12
1 = ID 1 | 5 = ID 5 | 9 = ID 9 | D = ID 13
2 = ID 2 | 6 = ID 6 | A = ID 10 | E = ID 14
3 = ID 3 | 7 = ID 7 | B = ID 11 | F = ID 15</td><td>17(11h)</td></tr>
<tr><td>Baud rate</td><td colspan="4">Set by SW2:
SW2-3 SW2-2 SW2-1 RS-485 Baud-rate (bps)
OFF OFF OFF 9600
OFF OFF ON 19200
OFF ON OFF 38400
OFF ON ON 57600
ON OFF OFF 115200</td><td>115200 bps</td></tr>
<tr><td>Modbus Protocol</td><td colspan="4">Set by SW2-5
ON : Modbus ASCII
OFF : Modbus RTU</td><td>Modbus ASCII</td></tr>
<tr><td>Terminal Resistor (120R)</td><td colspan="4">Set by SW2-4
ON : Link to internal terminal resistor 120R.
OFF : Do not use internal terminal resistor.</td><td>NA</td></tr>
</table>

NOTE It is suggested to use RS485 which supports all the communication control feature of the drive. (RS232 do not support multi-drive protocol).

NOTE Slave ID、Baud rate and Modbus protocol is fixed for RS232 and cannot be programmed.

NOTE Multi-drive / Multi-drive lite are customized protocol based on the Modbus protocol to control multiple drives with one command message.

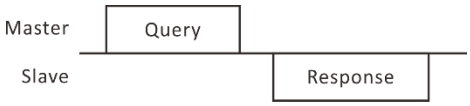
NOTE This manual only describes the commands in Modbus RTU protocol.

2. Standard Modbus communication mode

Modbus protocol communication is based on the single-master / multi-slave method. Messages are sent in one of two method below:

Unicast mode

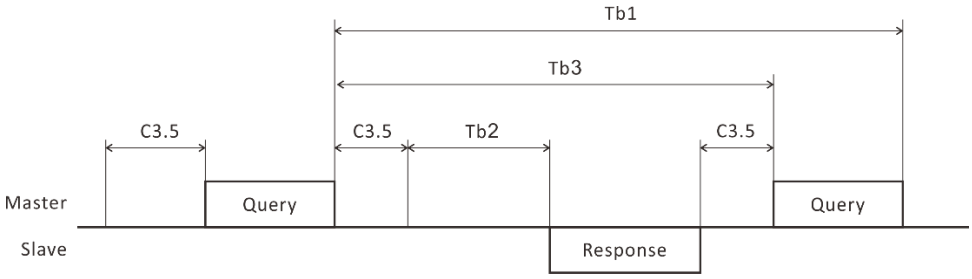
The master sends a query to only one slave.
The slave processes the request then returns a response.



Broadcast mode

The master can send a query to all the slaves with slave ID as 0 in the message.
Each slave processes the request but does not return a response.

Communication Timing



Character	Name	Description
Tb1	Timeout duration	If the slave does not receive any query over the interval set by the parameter “09-12/09-14 RS485/RS232 timeout”, a timeout error is generated.
Tb2	Transmission waiting time	The time after the slave switches its communication line to the transmission mode upon receiving a query from the master. It is about 3 ~ 5ms. In Modbus RTU, the actual transmission waiting time is the C3.5 + processing time + Tb2.
Tb3	Broadcasting interval	The minimum interval between the broadcasting query and the next query. A time equal to or longer than the silent interval (C3.5) plus 5ms is required.
C3.5	Silent interval	The interval between queries. If this time is less than 3.5 characters long, the drive may not respond. The silent interval should be 1.75ms when the baud rate is 19200 bps. (Silent intervals can be set by parameter 09-09 to make it shorter).

2.1 Query message

Query message structure

ID	FC	Data	CRC
8 bits	8 bits	N x 8 bits	16 bits

ID (Slave ID)

Specify the slave address in unicast mode.
If the slave ID is set to o, the master sends a query to all slaves (broadcast mode).

FC (Function Code)

The drive supports following Modbus function code:

FC (Function Code)	Description	Broadcast
03h	Read from holding registers (1 to 16).	No
06h	Write to a holding register.	Yes
10h (16)	Write to multiple holding registers (1 to 16).	Yes

Data

Set data associated with the function code. The data length varies depending on the function code.

CRC (Error Check)

The error check is based on the CRC-16 method. If the calculated CRC-16 value matches the error check in the message, the slave determines that the message is normal.
CRC-16 calculation method

1. Calculate an XOR value with FFFFh and the first byte of the message (Slave ID).
2. Shift the result of step 1 by 1 bit to the right (fill zero to the left).
3. If the result of step 2 is not zero, calculate an XOR with the result and A001h.
4. Repeat step 2 ~ 3 for all the 8-bits of the byte.
5. Repeat step 2 to 4 for all byes. Switch the high byte and low byte of the result to put into the message.

2.2 Response message format

There are three types of slave returned responses: Normal response, no response, exception response.
The response messages structure is the same as the query message.

ID	FC	Data	CRC
8 bits	8 bits	N x 8 bits	16 bits

2.2.1 Normal response

The slave processes the received query from the master then returns a response.

2.2.2 No response

The slave may not return a response to the query sent by the master.
The cause of the no response as follows:

Transmission error

Cause of transmission error	Description
Framing error	Stop bit is not the same as the setting of the drive.
Parity error	Parity is not the same as the setting of the drive.
Mismatched CRC	The calculated value of CRC-16 was found not matching the error check value in the message.
Invalid message length	The message length is over the limitation.

Other than transmission error

Cause	Description
Broadcast	If the query was broadcast (ID=0), the slave executes the request but does not return a response.
Mismatched slave ID (address)	The slave ID in the query is not the same as the setting of the drive.

2.2.3 Exception response

When the slave cannot execute the request of the query properly, it returns an exception response with the exception code indicating why the request cannot be executed properly.. The exception response format is:

ID	FC + 80h	EC (exception code)	CRC
8 bits	8 bits	16 bits /8 bits	16 bits

The function code in the exception response is the sum of query function code and 80h. For example: Query function code 03h → Exception function code: 83h
When the bit 5 of parameter 09-16 is 0, the EC is 16bits (default, non-standard Modbus).
When the bit 5 of parameter 09-16 is 1, the EC is 8biys (standard Modbus)

Exception code

EC	COMM Error Code	Cause	Description
01h	88h	Invalid function	The function code is not supported.
02h		Invalid register address	The register address is out of range,
033	8Ch	Invalid data	The data or data length is out of range. The number of requested registers is over 16 in the query.
04h	85h 8Ch 8Dj	Slave error	The slave cannot execute the request because one of the following status: Timeout (85h) Parameter setting out of range (8Ch) The command cannot be executed during the motor running status (8Dh).

Example of exception response

When the bit 5 of parameter 09-16 is 0 (E is 16 bits).:

Master

Slave ID		01h	→
Function Code		06h	Query
Data	Register address (upper)	01h	
	Register address (lower)	00h	
	Data value (upper)	FFh	←
	Data value (lower)	FFh	Response
CRC (lower)		89h	
CRC (upper)		86h	

Slave

Slave ID		01h
Function Code		86h
Data	Exception code (upper)	00h
	Exception code (lower)	04h
CRC (lower)		E1h
CRC (upper)		F2h

When the bit 5 of parameter 09-16 is 1 (EC is 8 bits):

Master

Slave ID		01h	→
Function Code		06h	Query
Data	Register address (upper)	01h	
	Register address (lower)	00h	
	Data value (upper)	FFh	←
	Data value (lower)	FFh	Response
CRC (lower)		89h	
CRC (upper)		86h	

Slave

Slave ID		01h
Function Code		86h
Data	Exception code (upper)	00h
CRC (lower)		E1h
CRC (upper)		F2h

2.3 Modbus function code

2.3.1 Read holding register (03h)

The function code to read holding registers. Up to 16 successive registers (16x16bits) can be read in one query.

Example

Read operation data for speed of No.0 and No.1 in the EEP.

Description	Register address (hex)	Data value (hex)	Decimal value
Digital speed No.0 (upper)	03h	0Bh	3000
Digital speed No.0 (lower)	08h	B8h	
Digital speed No.1 (upper)	03h	0Bh	3000
Digital speed No.1 (lower)	09h	B8h	

Query

Field name		Data	Description
Slave ID		01h	Slave ID = 1
Function Code		03h	Read holding registers
Data	Register address (upper)	03h	The register address to start reading from.
	Register address (lower)	08h	
	Data value (upper)	00h	The number of holding registers to read. (2 = 0002h)
	Data value (lower)	02h	
CRC (lower)		45h	Calculated CRC-16.
CRC (upper)		8Dh	

Response

Field name		Data	Description
Slave ID		01h	Same as query
Function Code		03h	Same as query
Data	Data byte count	04h	2 * the number of holding registers in the query.
	Value read from holding register address (upper)	0Bh	Value read from holding register address 0308h
	Value read from holding register address (lower)	B8h	
	Value read from holding register address+1 (upper)	0Bh	Value read from holding register address 0309h
	Value read from holding register address+1 (lower)	B8h	
CRC (lower)		7Fh	Calculated CRC-16.
CRC (upper)		70h	

2.3.2 Writing to a holding register (06h)

The function code to data to write to a holding register.

Example

Write operation data for speed No.0 to the RAM address.

Description	Register address (hex)	Data value (hex)	Decimal value
Digital speed No.0 RAM (upper)	3Fh	01h	300
Digital speed No.0 RAM (lower)	08h	2Ch	

Query

Field name		Data	Description
Slave ID		01h	Slave ID = 1
Function Code		06h	Writing to a holding register
Data	Register address (upper)	3Fh	The register address to be written.
	Register address (lower)	08h	
	Written data value (upper)	01h	Written value for the holding register.
	Written data value (lower)	2Ch	
CRC (lower)		04h	Calculated CRC-16.
CRC (upper)		51h	

Response

Field name		Data	Description
Slave ID		01h	Same as query
Function Code		06h	Same as query
Data	Register address (upper)	3Fh	Same as query
	Register address (lower)	08h	
	Written data value (upper)	01h	Same as query
	Written data value (lower)	2Ch	
CRC (lower)		04h	Calculated CRC-16.
CRC (upper)		51h	

2.3.3 Writing to multiple holding registers (10h)

The function code to write data to up to 16 successive holding registers.

Example

Write to the RAM of operation dara for speed No.0 to No.3 to the slave with ID set to 2.

Description	Register address (hex)	Data value (hex)	Decimal value
Digital speed No.0 RAM (upper)	3Fh	01h	300
Digital speed No.0 RAM (lower)	08h	2Ch	
Digital speed No.1 RAM (upper)	3Fh	02h	600
Digital speed No.1 RAM (lower)	09h	58h	
Digital speed No.2 RAM (upper)	3Fh	01h	300
Digital speed No.2 RAM (lower)	0Ah	2Ch	
Digital speed No.3 RAM (upper)	3Fh	02h	600
Digital speed No.3 RAM (lower)	0Bh	58h	

Query

Field name		Data	Description
Slave ID		02h	Slave ID = 2
Function Code		10h	Writing to holding registers
Data	Register address (upper)	3Fh	Register address to start writing from
	Register address (lower)	08h	
	Number of registers (upper)	00h	Number of registers to be written from the starting register address.
	Number of registers (lower)	04h	
	Daya byte count	08h	2 * the number of holding registers to write.
	Written value for holding register address (upper)	01h	Written value for holding register address 3F08h
	Written value for holding register address (lower)	2Ch	
	Written value for holding register address+1 (upper)	02h	Written value for holding register address 3F09h
	Written value for holding register address+1 (lower)	58h	
	Written value for holding register address+2 (upper)	01h	Written value for holding register address 3F0Ah
	Written value for holding register address+2 (lower)	2Ch	
	Written value for holding register address+3 (upper)	02h	Written value for holding register address 3F0Bh
	Written value for holding register address+3 (lower)	58h	
CRC (lower)		8Dh	Calculated CRC-16.
CRC (upper)		D5h	

Response

Field name		**Data**	**Description**
Slave ID		02h	Same as query
Function Code		10h	Same as query
Data	Register address (upper)	3Fh	Same as query
	Register address (lower)	08h	
	Number of registers (upper)	00h	Same as query
	Number of registers (lower)	04h	
CRC (lower)		4Ch	Calculated CRC-16.
CRC (upper)		2Fh	

3. Registers, operation data, and parameters

3.1 Operation commands

Registers for standard Modbus to control the motor. These registers are RAM only.

Register (Hex)	Name	Description	Read/Write
1400h	NET-IO (remote NET-IN)	A bit field that each bit can be assigned to an input function by parameter 09-01 ~ 09-08. Set the bit to 1 to make the assigned input function ON. Clear the bit to 0 to make the assigned input function OFF.	R/W

Register (hex)		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1400h	upper	-	-	-	-	-	-	-	-
	lower	NET-X7	NET-X6	NET-X75	NET-X4	NET-X3	NET-X2	NET-X1	NET-X0

3.2 Maintenance commands

Commands to reset alarm, clear alarm history and configure some parameters to be effective Write an one to the register to process the maintenance commands.

Register (hex)	Name	Description	Read/Write
0A00h	Alarm reset	Resets the alarms that are present. Some alarms cannot be reset with this function.	R/W
0A22h	Clear the alarm history	Clear alarm records	R/W
0A26h	Clear the comm error history	Clear the communication error records.	R/W
0A27h	Configuration	Executes the parameter recalculation and the setup.	R/W

3.3 Monitor commands

Commands to monitor operation data and the motor status. All the monitor commands are read only.
There are two types of monitor commands: dynamic data and monitor data.

3.3.1 Dynamic data

Dynamic data is for the A_HMI software to monitor the drive. Set the parameter 09-11 “Watch data page” to switch between different pages. Each page shows 16 data.
It is suggested to use monitor data instead for the communication control.

Register Hex	ID	09-11 setting	Field name	Description	Range
0000h	01	0 to 3	Motor state	The current motor operation state.	0: STOP 2: RUN 3: EBRAKE 4: FREE 5: FAULT 6: WAIT/INHIBIT 7: MOVING(SERVO ON) 8: SLIGHT-POS-KEEPING
Register	**ID**	**09-11**	**Field name**	**Description**	**Range**

Hex		setting			
0001h	02	0 to 2	Reserved	-	-
		3	Command speed	The target speed of the operation.	0 ~ 65535 r/min
0002h	03	0 to 3	Motor speed	The current speed of the motor.	0 ~ 65535 r/min
0003h	04	0 to 3	Alarm code	The present alarm codes.	Refer to “A1 -Protect and alarm code”
0004h	05	0 to 3	Motor direction	The current operation direction of the motor.	0: CW 1: CCW
0005h	06	0 to 2	Command speed	The target speed of the operation.	0 ~ 65535 r/min
		3	Operation data No.	The current operation data No. set by the M0, M1, M2 input.	0 ~ 7
0006h	07	0 to 2	Reserved	-	-
		3	Hall count	The count for hall signal edge change which increases 1 in CW operation and decreases 1 in CCW operation.	-32767 ~+32768 counts
0007h	08	0 to 3	Output power	The current output power of the drive.	0 ~ 65535 W
0008h	09	0	Direct digital input status	Each digit as a digital input state. Unit=X1, ten=X2, hundred=X3, thousand=X4, Ten thousand=X5	0 = OFF 1 = ON
		1	Direct digital output status	Each digit as a digital output state. Unit=Y1, ten=Y2, hundred=YH	0 = OFF 1 = ON
		2 to 3	Direct I/O status	A binary bit field that each bit as an I/O state. bit0=X1, bit1=X2, bit2=X3, bit3=X4, bit4=X5, bi5~bit7=NA, bit8=Y1, bit9=Y2, bit9=YH, bit10~15=NA.	0 = OFF 1 = ON
0009h	10	0/2 to 3	DC BUS Voltage	The current DC bus voltage	0 ~ 65535 (0.01VDC)
		1	Acceleration time	The current acceleration time	0 ~ 65535 (0.1sec)
000Ah	11	0/2	Reserved	-	-
		1	Deceleration time	The current deceleration time	0 ~ 65535 (0.1sec)
		3	Output current	The output current of the drive.	0 ~ 65535 (0.01A)
000Bh	12	0/3	Output %	The current output voltage % +: The output torque and the motor operation direction are the same. -: The output torque and the motor operation direction are opposite.	-1000 ~ +1000 (0.1%)
		1/2	Reserved	-	-

Register Hex	ID	09-11 setting	Field name	Description	Range
000Ch	13	0	Output current	The output current of the drive.	0 ~ 65535 (0.01A)
		1	A1 input voltage	The current voltage of analog input A1.	0 ~ 65535 (0.01VDC)
		2	Reserved	-	-
		3	Target position upper (Multi-drive)	The current target position index/step H	Index or step H
000Dh	14	0/2	Reserved	-	-
		1	A2 input voltage	The current voltage of analog input A2.	0 ~ 65535 (0.01VDC)
		3	Target position lower (Multi-drive)	The current target position step/step L	Step or step L
000Eh	15	0/2	Reserved	-	-
		1	X5(XH) duty	The PWM duty when X5 as PWM input.	0 ~1000 (0.1%)
		3	Motor position (upper)	The current encoder position Index/step H	Index or step H
000Fh	16	0/2	Reserved	-	-
		1	X5(XH) frequency	The pulse frequency when X5 as pulse input.	0 ~1000 (0.1%)
		3	Motor position (lower)	The current encoder position step/step L	Step or step L

3.3.2 Motor state description

No.	Motor State	Condition	Magnetic Brake Output
0	STOP	The stop state of the motor when in speed or duty control mode (parameter 08-01=0 or 1) but slight-position-keeping is not in use (parameter 08-11 is 0: FREE or 1: Phase Short).	Lock.
2	RUN	Motor in operation in CW or CCW direction when in speed or duty control.	Release.
3	BRAKE	When EBRAKE (input or command) is ON, the drive will short the phase of the motor to brake the motor. Priority lower than FREE, FAULT, SERVO OFF	Release unit motor stops, then turn into Lock.
4	FREE	When FREE (input or command) is ON, the drive will turn off all the output to the motor. Priority lower than FAULT, SERVO OFF	Release.
5	FAULT	When an alarm generates, the motor stops, and the state will be FAULT. There will be no output from the drive to the motor. Priority lower than SERVO OFF	Releases when the FREE is ON otherwise it locks.
6	WAIT/INHIBIT (SERVO OFF)	The drive output is disabled when one of the following conditions holds: SERVO-ON (input or command) is OFF when parameter 02-14 is 1 or 2 (Enable by SERVO ON mode). Main power (B+) is under the under-voltage point.	Releases when parameter 02-14 is 2. Releases when parameter 02-14 is 0 or 1 and the FREE is ON.
7	MOVING(SERVO ON)	The motor is in position control mode when parameter 08-01 is set to 2 (position control mode). This state is for encoder models only.	Release.
9	SLIGHT-POS-KEEPING	The drive holds the motor position when it stops with a max of 50% rated torque when parameter 08-11 is set to 2 (slight-position-keeping).	Release.

3.3.3 Monitor data

Register for users to monitor the operation data through communication (RS232/RS485).

Register Hex	Field name	Description	Range
4600h	Motor state	The current motor operation state.	0: STOP 2: RUN 3: EBRAKE 4: FREE 5: FAULT 6: WAIT/INHIBIT (SERVO OFF) 7: MOVING(SERVO ON) 8: SLIGHT-POS-KEEPING
4061h	Alarm code	The present alarm codes	Refer to “A1 -Protect and alarm code”
4602h	Operation data No.	The current operation data No. set by the M0, M1, M2 input.	0 ~ 7
4603h	Command speed	The target speed of the operation.	Positive for CW operation, negative for CCW operation. -32767 ~ +32768 r/min 0 = stop
4604h	Motor speed	The current speed of the motor.	
4605h	Direct I/O status	A binary bit field that each bit as an I/O state.	0 = OFF

		bit0=X1, bit1=X2, bit2=X3, bit3=X4, bit4=X5, bi5~bit7=NA, bit8=Y1, bit9=Y2, bit9=YH, bit10~15=NA.	1 = ON
Register Hex	**Field name**	**Description**	**Range**
4606h	Output power	The current output power of the drive.	0 ~ 65535 W
4607h	DC BUS voltage	The current DC bus voltage	0 ~ 65535 (0.01VDC)
4608h	Output %	The current output voltage % +: The output torque and the motor operation direction are the same. -: The output torque and the motor operation direction are opposite.	-1000 ~ +1000 (0.1%)
4609h	Output current	The output current of the drive.	0 ~ 65535 (0.01A)
460Ah	Torque limit current	The current limit set value for the torque limit function.	0 ~65535 (1=0.01A)
460Bh	Acceleration time	The current acceleration time	0 ~ 65535 (0.1sec)
460Ch	Deceleration time	The current deceleration time	0 ~ 65535 (0.1sec)
460Dh	A1 input voltage	The current voltage of analog input A1.	0 ~ 65535 (0.01VDC)
460Eh	Reserved	NA	NA
460Fh	X5(XH) duty	The PWM duty when X5 as PWM input.	0 ~1000 (0.1%)
4610h	X5(XH) frequency	The pulse frequency when X5 as pulse input.	0 ~1000 (0.1%)
4611h	Reserved	NA	NA
4612h	Hall count	The count for hall signal edge change which increases 1 in CW operation and decreases 1 in CCW operation.	-32767 ~+32768 counts
4613h	Target position upper (Multi-drive)	The current target position index/step H	Index or step H
4614h	Target position lower (Multi-drive)	The current target position step/step L	Step or step L
4615h	Motor position upper (Multi-drive)	The current encoder position Index/step H	Index or step H
4616h	Motor position lower (Multi-drive)	The current encoder position step/step L	Step or step L

3.3.4 Alarm history

Register Hex	ID	Field name	Description	Range
3300h	01	Alarm history 1	The most recent alarm code.	Refer to “A1 -Protect and alarm code”
3301h	02	Alarm history 2	Alarm history from the second recent to the oldest (2 to 10th).	
3302h	03	Alarm history 3		
3303h	04	Alarm history 4		
3304h	05	Alarm history 5		
3305h	06	Alarm history 6		
3306h	07	Alarm history 7		
3307h	08	Alarm history 8		
3308h	09	Alarm history 9		
3309h	10	Alarm history 10		

3.4 Parameters and operation data

There are two register types for parameter and operation data, RAM and EEP address.
It takes 20ms for the EEP writing operation but less than 5ms to update the RAM data.
Please write to the RAM address for motor control and only use EEP address for parameter setting.

The effective column indicates the timing for the data to become effective:
A: Effective immediately.
B: Effective after stopping the operation.
C: Effective after executing the configuration
D: Effective after turning the power ON again.

The mode column indicates which of the control mode is be affected by the parameter:
S: Speed mode
D: Duty mode
P: Position mode (encoder model only)

3.4.1 Operation data

Operation data can be used to set the speed, output duty (duty mode only), torque limit current, acceleration, or deceleration for the motor operation.
Users can preset the operation data in EEP or set the RAM address through communication (RS232/RS485) during operation.
There are 8 data per operation data which can be selected by the operation data No. set by the M0, M1, M2 (input or command) indexing.

ID	Field name	Register (hex)		Description	Range	Default	Effective
		EEP	RAM				
03-09 to 09-16	Speed No.0n to Speed No.7	0308h to 030Fh	3F08h to 3F0Fh	Target speed for speed mode. Terminal speed for position mode.	60 ~ 10000 r/min	3000	A
04-01 to 04-08	ACC time No. 0 to ACC time No. 7	0400h to 0407h	4000h to 4007h	Time to accelerate from 0 to 3000r/min or Time to accelerate from 0 to 100% duty.	2 ~ 100 (1=0.1s)	10	A
04-09 to 04-16	DEC time No. 0 to DEC time No. 7	0408h to 040Fh	4009h to 400Fh	Time to decelerate from 3000 to 0r/min or Time to decelerate from 100% to % duty.	2 ~ 100 (1=0.1s)	10	A
07-01 to 07-08	Tq limit No.0 to Tq limit No.7	0700h to 0707h	4300h to 4307h	Current limit value for torque limit function.	0 ~ 2000 (1=0.1%)	2000	A
07-09 to 07-16	Duty No.0 to Duty No.7	0708h to 070Fh	4308h to 430Fh	Output duty % for duty mode.	0 ~ 1000 (1=0.1%)	100 200 300 300 400 500 600 5800 1000	A

3.4.2 Motor parameters

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
01-01	Hall sequence (Hall model)	0100h	3D00h	Hall u edge to the motor back emf. 0: B sequence (rising edge) 1: A sequence (falling edge)	1	A	S/D
01-02	Motor poles	0101h	3D01h	Number of rotor poles in 2/4/8/10	8	A	S/D/P
01-03	No load full speed	0102h	3D02h	100 ~ 65535 r/min	4188	A	S
01-04	CW definition	0103h	3D03h	0: view from motor shaft side 1: view from motor bottom side	0	A	S/D/P
01-14	Encoder resolution (Encoder model)	010Dh	3D0Dh	Pulse per revolution per channel. 0 ~65535 pulse	2500	A	S/D/P
05-01	Motor OT sensor type	0500h	4100h	0: normal open 1: normal close 2: deactivated	1	C	S/D/P

3.4.3 I/O parameters

The corresponding function is activated when any of the input functions is ON (include direct Input and remote NET-IN).

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
02-01	SC/CC mode	0200h	3E00h	Select the input function to control run, stop operation and direction. 0: SC mode. START/STOP, CCW/CW input. 1: CC mode. FWD, REV input.	0	C	S/D/P
02-15	VA-OUT range	020Eh	3E0Eh	The VA-OUT output is ON when the difference between command speed and motor speed is within this range.	100	C	S/D/P
02-16	EN-OUT speed	020Fh	3E0Fh	The EN-OUT output is ON when the motor speed is higher than this setting.	1000	C	S/D/P
06-01	X1 input function	0600h	4200h	The function setup of direct input. 0: NC (PULSE-IN) 1: START/STOP (FWD) 2: CCW/CW (REV) 5: FREE 6: STOP-MODE 7: EBRAKE/ALM-RST 8: ALM-RST 9: STOP-MODE2 10: M0 11: M1 12: M2 13: EBRAKE 14: SERVO-ON 17: STOP 21: EXT-ERROR When using PWM or frequency to control speed through X5(XH5), set the function of X5(XH) to 0:PULSE-INPUT.	1	C	S/D/P
06-02	X2 input function	0601h	4201h		2	C	S/D/P
06-03	X3 input function	0602h	4202h		5	C	S/D/P
06-04	X4 input function	0603h	4203h		8	C	S/D/P
06-05	X5(XH) input function	0604h	4204h		10	C	

06-06	Always ON input 1 (AOI1)	0605h	4205h	The state of the input function assigned to these virtual inputs will be ON. NOTE: Do not assign START/STOP, FWD, REV to these inputs unless you do it on purpose to make the motor start running right after power on.	0	C	S/D/P
06-07	Always ON input 2 (AOI1)	0606h	4206h		0	C	S/D/P
06-08	Always ON input 3 (AOI1)	0607h	4207h		0	C	S/D/P
ID	**Field name**	**Register (hex)**		**Description**	**Default**	**Effective**	**Mode**
		EEP	**RAM**				
06-09	Y1 output function	0608h	4208h	The function setup of direct output. 0: NC 1: SPD-OUT 2: ALM-OUT 3: BUSY-OUT 4: VA-OUT 5: EN-OUT 6: ALM-PULSE 7: BUS-ALM-PULSE 11: RUN-OUT 12: DIR-OUT 13: VA-OUT2 14: VA-EN-OUT	3	C	S/D/P
06-10	Y2 output function	0609h	4209h		2	C	S/D/P
06-11	YH output function	060Ah	420Ah		1	C	S/D/P
06-12	OU1 output function	060Bh	420Bh	13: MBRAKE (magnetic brake) 14: MBRAKE-RELEASE	13	C	S/D/P
06-13	OU2 output function	060Ch	420Ch		0	C	S/D/P
06-16	I/O ON logic	060Fh	420Fh	The ON logic setup of the direct I/O. 0: open circuit as ON 1: short circuit as ON Bit 0: X1 logic Bit 1: X2 logic Bit 2: X3 logic Bit 3: X4 logic Bit 4: X5(XH) logic Bit 5: AOI1 logic Bit 6: AOI2 logic Bit 7: AOI3 logic Bit 8: Y1 logic Bit 9: Y2 logic Bit 10: YH logic Bit 11: OUT1 logic Bit 12: OUT2 logic	65535	C	S/D/P
09-01	NET-X0	0900h	4500h	The function setup of remote input. 0: NC 1: SPD-OUT 2: ALM-OUT 3: BUSY-OUT 4: VA-OUT 5: EN-OUT 6: ALM-PULSE 7: BUS-ALM-PULSE 11: RUN-OUT 12: DIR-OUT 13: VA-OUT2 14: VA-EN-OUT	1	C	S/D/P
09-02	NET-X1	0901h	4501h		2	C	S/D/P
09-03	NET-X2	0902h	4502h		8	C	S/D/P
09-04	NET-X3	0903h	4503h		6	C	S/D/P
09-05	NET-X4	0904h	4504h		10	C	S/D/P
09-06	NET-X5	0905h	4505h		11	C	S/D/P
09-07	NET-X6	0906h	4506h		0	C	S/D/P
09-08	NET-X7	0907h	4507h		0	C	S/D/P

3.4.4 Operation parameters

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
02-02	Starting output (Hall model)	0201h	3E01h	The starting output %. Increase this value to increase the response during heaving load starting. 0 ~ 300 (1=0.1%)	0	C	S/D
02-03	Operation data source	0202h	3E02h	Set the operation data setting method. 0: Speed by internal VR 1: By digital indexing (M0, M1, M2) 4: By external analog A1 Please refer to “A2 -Operation data source setting” for details.	4	C	S/D
02-10	Speed control method	0209h	3E09h	Set the speed control method in speed or duty mode. 0: analog input or digital indexing 1: XH PFM (pulse frequency) 2: XH PWM 3: RS485 Multi-drive lite	0	C	S/D
02-14	Enable method	020Dh	3E0Dh	The drive can only output to the motor after enabled. 0: Enable when power up. 1: Enable by SERVO-ON input. MBRAKE is controlled by FREE input. 2: Enable by SERVO-ON input. MBRAKE is released in SERVO-OFF state.	0	C	S/D/P
08-01	Control mode	0800h	4400h	0: speed 1: duty 2: position (multi-drive)	0	C	S/D/P
08-02	Speed gain P	0801h	4401h	Speed PID control P gain. 0 ~ 65535.	10	C	S
08-03	Speed gain D	0802h	4402h	Speed PID control D gain. 0 ~ 65535.	100	C	S
08-07	Direction mode	0806h	4406h	0: Cannot change direction during operation (need a full stop before changing direction). 1: Can change direction during operation.	1	C	S/D
08-11	Position keeping	080Ah	440Ah	Position keeping setting when stopped in speed/duty mode. 0: Free (position keeping disabled) 1: Servo-lock (encoder model) 1: short brake (hall model) 2: Slight-position-keeping (hall model)	1	C	S/D
08-15	Position data type	080Eh	440Eh	Set the encoder position data type (in 16-bits): Default: 10,000 steps per turn (0.036 deg) 0: Index(turns) + step -32,768 ~ +32,767 index, 0 ~ 10,000 steps 1: step(upper) + step(lower) -327,680,000 ~ +327,670,000	0	C	S/D/P

3.4.5 Analog and pulse input parameters

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
02-04	Analog input range	0203h	3E03h	0: 0 ~ 5VDC (max deadband 4.8V) 1: 0 ~ 10VDC (max deadband 9.8V)	0	C	S/D
02-05	Analog / Pulse input gain	0204h	3E04h	A1: 0 ~ 10,000 r/min per V PFM: 0 ~ 10,000 r/min per 200Hz PWM: 0 ~ 10,000 r/min per 10%	708	C	S
02-06	Analog / Pulse input offset	0205h	3E05h	0 ~ 200 A1: 1=0.01VDC PFM: 1=2Hz PWM: 1=0.01%	10	C	S/D
02-07	Offset speed	0206h	3E06h	Analog/pulse Input offset speed. 0 ~ 10,000 r/min	85	C	S
02-08	Minimum deadband action	0207h	3E07h	Operation when analog / pulse input is smaller than offset value. 0: stop 1: run with min speed	0	C	S/D
02-09	Analog ACC/DEC time setting	0208h	3E08h	The set value of most CCW/max V when setting ACC/DEC by VR / A2: 0: ACC/DEC time max 1: ACC/DEC time min	1	C	S/D
03-01	Max speed	0300h	3F00h	Speed upper limit when set by analog / pulse input. 100 ~ 10,000 r/min	3600	C	S
03-02	Min speed	0301h	3F01h	Speed lower limit when set by analog / pulse input. Encoder model: 1 ~ 10,000 r/min Hall model: 60 ~ 10,000 r/min	85	C	S
03-03	Analog ACC/DEC time max	0302h	3F02h	Max ACC/DEC time when set by VR/A2. 1 ~ 100 (1=0.1 sec)	100	C	S/D
03-04	Analog ACC/DEC time min	0303h	3F03h	Min ACC/DEC time when set by VR/A2. 1 ~ 100 (1=0.1 sec)	1	C	S/D
03-05	Analog torque limit max	0304h	3F04h	0 ~ 2000 (1=0.1 %)	2000	C	S/D/P
03-06	Analog torque limit min	0305h	3F05h	0 ~ 2000 (1=0.1 %)	100	C	S/D/P
03-07	Max duty	0306h	3F06h	Max duty when set by analog / pulse input. 0 ~ 1000 (1=0.1 %)	1000	C	D
03-08	Min duty	0307h	3F07h	Min duty when set by analog / pulse input. 0 ~ 1000 (1=0.1 %)	0	C	D
08-09	XH PWM offset	0308h	3F08h	Signal falling/raising time offset. 0 ~ 32767: 1 = +0.0167us 65535 ~ 32768: 1 = - 0.0167us	0	C	S/D

3.4.6 Protect parameters

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
05-01	Motor OT sensor type	0500h	4100h	0: normal open 1: normal close 2: deactivated	1	C	S/D/P
05-02	Initial operation error	0501h	4101h	Alarm when main power supply was cycled during START/STOP, FWD, REV input is ON. 0: initial operation error disabled 1: initial operation error enabled	0	C	S/D/P
05-03	Motor feedback signal alarm	0502h	4102h	Hall model: 0: disabled 1: enabled Encoder model: 0,1: position overflow alarm enabled 2: position overflow alarm disabled	0	C	S/P
05-04	Over speed alarm	0503h	4103h	Generates an alarm when the motor speed is higher than this value. 0: disabled 1 ~ 10,000 r/min	5000	C	S/D/P
05-07	Torque limit stall alarm	0506h	4106h	Generates alarm when motor is stuck for a given time. 0: disabled (continue output) 1 ~ 65535 (1=1 ms)	5000	C	S/D/P
05-08	Overboost time	0507h	4107h	The time allowed for the output being over the torque limit current. 0 ~ 1000 (1= 0.1 sec)	300	C	S/D/P
05-09	Recovery time	0508h	4108h	The time required for the output to be lower than the torque limit current to overboost again once it was overboosted. 0 ~ 1000 (1= 0.1 sec)	600	C	S/D/P
05-15	Overload action	050Eh	410Eh	Actions when overloaded. 0: Fold-back current to the rated output 1: Alarm	0	C	S/D/P

3.4.7 Communication parameters

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
09-09	Modbus RTU C3.5	0908h	4508h	Minimum silent interval setting: 0=1.75ms 1=1.50ms 2=1.25ms 3=1.00ms 4=0.75ms 5=0.50ms	0	C	S/D/P

ID	Field name	Register (hex)		Description	Default	Effective	Mode
		EEP	RAM				
09-10	COMM error alarm action	0909h	4509h	Action when communication error alarm occurs. 0: Fault (motor stops) 1: Clear NET-IO 2: Fault + clear NET-IO	0	C	S/D/P
09-11	Watch Data Select	090Ah	450Ah	Set the dynamic data display page. 0 ~ 1 page	0	C	S/D/P
09-12	RS485 timeout	090Bh	450Bh	0: No timeout 1 ~ 1000 ms	0	C	S/D/P
09-13	RS485 COMM error	090Ch	450Ch	Number of times for communication error to generate an alarm. 1 ~ 10 times	0	C	S/D/P
09-14	RS232 timeout	090Dh	450Dh	0: No timeout 1 ~ 1000 ms	0	C	S/D/P
09-15	RS232 COMM error	090Eh	450Eh	Number of times for communication error to generate an alarm. 1 ~ 10 times	0	C	S/D/P
09-16	RS485 physical settings	090Fh	450Fh	Parity, Stop bits and data bits setting in bit field.(Do not change this setting) Parity (bit0,1): 0(00b): None 1(01b): Odd 2(10b): Even Stop Bits (bit2): 0: 1 bit 1: 2 bits Data Bits (bit3): 0: 8 bits 1: 7 bits	0	C	S/D/P
09-01	NET-X0 input function	0900h	4500h	NET-IN (NET-IO) is a register of each bit as a digital input function. Set a bit to 1 to have the corresponding function ON or clear the bit to 0 to have the function OFF. 0900h ~ 0907h is the function setting of each bit. 0: NC (PULSE-INPUT) 1: START/STOP (FWD) 2: CCW/CW (REV) 5: FREE 6: STOP-MODE 7: EBRAKE/ALM-RST 8: ALM-RST 10: M0 11: M1 12: M2 13: EBRAKE 14: DRV-EN 17: STOP 21: EXT-ERROR	1	C	S/D/P
09-02	NET-X1 input function	0901h	4501h		2	C	S/D/P
09-03	NET-X2 input function	0902h	4502h		8	C	S/D/P
09-04	NET-X3 input function	0903h	4503h		6	C	S/D/P
09-05	NET-X4 input function	0904h	4504h		10	C	S/D/P
09-06	NET-X5 input function	0905h	4505h		11	C	S/D/P
09-07	NET-X6 input function	0906h	4506h		0	C	S/D/P
09-08	NET-X7 input function	0907h	4507h		0	C	S/D/P

4. Multi-drive control

Multi-drive is a customized RS485 protocol which is based on the customized function code of the Modbus protocol.
With Multi-drive, one can control up to 4 different drives with different operations in one message. And each drive can respond in sequence.
Multi-drive supports both continuous(speed) and positioning operation.

NOTE Multi-drive is only available for encoder model.

4.1 To use Multi-drive

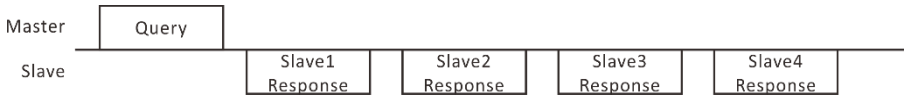
Check the hardware settings of the communication (SW1, SW2).
Set the parameter 08-01 "Control mode" to 2: position (multi-drive) to use multi-drive control.
Select the encoder position data type by parameter 08-15 "Position data type".
Set operation data (acceleration/deceleration time, terminal speed, torque limit).
Send commands through RS485.

4.2 Multi-drive communication mode

Based on the standard Modbus broadcast with customized function code.
The master sends a query in broadcast and the slaves respond in sequence or nothing depends on the function code in the query.

Example 1

4 slaves. All slaves with a response.

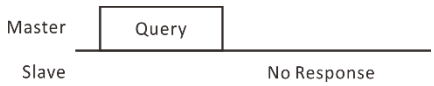


Example 2

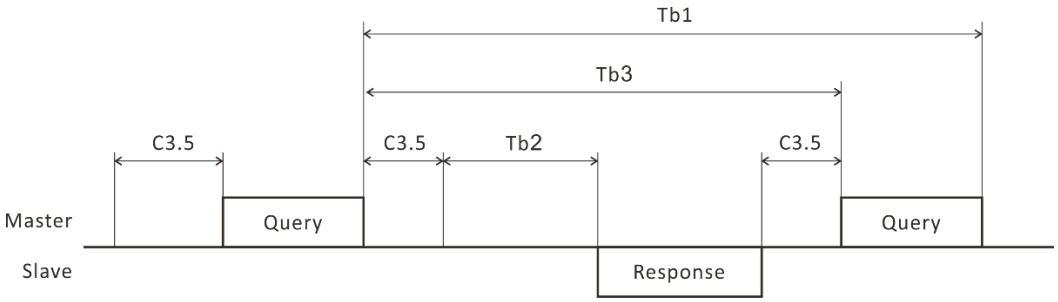
4 slaves. Only ID2 and ID4 respond.

Example 3

4 slaves. No slaves respond.



Communication Timing



Character	Name	Description
Tb1	Timeout duration	If the slave does not receive any query over the interval set by the parameter "09-12/09-14 RS485/RS232 timeout", a timeout error is generated.
Tb2	Transmission waiting time	In Multi-drive, it takes about 3ms for each slave to complete the response after the query.
Tb3	Broadcasting interval	The minimum interval between the broadcasting query and the next query. A time equal to or longer than the silent interval (C3.5) plus 5ms is required.
C3.5	Silent interval	The interval between queries. If this time is less than 3.5 characters long, the drive may not respond. The silent interval should be 1.75ms when the baud rate is 19200 bps. (Silent intervals can be set by parameter 09-09 to make it shorter).

4.3 Multi-drive command data

There are two data can bet set in the Multi-drive protocol. Target Speed for speed operation and target position for moving operation. There are 2 types of position data which can be set by parameter 08-15.

Parameter 08-15	Data		Description	Default range
0 or 1	Upper (16 bits)	0	The target speed of continuous (speed) operation in Multi-drive control.	-4000 to + 4000 r/min
	Lower (16 bits)	Speed		
0	Upper (16 bits)	Position index	1 index per rev (10,000 steps as default).	-32,768 to +32,767
	Lower (16 bits)	Position step	Minimum unit of the position. Default with 10,000 steps per rev. (can only be positive)	0 to 10,000 steps
1	Upper (16 bits)	Position step upper	Minimum unit of the position. Default with 10,000 steps per rev.	-327,680,000 to +327,670,000 steps
	Lower (16 bits)	Position step lower		
0 or 1	16 bits	Acceleration time	Set by operation data register with standard Modbus protocol (see 3.4.1 Operation data)	0.1 to 10.0 sec (0 to 3000r/min)
0 or 1	16 bits	Deceleration time		to 10.0 sec (3000 to 0r/min)
0 or 1	16 bits	Torque limit		0 to 200.0 %

Position data setting example

When parameter 08-15 is 0. Encoder resolution = 2500 pulse per channel.

Parameter 08-15	Example	Position data	
		Upper decimal (hex)	Lower decimal (hex)
0	CW for 2 and 1/4 turns	2 (0002h)	2500 (09C5h)
	CCW for 2 and 1/4 turns = CCW for 3 turn then CW for 3/4 turns	-3 (FFFDh)	7500 (1D4Ch)
1	CW 2 and 1/4 turns	0 (0000h)	22500 (57E4h)
	CCW 2 and 1/4 turns	-1 (FFFFh)	-22500(A81Ch)

4.4 Multi-drive Modbus function code (FC)

Use function code in the customized area of standard Modbus.

FC		Function	Description
Hex	Decimal		
65h	101	Query from the master to the slaves(drives).	The master sends query with the broadcast ID (0) and the function code 65h to query up to 4 slaves in one message.
66h	102	Slave normal response.	After receiving function code 65h in broadcast, the slaves (drives) will respond in sequence on after one. Each slave responds with a function code depends on if the query can be processed normally or not. If the query can be processed normally the slave responds with function code 66h otherwise it responds with function code 67h as exception response.
67h	103	Slave exception response.	

4.5 Multi-drive query format (65h)

The message length can be different depends on the number of the slaves to control in the query.

Modbus	Data	Example	Bytes	Description
Slave address	ID	00h	1	Always use broadcast mode in Multi-drive.
Function code	FC	65h	1	Query from the master to the slaves(drives).
Data	Sub ID Number	02h	1	Number of slaves to query. This will determine the length of the message.
	Sub ID 1	01h	1	The slave address of the first slave (drive).
	Command 1	0Ch	1	The command to the first slave (drive).
	DATA1 upper	0000h	2	The data of the commands to the first slave (drive).
	DATA1 lower	0010h	2	
	Sub ID 2	02h	1	The slave address of the second slave (drive).
	Command 2	0Ch	1	The command to the second slave (drive).
	DATA2 upper	0000h	2	The data of the commands to the second slave (drive).
	DATA2 lower	0010h	2	
	Sub ID 3	-	1	The same rules as above. If the Sub ID number is 1 then the message after DATA1 lower will be blank (except the CRC). If the Sub ID number is 2 then the message after DATA2 lower will be blank (except the CRC). Up to 4 slaves can be controlled in the query.
	Command 3	-	1	
	DATA3 upper	-	2	
	DATA3 lower	-	2	
	Sub ID 4	-	1	
	Command 4	-	1	
	DATA4 upper	-	2	
	DATA4 lower	-	2	
CRC	-	CRC	2	Add CRC-16 of the standard Modbus to the end of the message.

4.6 Multi-drive response format (66h, 67h)

The slave sends response with function code 66h or 67h If the command in the query require the slave to response (echo).

NOTE The slave sends response in sequence. If any of the slaves failed to respond, then the slaves after it would not response.

NOTE The slave responds data at the time point it received and processed the query to reduce time point difference of the data of each slave.

Modbus	Data	Example	Bytes	Description
Slave address	ID	00h	1	Always use broadcast mode in Multi-drive.
Function code	FC	66h or 67h	1	66h for normal response. 67h for exception response.
Data	DATA upper	0000h	2	The position of the motor. For parameter 08-15 = 0: Index + step For parameter 08-15 = 1: step upper + step lower
	DATA lower	0010h	2	
CRC	-	CRC	2	Add CRC-16 of the standard Modbus to the end of the message.

4.7 Multi-drive commands

There are two categories of commands in Multi-drive, one with echo and the other with no echo (no response).
The drive will not respond if it receives a non-echo command.
The command address of non-echo = echo address + 100.

Command	Code Decimal (Hex)		Description	Use condition	DATA	
	Echo	Non-echo			Upper (16bi)	Lower(16bit)
ISTOP	0 (00h)	100 (64h)	Stop immediately.	Any operation.	0	0
JG	10 (0Ah)	110 (6Eh)	Speed operation. Set speed > 0 for CW operation Set speed < 0 for CCW operation Set speed = 0 for stop (stop method is set by the STOP-MODE input).	Any operation.	0	Command speed r/min
FREE	5 (05h)	105 (69h)	Enter FREE state.	Any operation.	0	0
SVON	6 (06h)	106 (6Ah)	Servo on.	Any operation.	0	0
SVOFF	7 (07h)	107 (6Bh)	Servo off. Can use to reset alarms.	Any operation.	0	0
IMR	11 (0Bh)	111 (6Fh)	Interrupt current operation and stop after moving for a set travel amount (distance to stop). The deceleration = (distance to stop) * 2 / (the speed at the time point to start IMR).	Any operation.	Travel amount (upper)	Travel amount (lower)
CS	14 (0Eh)	114 (72h)	Reset the command position and current motor position to a set value.	Motor stop or speed operation (JG).	Position reset value (upper)	Position reset value (lower)
CMR	15 (0Fh)	115 (73h)	Set the travel amount for positioning operation. Acceleration and deceleration are set by the operation data.	Not in IMR operation.	Travel amount (upper)	Travel amount (lower)
CMA	16 (10h)	116 (74h)	Set the position (from home) for positioning operation. Acceleration and deceleration are set by the operation data.	Not in IMR operation.	Command position (upper)	Command position (lower)
NULL	99 (63h)	199 (77h)	Commands to query the current position of the slave.	Any operation.	0	0

4.8 I/O function in Multi-drive

The following digital input function can be used in the Multi-drive operation.

No.	5	6	7	8	9	10
Function	FREE	STOP-MODE	EBRAKE/ALM-RST	ALM-RST	STOP-MODE2	M0
No.	11	12	13	14	17	21
Function	M1	M2	EBRAKE/RUN	SERVO-ON	STOP	EXT-ERROR

4.9 Multi-drive message examples

4.9.1 Continuous (speed) operation

Example 1

Modbus RTU, parameter 08-15=0, slave ID 1 CW for 300r/min and slave ID 2 CCW 300r/min

Master Query

Field name		Data	Description
Slave ID		00h	0 for broadcast.
Function Code		65h	65h for master query.
Data	Sub ID number	02h	Number of slaves to query = 2
	Sub ID 1	01h	Address of the first slave = 1
	Command 1	0Ah	JG command for the first slave.
	DATA1 upper	00h	012Ch = 300 r/min (CW)
		00h	
	DATA1 lower	01h	
		2Ch	
	Sub ID 2	02h	Address of the second slave =2
	Command 2	0Ah	JG command for the second slave.
	DATA2 upper	00h	FED4h = -300r/min (CCW)
		00h	
	DATA2 lower	FEh	
		D4h	
CRC (lower)		0Bh	Calculated CRC-16.
CRC (upper)		51h	

Slave 1 response

Field name		Data	Description
Slave ID		01h	Slave address = 1
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		6Ch	

Slave 2 response (send after slave 1 response)

Field name		Data	Description
Slave ID		02h	Slave address = 2
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		5Fh	

Example 2

Modbus RTU, parameter 08-15=0, stop immediately.

Master Query

Field name		**Data**	**Description**
Slave ID		00h	0 for broadcast.
Function Code		65h	65h for master query.
Data	Sub ID number	02h	Number of slaves to query = 2
	Sub ID 1	01h	Address of the first slave = 1
	Command 1	00h	ISTOP command for the first slave.
	DATA1 upper	00h	Data is 0 for ISTP command.
		00h	
	DATA1 lower	00h	
		00h	
	Sub ID 2	02h	Address of the second slave = 2
	Command 2	00h	ISTOP command for the second slave.
	DATA2 upper	00h	Data is 0 for ISTP command.
		00h	
	DATA2 lower	00h	
		00h	
CRC (lower)		DEh	Calculated CRC-16.
CRC (upper)		B9h	

Slave 1 response

Field name		**Data**	**Description**
Slave ID		01h	Slave address = 1
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		6Ch	

Slave 2 response (send after slave 1 response)

Field name		**Data**	**Description**
Slave ID		02h	Slave address = 2
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		5Fh	

4.9.2 Positioning operation

Example 1

Modbus RTU, parameter 08-15=0, slave ID 1 travel for index=300 + step=2000, slave ID 2 travel for index=310 + step=1500

Master Query

Field name		Data	Description
Slave ID		00h	0 for broadcast.
Function Code		65h	65h for master query.
Data	Sub ID number	02h	Number of slaves to query = 2
	Sub ID 1	01h	Address of the first slave = 1
	Command 1	0Fh	CMR command for the first slave.
	DATA1 upper	01h	Index = 300 Step = 2000
		2Ch	
	DATA1 lower	07h	
		D0h	
	Sub ID 2	02h	Address of the second slave = 2
	Command 2	0Fh	CMR command for the second slave.
	DATA2 upper	01h	Index = 310 Step = 1500
		36h	
	DATA2 lower	05h	
		DCh	
CRC (lower)		54h	Calculated CRC-16.
CRC (upper)		B8h	

Slave 1 response

Field name		Data	Description
Slave ID		01h	Slave address = 1
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		6Ch	

Slave 2 response (send after slave 1 response)

Field name		Data	Description
Slave ID		02h	Slave address = 2
Function Code		66h	Normal response.
Data	DATA upper	00h	Motor position Index = 100 Step = 5500
		64h	
	DATA lower	15h	
		7Ch	
CRC (lower)		47h	Calculated CRC-16.
CRC (upper)		5Fh	

5. Multi-drive lite control

Multi-drive lite is a customized RS485 protocol which is based on the customized function code of the Modbus protocol.
With Multi-drive lite, one can control up to 4 different drives with different operations in one message. And each drive can respond in sequence.

NOTE Multi-drive lite only supports continuous(speed) operation.

5.1 To use Multi-drive lite

Check the hardware settings of the communication (SW1, SW2).
Set the parameter 08-01 "Control mode" to 0: speed mode or 1: duty mode.
Set the parameter 02-01 "SC/CC mode" to 0: SC mode. START/STOP, CCW/CW input.
Set the parameter 02-03 "Operation data source" to 1: By digital indexing (M0,M1,M2)
Set the parameter 02-10 "Speed control method" to 3: RS485 Multi-drive lite
Set operation data (acceleration/deceleration time, terminal speed, torque limit).
Send commands through RS485.

5.2 Multi-drive lite communication mode

Based on the standard Modbus broadcast with customized function code.
The master sends a query in broadcast and the slaves respond in sequence or nothing depends on the echo bit field in the query.

The communication mode and timing chart of Multi-drive lite is identical to the Multi-drive. Please reference to "4.2 Multi-drive communication mode" for details.

5.3 Multi-drive lite command data

The speed (or duty in duty mode) can be set in the Multi-drive lite protocol. Other operation data can be set with the corresponding register (see 3.4.1 Operation data) with standard Modbus protocol.

Data		Description	Default range
16 bits	Speed / Duty	The target speed or target duty for Multi-drive lite control.	-4000 to + 4000 r/min -100.0% to 100.0%
16 bits	Acceleration time	Set by operation data register with standard Modbus protocol (see 3.4.1 Operation data)	0.1 to 10.0 sec (0 to 3000r/min)
16 bits	Deceleration time		to 10.0 sec (3000 to 0r/min)
16 bits	Torque limit		0 to 200.0 %

5.4 Multi-drive lite Modbus function code (FC)

Use function code in the customized area of standard Modbus.

FC		Function	Description
Hex	Decimal		
41h	65	Query from the master to the slaves(drives).	The master sends query with the broadcast ID (0) and the function code 41h to query up to 4 slaves in one message.
42h	66	Slave normal response.	After receiving function code 41h in broadcast, the slaves (drives) will respond in sequence on after one. Each slave responds with a function code depends on if the query can be processed normally or not. If the query can be processed normally the slave responds with function code 42h otherwise it responds with function code 43h as exception response.
43h	67	Slave exception response.	

5.5 Multi-drive lite query format (41h)

The message length can be different depends on the number of the slaves to control and the echo data requested in the query.

Modbus	Data	Example	Bytes	Description
Slave address	ID	00h	1	Always use broadcast mode in Multi-drive lite.
Function code	FC	41h	1	Query from the master to the slaves(drives).
Data	Sub ID Number	02h	1	Number of slaves to query. This will determine the length of the message.
	Sub ID 1	01h	1	The slave address of the first slave (drive).
	Command 1	0Ch	1	The command to the first slave (drive).
	DATA1	0000h	2	The data of the commands to the first slave (drive).
	Echo-BITF1	0001h	2	Echo bit field. To set what data to return in the response of the first slave (drive).
	Sub ID 2	02h	1	The slave address of the second slave (drive).
	Command 2	01h	1	The command to the second slave (drive).
	DATA2	0000h	2	The data of the commands to the second slave (drive).
	Echo-BITF2	0010h	2	Echo bit field. To set what data to return in the response of the second slave (drive).
	Sub ID 3	-	1	The same rules as above. If the Sub ID number is 1 then the message after Echo-BITF1 will be blank (except the CRC). If the Sub ID number is 2 then the message after Echo-BIT2 lower will be blank (except the CRC). Up to 4 slaves can be controlled in the query.
	Command 3	-	1	
	DATA3	-	2	
	Echo-BITF3	-	2	
	Sub ID 4	-	1	
	Command 4	-	1	
	DATA4	-	2	
	Echo-BITF4	-	2	
CRC	-	CRC	2	Add CRC-16 of the standard Modbus to the end of the message.

5.6 Multi-drive lite commands

Command	Code		Description	Use condition	DATA (16 bits)
	Hex	Decimal			
ISTOP	00h	0	Stop immediately.	Not in FREE or EBRAKE	0
JG	01h	1	Speed operation. Set speed > 0 for CW operation Set speed < 0 for CCW operation Set speed = 0 for stop (stop method is set by the STOP-MODE input).	Not in FREE or EBRAKE	-4000 to + 4000 r/min Or -100.0% to 100.0%
FREE	05h	5	Enter FREE state.	Any operation.	0
SVON	06h	6	Servo on.	Any operation.	0
SVOFF	07h	7	Servo off. Can use to reset alarms.	Any operation. (parameter 02-14 not 0)	0
ALM-RST	08h	8	Reset alarm.	parameter 02-14 not 0	0
BRAKE	09h	9	Motor 3 phase short brake to stop.	Not in FREE	0
NULL	63h	99	Commands to query the current position of the slave.	Any operation.	0

5.7 Multi-drive lite Echo bit field

The echo bit field in the query indicates the requested data for the slave to return in the response.
The echo bit field in the response indicates what data is in the response message.
The state of each bit in the echo bit field represents a corresponding data to return in the response or not. 0 means no return and 1 means return required.
When an echo bit field is 0000h, the corresponding slave responses nothing.
For example: set the echo bit field to 0064h to ask the slave to return speed, BUS voltage and output current in the response.

Bit	Data to return	Description
0	Motor state	0: STOP 2: RUN 3: EBRAKE 4: FREE 5: FAULT 6: WAIT/INHIBIT 7: MOVING(SERVO ON) 8: SLIGHT-POS-KEEPING
1	Motor position lower decimal	Hall : Hall Cnt lower decimal. Encoder : Encoder Step or Encoder position lower decimal.
2	Motor speed	The current speed of the motor. -32,767 to + 32,768 r/min. Positive as CW and negative as CCW.
3	Alarm code	The present alarm codes. Refer to “A1 -Protect and alarm code”.
4	Direct I/O status	A binary bit field that each bit as an I/O state. bit0=X1, bit1=X2, bit2=X3, bit3=X4, bit4=X5, bi5~bit7=NA, bit8=Y1, bit9=Y2, bit9=YH, bit10~15=NA.
5	BUS voltage	The current DC bus voltage. 0 ~ 65535 (1=0.01VDC).
6	Output current	The output current of the drive. 0 ~ 65535 (0.01A)

7	Motor position upper decimal	Hall : Hall Cnt upper decimal. Encoder : Encoder Index or Encoder position upper decimal.

NOTE Hall cnt: The count for hall signal edge change which increases 1 in CW operation and decreases 1 in CCW operation. -2147483648 ~ 2147483647.

5.8 Multi-drive lite response format (42h, 43h)

The slave sends response with function code 42h or 43h If the command in the query require the slave to response (echo).
The return data and message length vary depend on the echo bit field.

NOTE The slave sends response in sequence. If any of the slaves failed to respond, then the slaves after it would not response.

NOTE The slave responds data at the time point it received and processed the query to reduce time point difference of the data of each slave.

Modbus	**Data**	**Example 1**	**Bytes**	**Description**
Slave address	ID	00h	1	Always use broadcast mode in Multi-drive.
Function code	FC	42h or 43h	1	42h for normal response. 43h for exception response.
Data	Echo-BITF	0004h	2	0004h = 0100b represents to return motor speed.
	DATA	0100h	2	Motor speed 256 r/min.
CRC	-	CRC	2	Add CRC-16 of the standard Modbus to the end of the message.

Modbus	**Data**	**Example 2**	**Bytes**	**Description**
Slave address	ID	00h	1	Always use broadcast mode in Multi-drive.
Function code	FC	42h or 43h	1	42h for normal response. 43h for exception response.
Data	Echo-BITF	0064h	2	0064h = 0110 0100b represents to return motor speed, BUS voltage and output current.
	DATA1	0010h	2	Motor speed 256 r/min.
	DATA2	0960h	2	BUS voltage 24.00 VDC
	DATA3	0064h	2	Output current 1.00 A
CRC	-	CRC	2	Add CRC-16 of the standard Modbus to the end of the message.

5.9 Multi-drive let message examples

Example 1

Modbus RTU, slave ID 1 CW for 300r/min and slave ID 2 CCW 300r/min

Master Query

Field name		Data	Description
Slave ID		00h	0 for broadcast.
Function Code		41h	41h for master query.
Data	Sub ID number	02h	Number of slaves to query = 2
	Sub ID 1	01h	Address of the first slave = 1
	Command 1	01h	JG command for the first slave.
	DATA1	01h	012Ch = 300 r/min (CW)
		2Ch	
	Echo-BITF1	00h	0003h = 0000 0000 0000 0011b Return motor state and hall count.
		03h	
	Sub ID 2	02h	Address of the second slave =2
	Command 2	01h	JG command for the second slave.
	DATA2	FEh	FED4h = -300r/min (CCW)
		D4h	
	Echo-BITF2	00h	0035h = 0000 0000 0010 0011b Return motor state, hall count and BUS voltage.
		35h	
CRC (lower)		DCh	Calculated CRC-16.
CRC (upper)		62h	

Slave 1 response

Field name		Data	Description
Slave ID		01h	Slave address = 1
Function Code		42h	Normal response.
Data	Echo-BITF	00h	0003h = 0000 0000 0000 0011b Return motor state and hall count.
		03h	
	DATA1	00h	Motor state = stop
		00h	
	DATA2	01h	Hall count = 01F4h = 500
		F4h	
CRC (lower)		A7h	Calculated CRC-16.
CRC (upper)		D4h	

Slave 2 response (send after slave 1 response)

Field name		Data	Description
Slave ID		02h	Slave address = 2
Function Code		42h	Normal response.
Data	Echo-BITF	00h	0035h = 0000 0000 0010 0011b Return motor state, hall count and BUS voltage.
		35h	
	DATA1	00h	Motor state = stop
		00h	
	DATA2	FEh	Hall count = FE0Ch = -500
		0Ch	
	DATA3	09h	BUS voltage = 0992h = 24.5VDC
		92h	
CRC (lower)		BCh	Calculated CRC-16.
CRC (upper)		78h	

Example

Modbus RTU, Make both slave ID1 and ID2 to stop.

Master Query

Field name		Data	Description
Slave ID		00h	0 for broadcast.
Function Code		41h	41h for master query.
Data	Sub ID number	02h	Number of slaves to query = 2
	Sub ID 1	01h	Address of the first slave = 1
	Command 1	01h	JG command for the first slave.
	DATA1	00h	0 r/min = stop
		00h	
	Echo-BITF1	00h	0004h = 0000 0000 0000 0100b Return motor speed.
		04h	
	Sub ID 2	02h	Address of the second slave =2
	Command 2	01h	JG command for the second slave.
	DATA2	00h	0 r/min = stop
		00h	
	Echo-BITF2	00h	0004h = 0000 0000 0000 0100b Return motor speed.
		04h	
CRC (lower)		87h	Calculated CRC-16.
CRC (upper)		A2h	

Slave 1 response

Field name		Data	Description
Slave ID		01h	Slave address = 1
Function Code		42h	Normal response.
Data	Echo-BITF	00h	0004h = 0000 0000 0000 0100b Return motor speed.
		04h	
	DATA1	01h	012Ch = 300 r/min (CW)
		2Ch	
CRC (lower)		38h	Calculated CRC-16.
CRC (upper)		49h	

Slave 2 response (send after slave 1 response)

Field name		Data	Description
Slave ID		02h	Slave address = 2
Function Code		42h	Normal response.
Data	Echo-BITF	00h	0004h = 0000 0000 0000 0100b Return motor speed.
		04h	
	DATA1	FEh	FED4h = -300r/min (CCW)
		D4h	
CRC (lower)		78h	Calculated CRC-16.
CRC (upper)		08h	

A1 - Protect and alarm code

When an alarm generates, the motor coast to stop, the ALM-OUT will turn ON and the ALM-LED blinks. (The type of alarm can be confirmed by the alarm code or the blink count of ALM-LED).
Before resetting an alarm, always remove the cause of the alarm to ensure safety and perform one of the operations below to reset the alarm.
Turn the ALM-RST OFF for more than 0.5 sec then turn it ON for another 0.5 sec then turn it OFF again.
Cycle the power. When cycling the power please turn the power off for at least 1 min or till the PWR LED go off then turn the power on again.
NOTE Some alarms can only be reset by cycling the power.
NOTE The alarm cannot be reset if the drive operation command is ON (etc. START/STOP, FWD, REV input is ON). Please turn all the operation command to OFF before reset the alarm.

Alarm Code (LED Blinks)	Protect function	Description
1	Overcurrent	Excessive current has flown through the drive. Or the load exceeds the rated value has applied to the motor more than 5 sec. (the time allowed for the load exceeds the rated value could be different depends on the parameter setup.)
2	Overload	The load exceeds the rated value has applied to the motor more than 5 sec. (the time allowed for the load exceeds the rated value could be different depends on the parameter setup.)
3	Motor feedback fault	The hall sensor or encoder wiring is bad or not connected.
4	Over voltage	The input power supply voltage has exceeded the maximum Limit of the drive. Or the inertia of the load is too large.
5	Under voltage	The input power supply voltage is under the low limit.
6	Drive overheat	The drive's temperature is over its maximum limit.
7	Startup fault	The motor failed to start. The motor cable is not connected correctly.
8	EEP data error	Error in EEPROM data. (Can NOT be reset by ALM-RST input)
10	Motor overheat	The motor's temperature is too high. (The MOT-OT terminal has been set to ON state.)
12	Over speed	The speed has exceeded the maximum setup of the drive.
13	Encoder signal fault	Encoder signal error. Encoder was not connected.
14	Prevention of operation at power on	The main power supply was cycled when the FWD input or REV input was set to ON.
15	External stop	EXT-ERROR input is ON.
20	Hall sequence fault	The hall sequence was incorrect.
21	Communication error	The parameter setup value exceeds its limit or the communication command was not supported.
22	Parameter error	The parameter setup value was incorrect.

A2 - Operation data source setting

Parameter 02-03	Operation data No.	Speed/Duty Command source	Acceleration time command source	Deceleration time command source	Torque limit Command source
0	0	VR	Digital indexing	Digital indexing	Digital indexing
	1	A1			
	2 to 7	Digital indexing			
1	0 to 7	Digital indexing	Digital indexing	Digital indexing	Digital indexing
2	0	VR	Digital indexing	Digital indexing	A2
	1	A1			
	2 to 7	Digital indexing			Digital indexing
3	0 to 7	Digital indexing	Digital indexing	Digital indexing	A2
4	0 to 7	A1	Digital indexing	Digital indexing	Digital indexing
5	0	A1	VR	VR	A2
	1 ~ 7	Digital indexing	Digital indexing	Digital indexing	Digital indexing
6	0	A1	VR	VR	Digital indexing
	1 to 7	Digital indexing	Digital indexing	Digital indexing	
7	0	A1	A2	A2	VR
	1				Digital indexing
	2 to 7	Digital indexing	Digital indexing	Digital indexing	

Revision history

REV	Date	Remark
1.0	2020-09-17	Preliminary.
1.1	2021-12-10	Update 5.7 Multi-drive lite Echo bit field description.