



THE DEXTEROUS HAND (CAN SUPPLEMENTAL PROTOCOL)

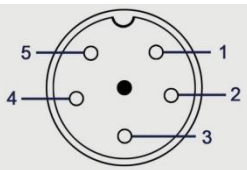


Dexterous Hands RH56 Series

CAN Supplemental Protocol

1. Pin definition

The electrical interface of the dexterous hand is shown in Figure 1. The interface is a standard aviation plug with GX12 pins. The pins are defined as follows:

Interface type	Pin definition												
CAN	<table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th style="font-size: 8px;">Pin NO.</th> <th style="font-size: 8px;">CAN</th> </tr> </thead> <tbody> <tr><td style="font-size: 8px;">1</td><td style="font-size: 8px;">GND</td></tr> <tr><td style="font-size: 8px;">2</td><td style="font-size: 8px;">VCC</td></tr> <tr><td style="font-size: 8px;">3</td><td style="font-size: 8px;">C_H</td></tr> <tr><td style="font-size: 8px;">4</td><td style="font-size: 8px;">C_L</td></tr> <tr><td style="font-size: 8px;">5</td><td style="font-size: 8px;">GND</td></tr> </tbody> </table> 	Pin NO.	CAN	1	GND	2	VCC	3	C_H	4	C_L	5	GND
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1	GND												
2	VCC												
3	C_H												
4	C_L												
5	GND												

(Figure 1) Interface Description

2. Register reading/writing of CAN

The default baud rate is 1000K. It adopts the extended identifier and data frame format. It does not use the standard identifier and remote frame. The extended identifier has 29 bits, which are defined from low-order to high-order bits as follows:

bit0-13: Hand_ID supports up to 16383 devices;

bit14-25: Start address of the register to be operated;

bit26-28: Read/write flag bits; 0 indicates reading a register of the dexterous hand; 1 indicates writing to a register of the dexterous hand; 4 indicates reading the wrist register of the dexterous hand; 5 indicates writing to the wrist register of the dexterous hand.

Identifier	bit 31-29	bit 26-28	bit14-25	bit 13-0
Meaning	Reserve	W/R 0: R - Reading a register of the dexterous hand 1: W - Writing to a register of the dexterous hand 4: R - Reading the wrist register of the dexterous hand 5: W - Writing to the wrist register of the dexterous hand	Register address	Hand_ID

2.1 Register reading

The identifier settings of register reading are as follows:

Identifier	bit 31-29	bit 26-28	bit14-25	bit 13-0
Meaning	Reserve	0	Address	Hand_ID

The data length is 1 byte.

Data content: Length of the register data to be read

After the dexterous hand receives and correctly analyzes the aforesaid instruction, it will return the following frame:

Identifier:

Identifier	bit 31-29	bit 26-28	bit14-25	bit 13-0
Meaning	Reserve	0	Address	Hand_ID

Data length: Length of the data to be returned to the register

Data content: Register data

For example, if we want to read the current actual angle of the index finger of the dexterous hand (ID=1), the following frame should be sent to the CAN bus:

Identifier: The binary number is 0000 0001 1000 0100 0000 0000 0000 0001.

bit 31-29	bit 26-28	bit14-25	bit 13-0
0	0	Address of ANGLE_ACT(3) = 1552; The binary number is 011000010000.	1

Data length: 1

Data content: 2; the current actual angle of the index finger is an integer data; the data length is 2 bytes.

The dexterous hand returns the following frame:

Identifier: The binary number is 0000 0001 1000 0100 0000 0000 0000 0001.

bit 31-29	bit 26-28	bit14-25	bit 13-0
0	0	Address of ANGLE_ACT (3) = 1552; The binary number is 011000010000.	1

Data length: 2

Data content: The current actual angle of the index finger is POS_ACT (3), which is an integer. The following data should be converted to integers (low-order bytes are followed by high-order

bytes). After high-order and low-order bytes are exchanged, the hexadecimal number is 0x01F4, and the decimal number is 500 (the current actual angle of the index finger is 500).

byte0	byte1
0xF4	0x01

2.2 Register writing

The identifier settings of register writing are as follows:

Identifier	bit 31-29	bit 26-28	bit14-25	bit 13-0
Meaning	Reserve	1	Address	Hand_ID

Data length: Length of the data to be written to the register

Data content: Data to be written to the register

After the dexterous hand receives and correctly analyzes the aforesaid instruction, it will return the following frame:

Identifier	bit 31-29	bit 26-28	bit14-25	bit 13-0
Meaning	Reserve	1	Address	Hand_ID

Data length: 0

For example, if we want to set the angle of the index finger of the dexterous hand (ID=1) to 600, the following frame should be sent to the CAN bus:

Identifier: The binary number is 0000 0101 0111 0101 0000 0000 0000 0001.

bit 31-29	bit 26-28	bit14-25	bit 13-0
0	1	Address of ANGLE_SET(3) = 1492; The binary number is 010111010100.	1

Data length: 2

Data content: The current actual angle of the index finger is ANGLE_SET(3), which is an integer. It is necessary to split the integer data into high-order and low-order bytes and then exchange these bytes; that is, 600 (0x0258) is converted to the data content below:

byte0	byte1
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0x58	0x02
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The dexterous hand returns the following frame:

Identifier: The binary number is 0000 0101 0111 0101 0000 0000 0000 0001.

bit 31-29	bit 26-28	bit14-25	bit 13-0
0	1	Address of ANGLE_SET (3) = 1492; The binary number is 01 0111 0101 00.	1

Data length: 0

2.3 CAN Communication Example

2.3.1 Modify HAND_ID (Dexterous Hand ID)

The default HAND_ID is 0x01. Changing it to 0x02 can be saved.

Identifier	CAN frame data section	Data length
0x04FA0001	0x02 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	0x01

2.3.2 REDU_RATIO (Baud rate setting)

Default value = 0; range: 0-1; it can be saved.

0: Baud rate = 1000k

1: Baud rate = 500k

Modify Baud Rate to 500k Frame Format

Identifier	CAN frame data section	Data length
0x04FA8001	0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	0x01

2.3.3 CLEAR_ERROR (error clearance)

Default value = 0; range: 0-1; it cannot be saved.

After 1 is written, clearable errors (errors such as locked-rotor, overcurrent, abnormal operation, or communication error of Micro Linear Servo Actuator, which hereinafter referred to as “actuator”) in the dexterous hand will be cleared.

Clear Fault Frame Format

Identifier	CAN frame data section	Data length

0x04FB0001	0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00	0x01
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Note: The over temperature error of the actuator is not clearable. When the temperature falls, such error will be cleared automatically.

2.3.4 SAVE parameters to FLASH

Default value = 0; range: 0-1; it cannot be saved.

After 1 is written, the dexterous hand will write current parameters in the Flash. These parameters will not be lost after power failure.

Save Instruction Frame Format

Identifier	CAN frame data section	Data length
0x04FB4001	0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00	0x01

2.3.5 POS_SET(m) (set value of the actuator position for each DOF)

This register group consists of six registers corresponding to the set value of the actuator position of the dexterous hand for 6 DOF, with details in the table below. These parameters cannot be saved.

Address	Name	Description	Data type	Range
1474-1475	POS_SET(0)	Actuator position setting for the little finger	short	0-2000
1476-1477	POS_SET(1)	Actuator position setting for the ring finger	short	0-2000
1478-1479	POS_SET(2)	Actuator position setting for the middle finger	short	0-2000
1480-1481	POS_SET(3)	Actuator position setting for of the index finger	short	0-2000
1482-1483	POS_SET(4)	Actuator position setting for of the thumb bending	short	0-2000
1484-1485	POS_SET(5)	Actuator position rotation setting for thumb rotation	short	0-2000

Set Little Finger Position to 500 in CAN Frame Format

Identifier	CAN frame data section	Data length
0x05708001	0xF4 0x01 0x00 0x00 0x00 0x00 0x00 0x00	0x02

0: Minimum actuator stroke, corresponding to the maximum finger angle (i.e., holding fingers open);

2000: Maximum actuator stroke, corresponding to the minimum finger angle (i.e., bending fingers);

-1: The actuator does not take any action.

Note: It is not recommended to set the finger position angle by setting this register group.

2.3.6 ANGLE_SET(m) (set value of the angle for each DOF)

This register group consists of six registers corresponding to the set value of the angle of the dexterous hand for 6 DOF, with details in the table below. These parameters can be saved after power failure. When the angle value for a degree of freedom (DOF) is set to the data within 0-1000, the corresponding finger will take an immediate action. If the angle value is set to -1, the corresponding finger will make no response. For example, after the angle values of six registers (ANGLE_SET(0)- ANGLE_SET(5)) are set to 500, 500, -1, 0, 500 and 500 respectively, the little and ring fingers and the thumb will be bent, and the thumb will rotate by 4 DOF and move to an angle corresponding to "500"; the index finger will move to an angle corresponding to "0"; and the middle finger will not move (i.e., it will be maintained in the current position without action).

Address	Name	Description	Data type	Range
1486-1487	ANGLE_SET(0)	Initial power-on angle of the little finger	short	-1, 0-1000
1488-1489	ANGLE_SET(1)	Initial power-on angle of the ring finger	short	-1, 0-1000
1490-1491	ANGLE_SET(2)	Initial power-on angle of the middle finger	short	-1, 0-1000
1492-1493	ANGLE_SET(3)	Initial power-on angle of the index finger	short	-1, 0-1000
1494-1495	ANGLE_SET(4)	Initial power-on angle of thumb bending	short	-1, 0-1000
1496-1497	ANGLE_SET(5)	Initial power-on angle of thumb rotation	short	0-1000

Set Little Finger Degree to 500 in CAN Frame Format

Identifier	CAN frame data section	Data length
0x05738001	0xF4 0x01 0x00 0x00 0x00 0x00 0x00 0x00	0x02