5JXX Metering Pump Series

Shenzhen Keyto Fluid Technology Co., Ltd.

Contents

Contents 1-2

1. Product Overview 3

1.1 The main features of 5JXX series metering pumps 3

1.2 Nouns 3

2. Products Basic Parameters 4

2.1 Naming Convention 4-5

2.2 Specification 5

2.3 5JXX Series Metering Pump Structure 6-9

2.4 5JXX Series Metering Pump Displacement Calibration 10-11

2.5 5JXX Series Metering Pump Controller 12

3. Product Electrical Interface 13

3.1 Nema 42 Stepper Motor 13-14

3.2 Optical Switch 14-17

4. Controller Description 18

4.1 Serial Port Communication 18-22

4.2 Serial Command 22-30

4.3 LED Indication 31

4.4 CAN Object Dictionary 31-33

4.5 Program Application Flow 33-35

5. Metering Pump Application Notes 35

5.1 Working medium 35

5.2 Working Displacement 35

5.3 Complete Machine

Installation 35

5.4 Accurate Dispensing 36

5.5 Initialization Recommendations 36

5.6 Vibration damping recommendations 36

5.7 Recommended Environmental Conditions 36

5.8 Cleaning Recommendations for Pumps After Crystallization 36-37

5.9 Metering Pump Timing Diagram 37

6. Common Troubles and Their Troubleshooting 38

7. Safety Precautions 39

1. Product Overview

The 5JXX series metering pump is a precision dosing pump independently developed by Keyto, designed primarily for the accurate and precise filling of liquid. The pump's bracket and transmission structure are compact, offering high accuracy and precision in aspiration and dispensing. The range of aspiration and dispensing varies depending on the diameter of the piston.

1.1 Main Features

The metering pump is driven by a stepper motor, ensuring smooth operation. The moving pair is equipped with imported ball screws, providing long-lasting durability. The quantitative aspiration and dispensing liquid is achieved by controlling the number of rotations of the stepper motor.

- Throughout the pump's lifecycle, it maintains extremely high and stable precision for aspirating and dispensing.
- Angle adjustment range: 0.5-20°
- Suction height: 4 meters
- Photoelectric sensor for positioning the starting point of aspiration and dispensing.
- Long-life, high-performance 1.8° two-phase stepper motor.

1.2 Nouns

- **Accuracy (f): Refers to the degree of deviation between measurement result and true value**

$$f_s = \frac{|X_0 - X|}{X_0} \times 100\%$$

fs: Accuracy

X: Measured value

X_0 : True value

- **Repeatability(CV):**

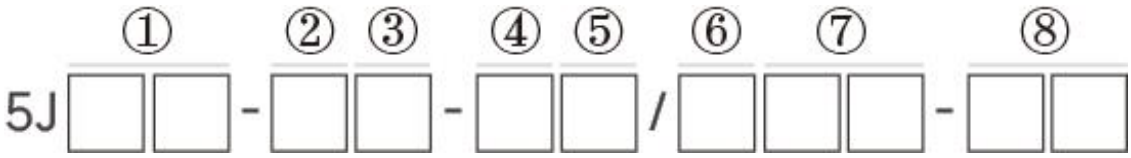
Repeatability is expressed using the coefficient of variation (Cv), which objectively and accurately reflects the dispersion of a set of data.

$$cv = \frac{sd}{mean} \times 100\%$$

sd:Standard Deviation
Mean:Average value

2. Products Basic Parameters

2.1 Naming Rules



Note code	Note type	Name	Product naming instructions
①	Volume	05	5mm(170ul max.)
		07	7mm(300ul max.)
		10	10mm(700ul max.)
②	Pump housing material	E	ETFE
		P	PVDF
③	Piston material	Z	Zirconia
		A	Alumina (99.7%)
④	Functions	1	Without rinse-port, without controller, without encoder
		2	With rinse-port, without controller, without encoder
		3	Without rinse-port, with controller, without encoder
		4	With rinse-port, with controller,

			without encoder
⑤	Port connection	U	1/4-28 UNF
		A	5/16-UNF
⑥	Process	P	Injection molding
⑦		• • •	Custom
⑧	Factory setting volume	30	30ul/r
		50	50ul/r
		100	100ul/r
		150	150ul/r
		200	200ul/r
		250	250ul/r
		500	500ul/r
		700	700ul/r

2.2 Specification

5JXX series metering pump parameter table

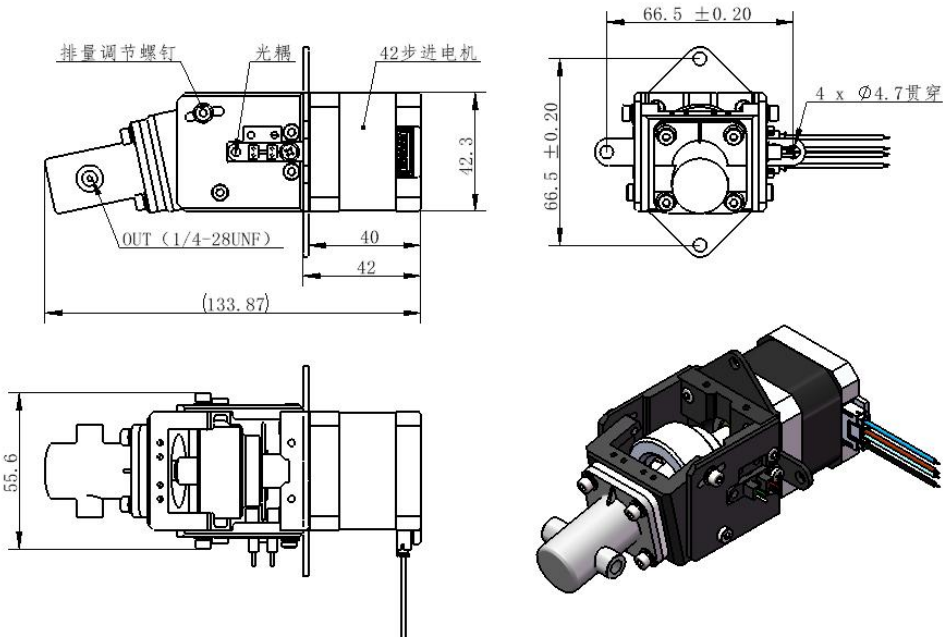
Maximum displacement (μL/r)	170	300	700
Piston diameter (mm)	5	7	10
Maximum pressure (MPa)	0.6		
Maximum Installation Angle (°)	20		
Maximum aspiration height (m)	4		2-4
Lifespan (cycles)	30 million		
CV	0.5%		
Accuracy	1%		

Piston Material	Zirconia/Alumina		
Housing material	ETFE/PVDF		
Stepper motor (1.8°)	Nema 42 stepper motor		
Port connection	1/4-28 UNF, 5-16-UNF (only for 10mm series)		
Speed (rpm)	5-600	5-600	5-300

Note: Accuracy data is tested using pure water at 300rpm with liquid pressure ≤50kPa; it is recommended that the liquid pressure be controlled within 150kPa.

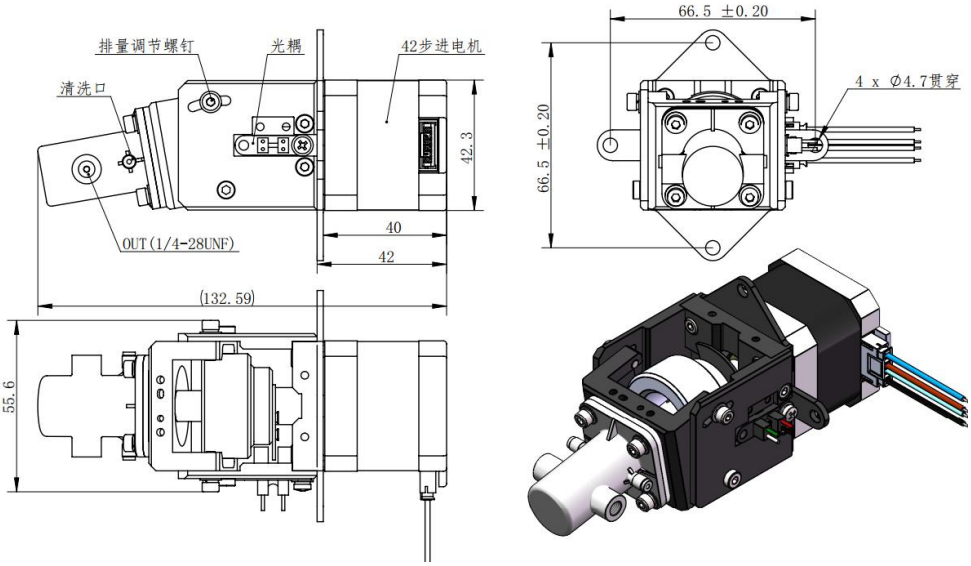
2.3 5JXX Series Metering Pump Structure

5J05 Non-Rinse Version Drawing



Installation method 1:
Port connection: 1/4-28 UNF

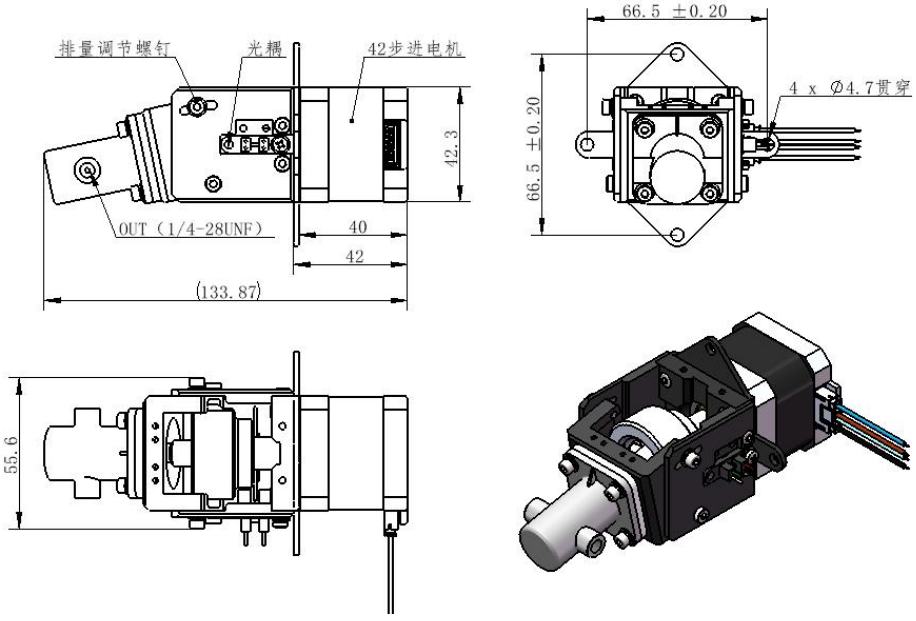
5J05 Rinse Version Drawing



Installation method 1:

This model has a 1/4-28 UNF thread.

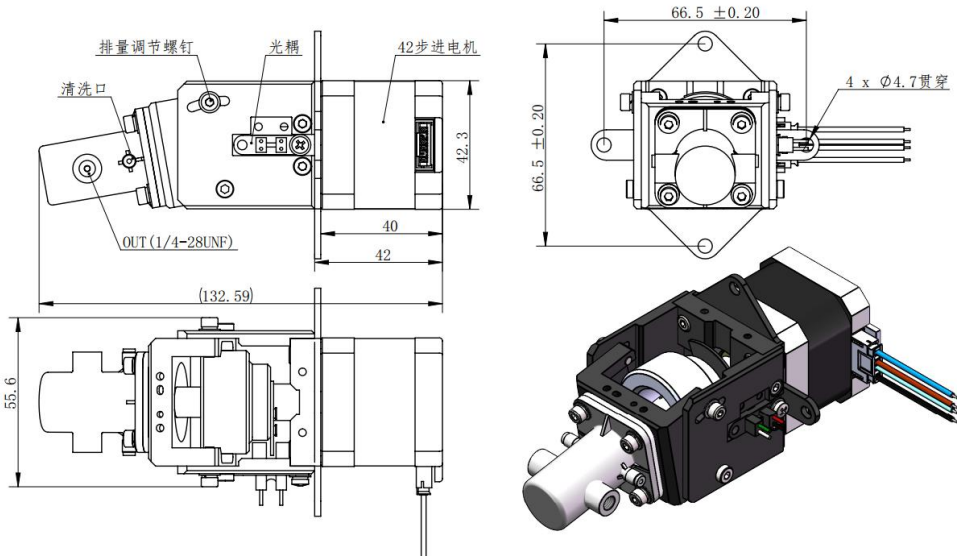
5J07 Non-Rinse Version Drawing



Installation method 1:

This model has a 1/4-28 UNF thread.

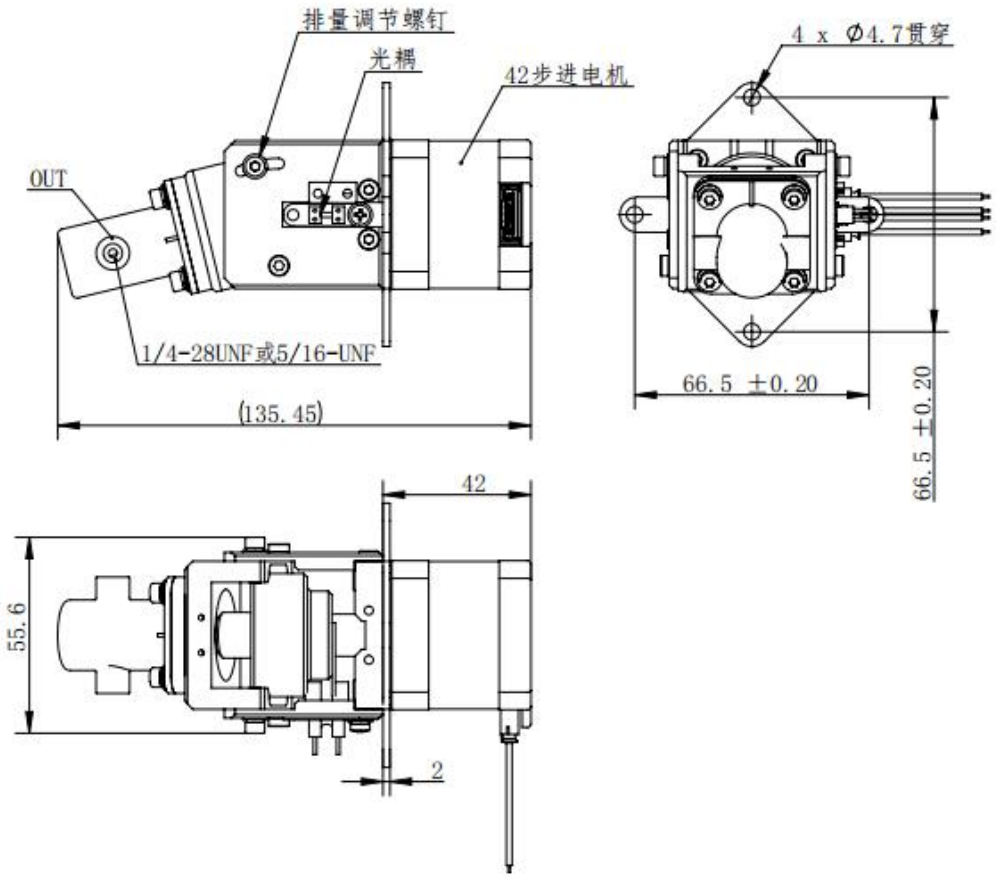
5J07 Rinse Version Drawing



Installation method 1:

This model has a 1/4-28 UNF thread.

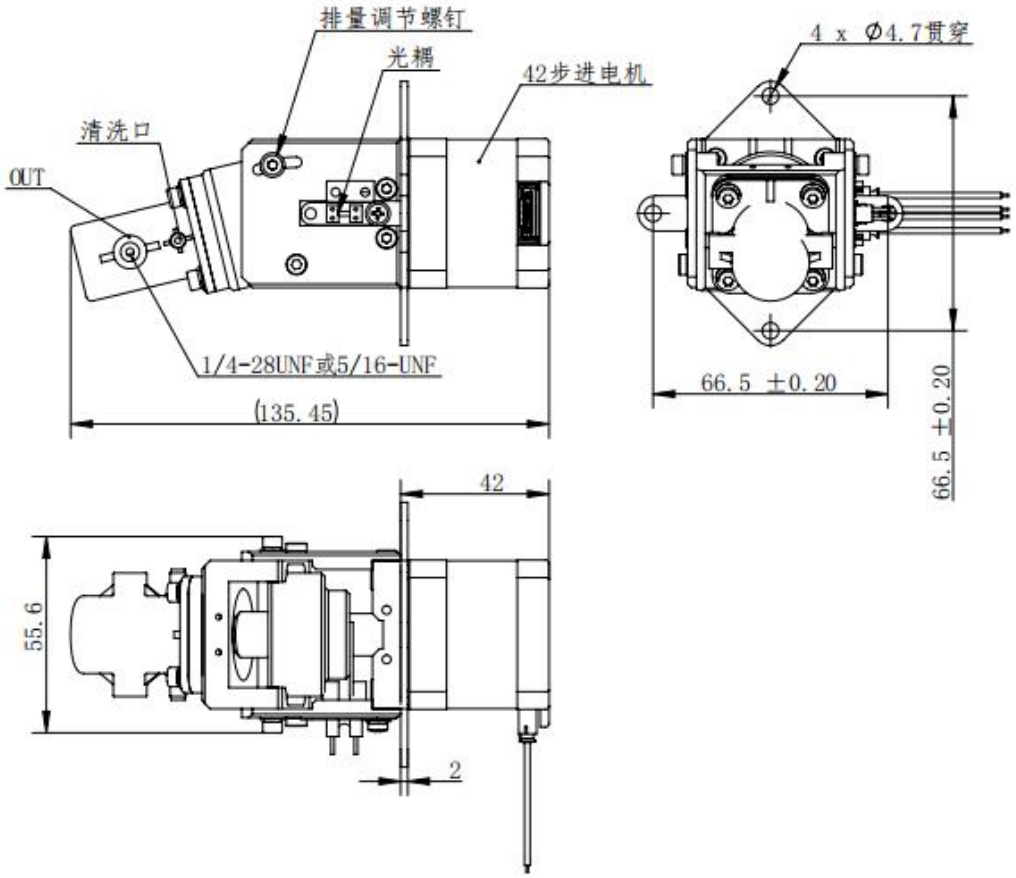
5J10 Non-Rinse Version Drawing



Installation method 1:

This model is available in 1/4-28UNF and 5/16-UNF threads, with the use of tube ID recommended to be greater than 2.5mm

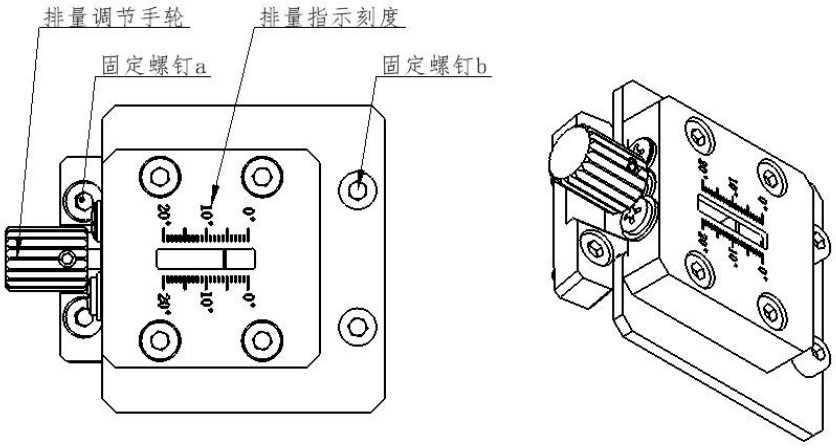
5J10 Rinse Version Drawing

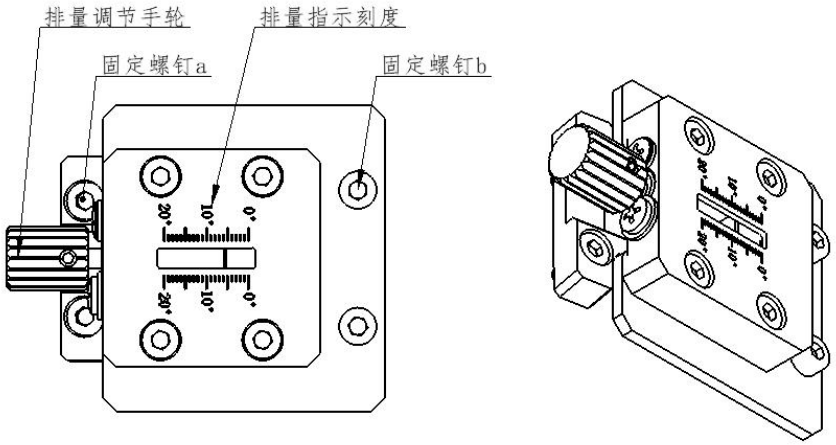


Installation method 1:

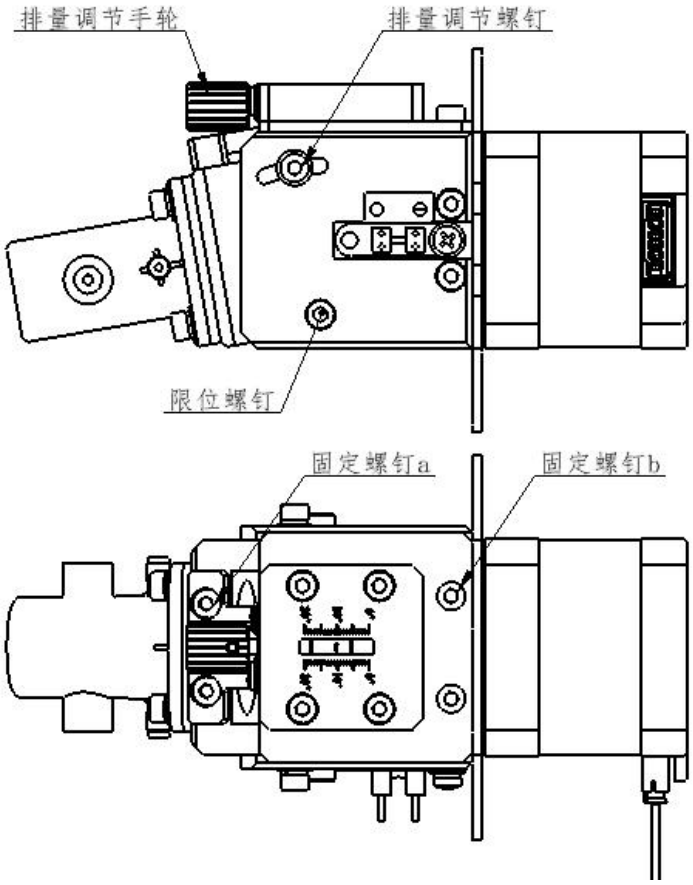
This model is available in 1/4-28UNF and 5/16-UNF threads, with the use of pipe ID recommended to be greater than 2.5mm

2.4 5JXX Series Metering Pump Displacement Calibration



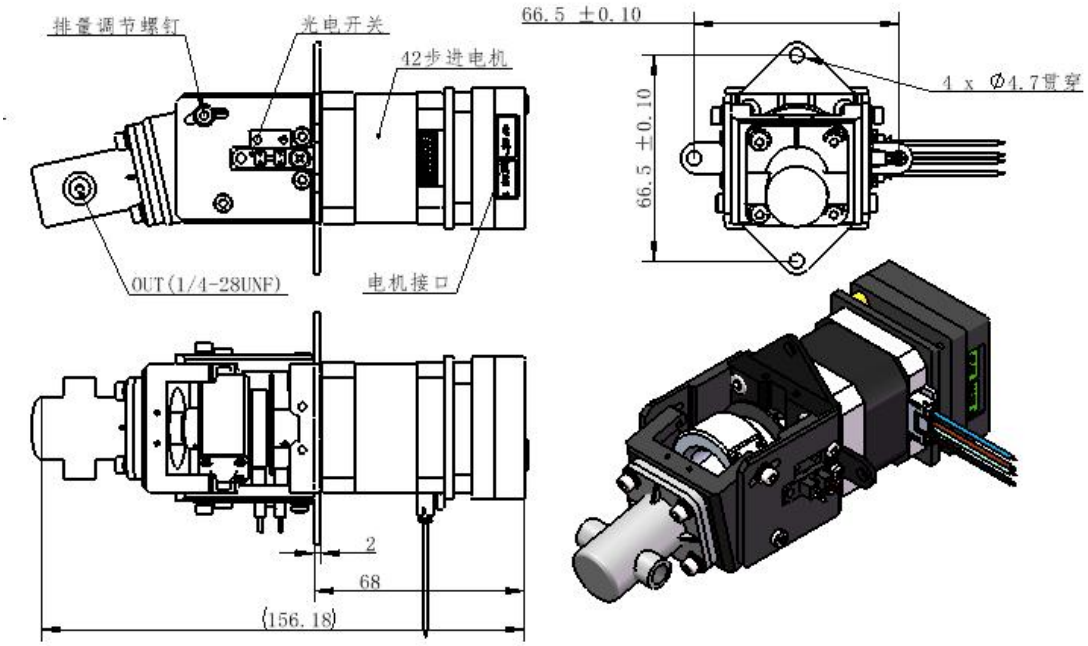


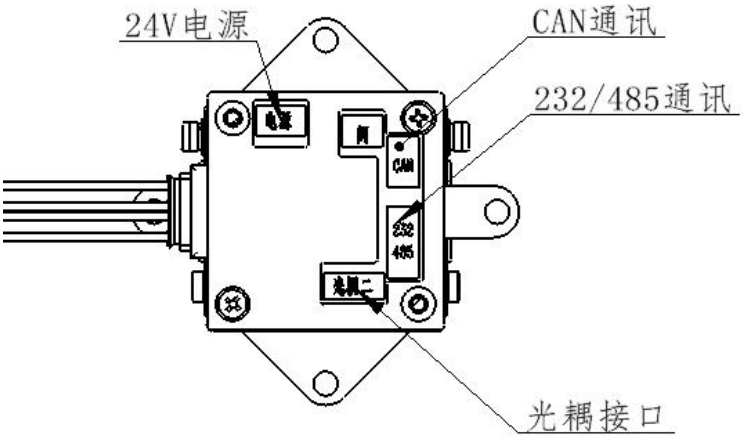
commissioning mechanism



Calibration Diagram

2.5 5JXX Series Metering Pump Controller

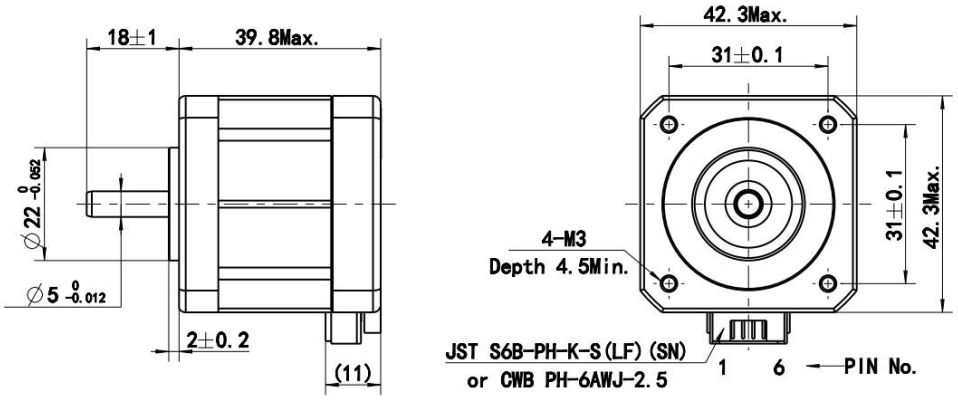
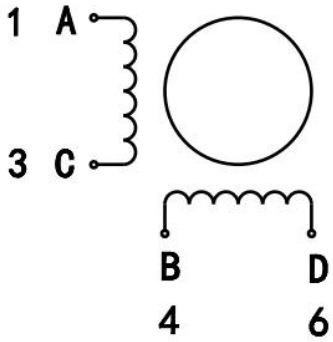




Controller Installation Example

3. Product Electrical Interface

3.1 Nema 42 Stepper Motor

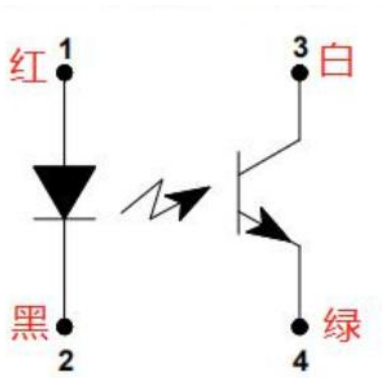
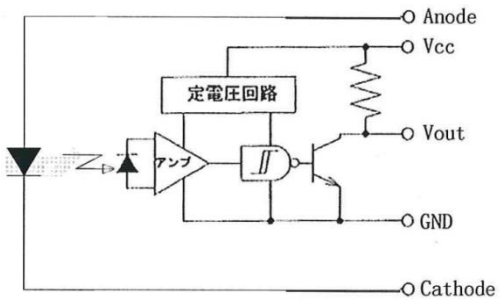
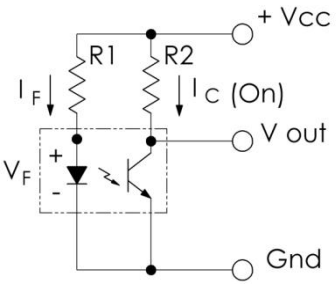
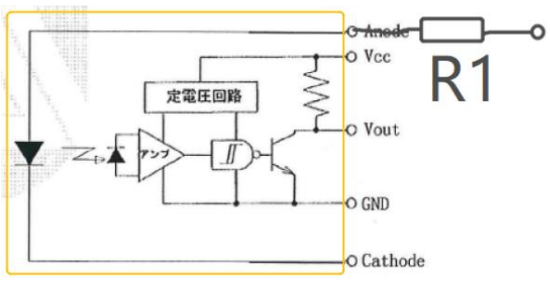
<table>
<tr><td></td><td colspan="2">2A motor</td></tr>
<tr><td>Dimensions</td><td colspan="2"> 
</td></tr>
<tr><td>Wiring</td><td colspan="2">接线图
Wiring Diagram
 

连接器针位vs.引线颜色
Pin No. vs. Lead Wire Colour
<table>
<tr><th>PIN No.</th><th>颜色 Colour</th></tr>
<tr><td>1</td><td>黑 BLK</td></tr>
<tr><td>3</td><td>绿 GRN</td></tr>
<tr><td>4</td><td>红 RED</td></tr>
<tr><td>6</td><td>蓝 BLU</td></tr>
</table></td></tr>
<tr><td rowspan="8">Electrical</td><td>Step angle</td><td>1.8°</td></tr>
<tr><td>Rated voltage</td><td>2.08V</td></tr>
<tr><td>Rated current</td><td>2A</td></tr>
<tr><td>Resistors</td><td>1.04ohm ±10%</td></tr>
<tr><td>Inductance</td><td>2.2mH ±20%</td></tr>
<tr><td>Holding torque</td><td>0.46Nm</td></tr>
<tr><td>Rotational inertia</td><td>57 g-cm^2</td></tr>
</table>

Current Setting	The output current is set equal to or slightly less than the motor rated current.

3.2 Optical Switch

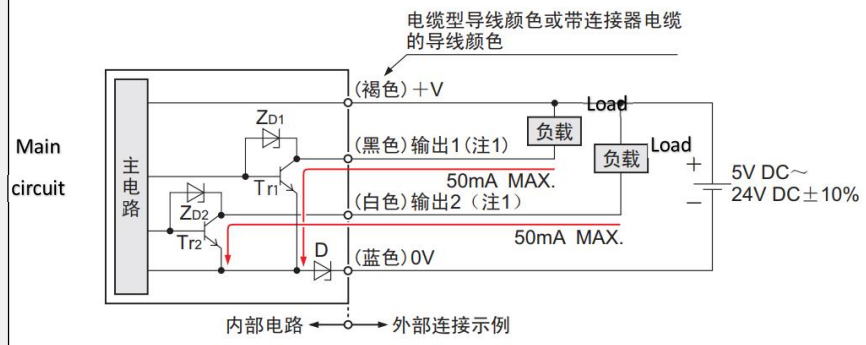
OP Optocoupler

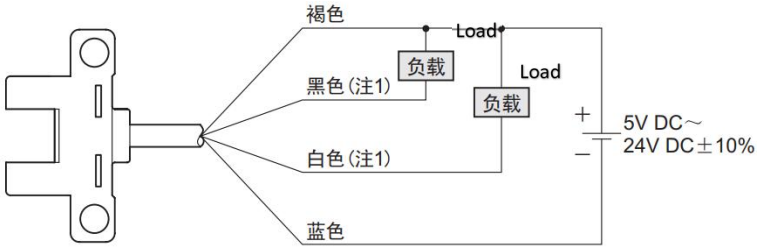
	Four-wire optocoupler		Five-wire optocoupler	
Dimensions				
Wiring Instruction	Color	Electrical signals	Color	Electrical signals
	Red	Anode	Red	Anode
	Black	Cathode	Black	Cathode
	White	Collector	White	Vcc
	Green	Emitter	Blue	Output
			Green	Ground
Electrical Specification				

Current Setting				
	Input Diode (E)		**Input Diode (E)**	
	Input Diode Power Dissipation	75mW	Input Diode Power Dissipation	No limit, only IF 50mA(MAX)
	Input Diode Forward D.C. Current	50mA	Input Diode Forward D.C. Current	50mA(MAX) Current limiting resistor must be added
	Input Diode Forward D.C. Voltage	2V	Input Diode Forward D.C. Voltage	5V
	Forward Voltage(VF)	1.8V(max)	Forward Voltage(VF)	1.3V(max)
	Output Diode (S)		**Sensor (S) Limit Value**	
	Collector-Emitter Voltage	30V	Supply Voltage (Vcc to Ground)	15V
	Output Photologic® Power Dissipation	100mW	Output Photologic® Power Dissipation	170 mW
	Emitter-Collector Voltage	5V	Voltage at Output lead (OUT≈Vcc)	VCCX0.9V
	Collector DC Current	30mA	Short Circuit Output to Ground	2

	Collector-Emitter Saturation Voltage		Low Level Output Voltage	
	VCE(SAT)	0.4V(max)	VOL	0.4V(max)
	IC	400uA	VCC	4.5V
	IF	20mA	IOL	16mA
			IF	0mA
	On-State Collector Current		High Level Output Voltage	
	IC(ON)	0.5mA(min)	VCC	3~13.2V
	VCE	10V	VOH	VCCX0.9V
	IF	20mA	IOL	1
			IF	10mA

Reference Formula	$R_1 = \frac{(V_{CC} - V_F)}{I_F}$ $R_2 = \frac{(V_{CC} - V_{CESAT})}{I_{C(ON)}}$	$R_1 = \frac{(V_{CC} - V_F)}{I_F}$
Wiring Instructions	▼ Red Wire: Choose a power supply voltage in the DC 5~24V range. Before use, a current-limiting resistor must be connected in series. Note: 1. The values of resistors R1 and R2 can be calculated using the reference formula and adjusted accordingly. 2. When using VOUT (white wire) as a PLC input, consider whether an amplification circuit is needed depending on the PLC input current. When connected to +5V, the recommended series resistor R1 value is 200Ω. When connected to +12V, the recommended series resistor R1 value is 510Ω. When connected to +24V, the recommended series resistor R1 value is 1KΩ. ▼ Black Wire: Connect to the negative terminal of the power supply. ▼ White Wire: Signal output wire. Connect to the positive terminal of the logic power supply with a voltage range of 5V~24V (add a pull-up resistor R2 if necessary). ▼ Green wire: Connect to the negative terminal of the logic power supply.	▼ Red Wire: For power supply voltages in the DC 5~12V range, connect a current-limiting resistor in series before use. When connected to +5V, the recommended series resistor R1 value is 360Ω. When connected to +12V, the recommended series resistor R1 value is 1KΩ. Note: It is not recommended to connect to 16V-24V as it will shorten the product's lifespan. The chip's maximum voltage limit is 13.2V, and the recommended voltage should be <13.2V. ▼ Black wire: Connect to the negative terminal of the power supply. ▼White Wire: Output terminal of the photodetector's logic power supply. When the voltage is 5V, no series resistor is needed. ▼ Green wire: Connect to the negative terminal of the logic power supply. ▼ Blue Wire: Signal output wire used for detecting the initial position of the piston assembly. Connect to the user's control equipment. When at the initial position, it outputs a low level; at other positions, it outputs a high level.
Precautions	1. The optocoupler output circuit is designed to drive CMOS digital inputs. Do not connect any additional loads, as this may cause signal instability. Common additional loads include components like indicator lights. 2. The output driving capability of the photoelectric switch is very weak. Please refer to the above-mentioned parameters for appropriate usage.	

<table>
<tr><td></td><td colspan="2">Panasonic Optocoupler</td></tr>
<tr><td>Input/Output Circuit Diagram</td><td colspan="2">


(注1)：不使用的输出线请务必进行绝缘处理。
符号… D：电源反向连接保护用二极管
ZD1、ZD2：电涌吸收齐纳二极管
Tr1、Tr2 ：NPN输出晶体管
</td></tr>
<tr><td rowspan="5">Wire Definition</td><td>Color</td><td>Electrical signals</td></tr>
<tr><td>Brown</td><td>+ V</td></tr>
<tr><td>Blue</td><td>0 V</td></tr>
<tr><td>Black</td><td>Output 1</td></tr>
<tr><td>White</td><td>Output 2</td></tr>
<tr><td>Wiring Diagram</td><td colspan="2">


(注1)：不使用的输出线请务必进行绝缘处理。
</td></tr>
<tr><td>Output Action</td><td colspan="2">
<table>
<tr><th>Output</th><th>Wire Color</th><th>Output Action</th></tr>
<tr><td>Output 1</td><td>Black</td><td>ON when light enters</td></tr>
<tr><td>Output 2</td><td>White</td><td>ON when light exits</td></tr>
</table>
</td></tr>
<tr><td rowspan="3">Supply Voltage</td><td colspan="2">Supply Voltage</td><td>5V-24V</td></tr>
<tr><td colspan="2">Current consumption</td><td><15mA</td></tr>
<tr><td colspan="2">Maximum Input Current (Output 1/Output 2)</td><td>50mA</td></tr>
</table>

4. Controller Description

The Controllers section is for metering pumps with controller models only, and the following

is a description of controller communications:

4.1 Serial Port Communication

The device supports 232 and 485 serial port communication, and the default serial port parameters are as follows:

Baud rate: 9600

Check bit: None

Stop bit: 1

Data bit: 8

Serial port 232 receive data will be automatically forwarded to 485 interface, 485 receive data will be automatically forwarded to 232 interface. This allows users to realize multiple applications without the need of 485 to 232 interface by using the 232 interface as the main input and another interface in parallel with the 485.

DT Protocol Format

The driver will parse the string every time it receives a string and verify whether the address matches and the syntax is correct, and return the status of the first command execution. If there are multiple commands, it is necessary to query the status to confirm whether the subsequent commands are executed successfully, and the command whose data in the sending data area is empty can query the status.

Data format

No.	Function	Number of Bytes	Description
1-2	Address	2	0-254: Target communication address. Each driver on the bus should be set with a unique address number, ranging from 1-32. Communication occurs only when the address matches; otherwise, received commands are ignored. 255: Address 255 is used for controlling multiple pumps simultaneously. All devices on the bus will process the received command, but no data response will be provided from this address.
3	Direction	1	Character ">" indicates data is being sent.
4+n	Data	n	ASCII command string. For details, refer to the operation commands.
5+n	End Symbol	1	Carriage return 0x0D. Each communication data should end with a carriage return.

No.	Function	Byte Count	Description
1-2	Address	2	The original device address, matches the address sent, indicates which address the data is returned from.
3	Direction	1	Character '<' indicates returned data.
	Status	2	See status table.
	Special Symbol	1	':' symbol, not shown if no data is returned.
4+n	Data	n	Returned data string, see operation commands for details.
5+n	End Symbol	1	Carriage return 0x0D, each communication data should end with a carriage return.

OEM Protocol Format

The communication protocol contains communication sequence number and checksum byte, which can effectively prevent data loss, so it is recommended to use OEM protocol to communicate with PUMP. During the working period, the controller queries the PUMP status by sending the empty command and analyzes the queried status to determine whether the PUMP executes the completed command or there is an error, and sends the command that the data area data is empty can be queried status.

Send command format

Data Field	Data Type	Byte Count	Description
Frame Header	Uint8	1	Fixed value 0XAA, indicating start of data
Sequence Number	Uint8	1	0X80-0xFF, communication sequence number. The user should increment the sequence number by +1 with each command. If the system detects that the sequence number and command are identical to the previous frame, the system will ignore the command.
Address	Uint8	1	0-254: Communication address, each driver on the bus should be assigned a unique address number within the range 1-32. Communication will occur only when the address matches, otherwise the command will be ignored. 255: Address 255 is used for simultaneous control of multiple pumps. All devices on the bus will process the received command, but no device will respond with any data.
Data Length	Uint8	1	Length of the data area

Data	Char	n	ASCII command string, see specific operation commands for details
Checksum	Uint8	1	8-bit checksum, calculated from the start of the frame header to the end of the data area. The obtained value uses the last 8 bits of data

Return data format

Data Field	Data Type	Byte Count	Description
Frame Header	Uint8	1	Fixed value 0X55, indicating start of data
Sequence Number	Uint8	1	Same as received sequence number
Address	Uint8	1	Communication address. Each driver on the bus should be assigned a unique address number. When returning data, the address is the original address of the device.
Status	Uint8	1	Current module status, see status table for details
Data Length	Uint8	1	Length of the data area. If the data area is empty, the data length is 0.
Data	Char	n	ASCII return data, see specific operation commands for details
Checksum	Uint8	1	8-bit checksum, calculated from the start of the frame header to the end of the data area. The obtained value uses the last 8 bits of data

CAN Protocol Format

Send Data Format

Frame type: data frame

Message identifier type: extended frame

ID: Extended ID is used, see table below

DLC: Data Length 8

Data field: The data length is fixed 8 bytes and contains the communication sequence number, register address, and data as shown in the table below.

ID Data Format

bit23-bit16	bit15-bit8	bit7-bit0
command	original address	target address

Data Area Data Format

Byte0	Byte1-byte2	Byte3	Byte4-byte7
Communication serial number	object index	Object Sub-Index	4-byte data

Return data format

Frame type: data frame

Message identifier type: extended frame

ID: Extended ID is used, see table below

DLC: Data Length 8

Data field: The data length is fixed 8 bytes and contains the communication sequence number, register address, and data as shown in the table below.

ID Data Format

bit23-bit16	bit15-bit8	bit7-bit0
command	original address	target address

Data Area Data Format

Byte0	Byte1-byte2	Byte3	Byte4-byte7
Communication serial number	object index	Object Sub-Index	4-byte data

Command: used to indicate the type of operation to change the frame data, as shown in the following table:

Command	Function	Description
0x00	response	Read and write data return.
0x01	write	Write Object Dictionary Return value: status, see status table
0x02	read	Read the object dictionary, if there is no corresponding object dictionary, then no data is returned.

Original address: the address of the sending terminal

Destination address: the address of the receiving terminal.

Communication serial number: used to distinguish which frame data is sent and received, it is recommended that the user +1 the communication serial number before each frame data is sent, so that it is not the same for each frame data.

Object Index: The object index is a 16-bit index address data used to define the Object Dictionary Table, see the Object Dictionary Table for the function of the Object Dictionary Table and the CAN Object Dictionary chapter for detailed information.

Object subindex: The subindex is an 8-bit subindex address data, which is used together with the object index to define the object dictionary table.

Data: 32-bit data representing communication data. This data is a signed integer. Detailed information is found in the CAN object dictionary section.

4.2 Serial Command

This chapter describes the data format of the data area in the OEM and DT protocols, specifically the format of operation commands. This data is represented as an ASCII string and can transmit multiple command sets simultaneously. The PUMP will parse and execute each command set one by one. These commands are categorized by functionality as follows:

- Initialization commands
- Control commands
- Parameter read/write commands
- Query commands
- System control commands

Command Syntax

<CMD><n1,n2,n3><CMD><n1,n2,n3><CMD><n1,n2,n3><CMD><n1,n2,n3>

The pump returns data in the following ASCII format:

<n1,n2,n3>

Among them:

<CMD>: Represents the command, indicated by letters a-z and A-Z, with a maximum of two letters (see Command Details).

<n1,n2,n3>: Represents the command parameters, separated by commas. Commands without parameters can be empty. If some parameters should use default values, leave the corresponding parameters before the comma empty. For example, for command ID1000, if the second parameter is empty, it would be ID1000,,2. If the last two parameters are empty, they can be omitted, so ID1000 implies that both last parameters are empty.

Attention:

1) < > are used to distinguish data blocks and should not be sent.

2) Commands are case-sensitive.

3) We agree that command letters are a maximum of two letters, with two-letter commands being an uppercase letter followed by a lowercase letter, and single-letter commands represented in

uppercase. The special character ? indicates a query command, {} indicates a loop control command, a single uppercase letter indicates a system control command, and a combination of an uppercase letter followed by a lowercase letter indicates a running control command.

Status

Each command returns a status indicating whether the command was executed successfully, whether the device encountered an error, or whether it is busy or idle. The status is represented as a one-byte hexadecimal data.

We agreed:

0-9: Working status.

10-19: command execution error status.

20-49: Alarm message, aspiration and dispense allowed after alarm.

>=50: Fault message, need to troubleshoot and re-initialize.

Value	Function	Description
0	Idle	Device is in idle state
1	Busy	In busy state, not accepting this command
2	Execution successful	Command executed successfully
3	Execution complete	Command execution completed
...	...	...
10	Parameter out of range	Command parameter exceeds range
11	Parameter error	Command parameter error
12	Syntax error	Command syntax error
13	Invalid command	Command not supported
14	Address error	Error in reading/writing register address
15	Write forbidden	Writing to this address is forbidden
16	Read forbidden	Reading from this address is forbidden
17	Not initialized	Not initialized
...	...	...
50	Motor stall error	Aspiration and dispense prohibited, reinitialize and troubleshoot
51	Driver failure	Aspiration and dispense prohibited, reinitialize and troubleshoot

52	Optocoupler 1 error	Aspiration and dispense prohibited, reinitialize and troubleshoot
53	Optocoupler 2 error	Aspiration and dispense prohibited, reinitialize and troubleshoot
54	Sensor error	Aspiration and dispense prohibited, reinitialize and troubleshoot
56	Power undervoltage	Aspiration and dispense prohibited, reinitialize and troubleshoot
57	Power overvoltage	Aspiration and dispense prohibited, reinitialize and troubleshoot
58	Motor short circuit	Aspiration and dispense prohibited, reinitialize and troubleshoot
59	Motor open circuit	Aspiration and dispense prohibited, reinitialize and troubleshoot
...	...	...

Command Details

This section describes the detailed individual commands, and the installation functions are divided as follows.

- Initialization commands
- Control commands
- Parameter read/write commands
- Query commands
- Cyclic control command

Attention:

[] indicates an optional parameter, if the optional parameter is empty it will follow the default parameter in the protocol.

The <> is internally an command; the symbol <> does not need to be sent, it is just used to distinguish between letters and commands.

Metering pump control commands

<Ct>n1 Initialize metering pumps

Metering pump initialization.

Comman	Parame	Data range	Unit	Default	Description

d	ter			value	
Ct	n1	-5.00-5.00	r/s	5	Initialize speed revolutions/S when n2=0, positive for positive revolutions, negative for negative revolutions
		-8000~8000	ustep/s	8000	Initialize speed microsteps with n2=1, positive number of positive rotations, negative number of reverse rotations
	[n2]	0~1		0	Parameter 1 unit 0:r 1: ustep

Return data: see status table

<Cr>n1,[n2] Metering pump continuous operation control

Controls the continuous operation of the metering pump, which only stops when a stop command T is received or in case of a power failure.

Command	Parameter	Data range	Unit	Default value	Description
Cr	n1	-20.00-20.00	r/s	5	Continuous running speed rpm/S when n2=0, positive number positive, negative number negative
		-32000~32000	ustep/s	8000	Continuous running speed microsteps at n2=1, positive number of positive revolutions, negative number of negative revolutions
	[n2]	0~1		0	Parameter 1 unit 0:r 1: ustep

Return data: see status table

<Cp>n1,[n2],[n3] Metering pump specified distance motion control

For metering pump control, the initialize metering pump command must have been executed before the first use, otherwise an uninitialized error is returned.

Command	Parameter	Data range	Unit	Default value	Description
Cp	n1	-2^31~2^31	r	0	n2=0 movement distance turn
		-2^31~2^31	ustep	0	n2=1 movement distance microsteps

	[n2]	0-20.00	r/s	5	n2 = 0 speed rpm
		0~32000	ustep/s	8000	n2=1 speed microstep
	[n3]	0~1		0	Parameter 1 unit 0:r 1: ustep

Return data: see status table

Parameter setting command

Register

The registers are used for the user to configure and view the parameters of the PUMP for flexible application.

Command	Parameter	Data range	Unit	Default value	Description
1	R			0	Current status (see status table), error elimination by setting zero after an error occurs, return value through the query status command? The return value is the same as that of the query status command?
2	R	0-1		0	Optocoupler 1 status
5	R	0-256		0	Queries the address of the current command pointer, where the string execution of the command set starts at 0
20	R	0-360	degree (angles, temperature etc)	0	Current metering pump angle
21	R	0-max	ustep/s		Current motor speed
24	R/W	0-max	step/s	10	Minimum motor speed
25	R/W	1-200000	step/ss	80000	Motor acceleration
26	R/W	1-200000	step/ss	80000	Motor deceleration
27	R/W	0-1		0	Motor direction 0: Positive 1: Reverse
28	R/W	1, 2, 4, 8,		8	Subdivision

		16, 32, 64 , 128, 256			
29	R/W	0-2000	mA	1400	Rated current
31	R/W	0-1		1	Optocoupler 1 trigger mode 0: Rising edge trigger 1: Falling edge trigger
50	R			0	Reads the number of revolutions that have been made by the current metering pump command. It will be cleared each time a motion is commanded, and is mainly used to count the number of revolutions the current motion has already made.
51	R/W			0	After powering on the metering pump pulse counting, regardless of positive and negative rotation, triggering an optocoupler the count plus 1 It will be cleared each time it is powered up and can be cleared by writing 0.
52	R/W			1	Setting the number of pulses counted in one revolution of the metering pump
53	R/W	-360-360	degree (angles , temperature etc)	15	Set the distance (angle) of movement after initialization of the metering pump, a positive number of initialized forward movement, negative initialized reverse movement
80	R/W			9600	Serial port baud rate
81	R/W			500	CAN baud rate
82	R/W	0-1		0	Serial communication, active uploading of data after completion of movement
83	R/W	0-10000	ms	1000	CAN heartbeat interval 0: Turn off the heartbeat Other values: heartbeat interval in ms
84	R/W	0-255		0	Device address
85	W			123456	Power-down save

86	W			123456	Restore Factory Settings
...					
90	R				Software version
91	R				Equipment Model
92	R				Device Serial Number

Register table

<Wr>n1,n2 Write registers

Write registers.

Command	Parameter	Data range	Unit	Default value	Description
Wr	n1	0~100			register address
	n2				write data

Return data: see status table for status section, not available for data area

<Rr>n1,[n2] Read registers

Read registers, read the specified number of registers from the start address, read registers larger than 1, return data separated by ',' semicolon.

Command	Parameter	Data range	Unit	Default value	Description
Rr	n1	0~100	None	None	Starting address
	n2				Number of registers

Return data: see the status table for the status part, the data area part is the data to be fetched, and the return data of multiple addresses are separated by ',' semicolon.

System Operating Commands

Status Query

<? >

By command? Query status.

Return data: see status table

Loop control command

Loop control commands are used to control the execution of string command loops, loops can be nested, an command string supports up to 20 loops including nested loops.

{ loop start position

Command	Parameter	Data range	Unit	Default value	Description
{	None		None	0	loop start

} [n1] loop end position

Command	Parameter	Data range	Unit	Default value	Description
}	[n1]	0-20		0	No parameters or 0: dead loop Other values: number of cycles

{: start of cycle

}: the end of the loop, followed by the loop count, if there is no loop count or the data is empty, it means a dead loop.

Note: Loops can be nested

<L>n1 Delay

The delay is used for internal system delays and is mainly used as a delay between the execution of two commands.

Command	Parameter	Data range	Unit	Default value	Description
L	n1	0~2147483647	ms	None	Delay Time

Return data: see status table

<T> [n1] Stop command

Stops the command currently being executed by the PUMP.

Command	Parameter	Data range	Unit	Default value	Description
T	n1	0-1		0	0: Stop immediately 1: Stop at a fixed angle, same as after initialization

<U> Reset command

This command is used as a device reboot reset operation.

Command	Parameter	Data range	Unit	Default value	Description
U	None				

<M>n1 Restore Factory Settings Command

After executing this command, a reboot of the device is required to take effect.

Command	Parameter	Data range	Unit	Default value	Description
M	n1			123456	The parameter must be 123456 for the factory settings to be restored successfully

<S> Power down to save setup parameters

After executing this command, the modified register parameters will be saved by power down.

Command	Parameter	Data range	Unit	Default value	Description
S	None				

Aging command

<RE> : n1 power-on automatic operation

Used to write or clear the power-on autorun process, the RE command must be followed by the ':' sign and the command process, if there is already a process in the system this command will replace the current process.

Command	Parameter	Data range	Unit	Default value	Description
RE	n1				Empty data: clears the power-up autorun process String: Power-up and run string process

Return data: see status table

Example: Command RE:Ct5,0Cr10,0

After power on will automatically run the process: initialization metering pump -> 10 rpm / S speed continuous rotation

4.3 LED Indication

1: Busy status LED is always on

LED status	
Off	Idle
ON	Busy
Flashes 1 time	Drive Failure Alarm
Flashes 2 times	Motor stall alarm
Flashes 3 times	Optocoupler Detection Alarm

4.4 CAN Object Dictionary

The object dictionary includes 8-bit main index and 8-bit sub-index, through the ordered index number indicates different operation and parameter read/write, all data including read/write permission. Control commands including initialization, aspiration, dispense, etc., are in accordance with the different main indexes indicate different commands, sub-index for different parameters, the number of parameters and the number of parameters of the serial port command is the same, such as the serial port command It[n1][n2][n3], such as the implementation of the command before the need to modify the default parameters

Note that before controlling the PUMP action you need to send a sub-index non-0 parameter, and finally send a sub-index 0 parameter to start the control, for example, to control the PUMP aspiration 100ul, aspiration speed of 500, stopping speed of 100

Send CAN data sequence:

Main Index	Sub-Indexes	Data
0x4001	1	500
0x4001	2	100
0x4001	0	10000

PUMP Control Commands

Function	Primary Index	Sub index	Read-write access	Data range	Default Value	Description
Metering pump initialization	0x5001	0	RW	-16000~16000ustep/s	mandatory field	Unit ustep when initializing speed microsteps
				-10.00~10.00r/s		Initialization speed rpm at unit r
Continuous rotation of the metering pump	0x5002	0	RW	-32000~32000ustep/s	mandatory field	Continuous rotation speed microsteps at unit ustep
				-20.00~20.00r/s		Continuous rotation speed rpm per unit r
The metering pump moves a specified distance	0x5003	0	RW	-2^31~2^31	mandatory field	Unit ustep when running distance ustep
				-2^31~2^31		Running distance revolutions per unit r
		1	RW	-32000~32000ustep/s	mandatory field	Unit ustep when running speed microsteps
				-20.00~20.00r/s		Running speed rpm per unit r
Metering pump parameters unit	0x5010	0	RW	0-1	0	Parameter units of metering pump control commands, will only modify the parameter units of CAN control commands 0x5001, 0x5002, 0x5003 0:r 1:ustep
cessation	0x4008	0	W	0	0	Stopping metering pump operation

Register Read/write

We agree that the main index 0x2000 is the internal register of the metering pump, the sub-index register address, the register address see register table

Process Data

The metering pump actively uploads process data via command 0x03, the process data dictionary is as follows

Function	Primary Index	Subindex	Read-write access	Data range	Default Value	Description
Motion Completion	0x7002	0	R	0-255	0	Data uploaded proactively at the completion of the motion 0: Normal Other values: error status, see status table

Heartbeat Data

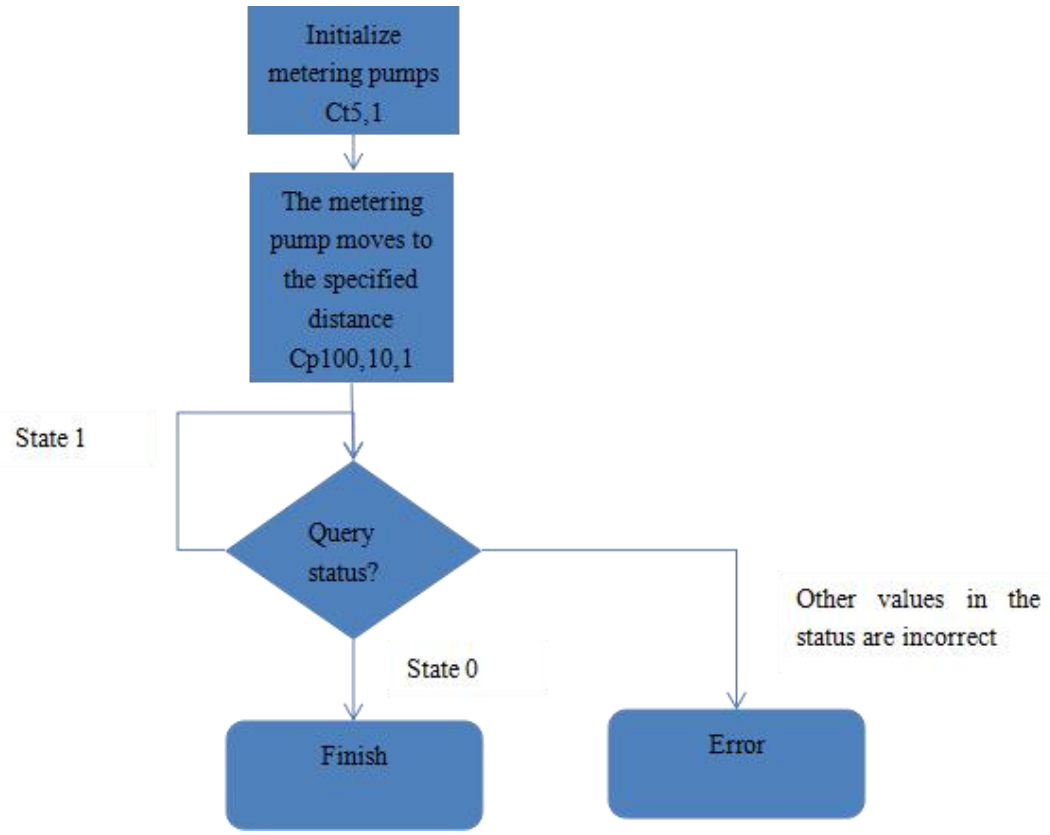
The metering pump sends heartbeat data via command 0x04, which can be used by the master device to detect whether the device is online or not

Alarm Data

The metering pump sends an alarm message via command 0x80, the alarm data format, the same as the error message of the query state

4.5 Program Application Flow

Note that the serial communication DT protocol has no data checking, so it is best to use it only for serial debugging, and the device should still use the OEM protocol, which has the same data format as the DT protocol data area, but with different header and footer data formats.When applying the OEM protocol, you should query the status of each operation to ensure that the command execution is completed before executing the next operation. The operation flow is as follows



Example of detailed communication data, metering pump address 1

Example of DT Protocol Applications

Initialization: 1>Ct5,1

Motion specified distance: 1>Cp100,10,1

Query Status 1>?

Examples of OEM Protocol Applications

Zeroing: aa ff 00 05 43 74 35 2c 30 f6

Return: 55 ff 00 02 00 56

Continuous rotation: aa ff 00 05 43 72 35 2C 30 f4

Return: 55 ff 00 02 00 56

Specified distance: aa ff 00 08 43 70 35 2c 32 30 2c 30 83

Return: 55 ff 00 02 00 56

Query Status: aa ff 01 01 3f ea

Examples of CAN Protocol Applications

Note: The serial number in the example data is automatically increased

Byte Description:

For example, initialization:

Send: ID:00010001 Data: 0150010000001F40

ID:	00	01	00	01
Write Command		Source address 0	Destination address 1	
Data:	01	5001	00	00001F40
Sequence number		Main Index	Sub-Index	Data

Command	Direction	ID	Data	Description
Initialization	Send	00010001	0150010000001F40	Send Object Dictionary 0x5001.0 data 8000 (hexadecimal forbidden 0x1F40), start initialization, speed 8000 ustep/S
	Receive	00000100	0150010000000002	Returns successful execution
Continuous operation of metering pump	Send	00010001	0250020000001F40	Send object dictionary 0x5002.0 data 8000 (hex disable 0x1F40), start continuous operation at 8000 ustep/s
	Receive	00000100	0250020000000002	Returns successful execution
Move Metering Pump to Specific Position	Send	00010001	0350030100001F40	Send object dictionary 0x5003.1 data 8000 (hexadecimal forbidden 0x1F40) to set the speed of the specified position of the motion 8000 ustep/S
	Receive	00000100	0350030100000002	Returns successful execution
	Send	00010001	0450030000013880	Send object dictionary 0x5003.0 data 80000 (hexadecimal 0x13880) to start movement to a specific position at 80000 ustep
	Receive	00000100	0450030000000002	Returns successful execution
Modify metering pump parameter	Send	00010001	0550100000000001	Send object dictionary 0x5010.0 data 1 to modify the metering pump action command parameter in units of revolutions
	Receive	00000100	0550100000000002	Returns successful execution
Stop the metering pump	Send	00010001	0640080000000000	Send Object Dictionary 0x4008.0 Stopped metering pump running
	Receive	00000100	0640080000000002	Returns successful execution
Query Status	Send	00020001	0720000100000000	Read object dictionary 0x2000.0, register 1 status data
	Receive	00000100	0720000100000001	Return to Busy Status

5. Metering Pump Application Notes

5.1 Working medium

When the working medium is special strong acid or alkali liquid, the pump head material is adjusted for the medium.

5.2 Working Displacement

The design value of the working aspiration and dispense volume is adjusted according to the customer's requirements within the maximum range, please do not adjust it privately to affect the precision and displacement. If there is a demand for displacement adjustment, please contact our company to provide displacement debugging accessories. Displacement adjustment accessories see section 2.4.

5.3 Complete Machine Installation

The metering pump should be installed with the adapter facing downward in the whole machine, and the installation level needs to be at the same height.

5.4 Accurate Dispensing

For dispenses with precise dosing, it is recommended that the liquid be dispensed below the liquid level.

5.5 Initialization Recommendations

When the metering pump is done with each test cycle, it is recommended to initialize the processing (optocoupler to find the zero position processing), so as to avoid the accumulated backlash error to be carried over to the next test cycle.

5.6 Vibration damping recommendations

Regarding motor drive, it is recommended that the hardware to set subdividing processing, to avoid vibration at low speed.

5.7 Recommended Environmental Conditions

The ambient temperature is between 5℃~55℃ and the humidity is between 30% to 85%.

5.8 Cleaning Recommendations for Pumps After Crystallization

Crystallized reagents tend to adhere to the ceramic moving parts of metering pumps, leading to blockages and mechanical stalling. Based on this issue, it is recommended to clean the pump after using crystallizing reagents. Below are cleaning suggestions for the metering pump:

1. For Non-Rinse Version Metering Pumps (refer to Chapter 2.3.1): It is advised to clean the pump after every use. A three-way valve can be used to direct the pump to aspirate a cleaning reagent or purified water to flush the flow path.
2. For Rinse Version Metering Pumps (refer to Chapter 2.3.1):

Option 1: Follow the same cleaning procedure as for non-rinse pumps.

Option 2: Since the pump's dispensing system is sealed and isolated from the cleaning system by the ceramic rod and sleeve, a cleaning tubings can be added to the cleaning port. During pump operation, a diaphragm pump or similar pump can be used to continuously deliver the cleaning reagent or purified water for simultaneous cleaning.

3. For Long Periods of Inactivity After Using Crystallizing Reagents: After using crystallizing reagents, it is recommended to clean both the dispensing system and the cleaning system of the pump. If the pump becomes jammed due to uncleaned crystallizing reagents, do not force the motor to rotate, as it may damage key components. Instead, immerse the pump head in warm water for a period of time to dissolve the crystallized reagent. Once the pump can operate smoothly without stalling, it can be used again.

Due to differences in reagent concentrations, the amount of crystallization, the dissolution rate of the crystallized solute, and the cleaning power of the cleaning reagent, the required soaking (cleaning) time may vary. Please determine the cleaning time based on the characteristics of the crystallizing reagent and the cleaning agent.

5.9 Metering Pump Timing Diagram

Metering pump operation timing diagram:

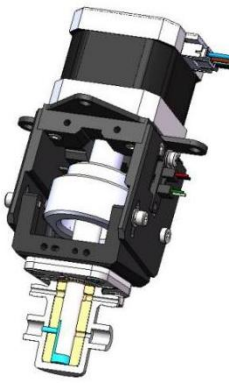


Figure 1

Aspiration

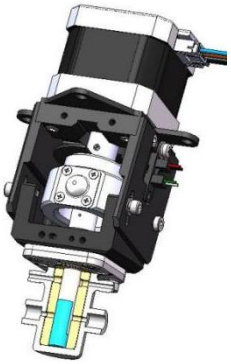


Figure 2

Aspiration complete.

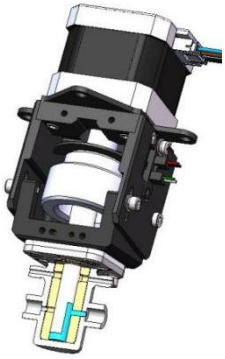


Figure 3

Dispense

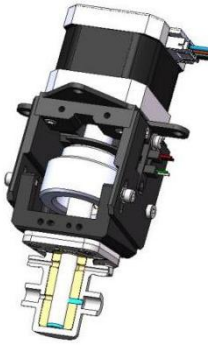


Figure 4

Dispense complete

During operation, to prevent backflow at the inlet and outlet of the metering pump, it is recommended to set the starting position at the reset point (Figure 1). At this position, the metering pump's operational cycle follows the sequence: aspiration → dispensing → aspiration (as shown in the operation sequence from Figure 1 to Figure 4). When observing from the bottom of the motor, the motor screw rotates counterclockwise, with the left side of Figure 1 indicating the IN port, where the blue color represents the liquid.

6. Common Troubles and Their Troubleshooting

Fault	Cause	Troubleshooting Method
Abnormal Flow Rate	Loose connectors	Tighten the connectors
	Angle deviation	Send back to our company for re-adjustment
	High inlet/outlet pressure, motor noise or damage	Send back to our company for repair
	Metering pump not reset	Reset the metering pump and retest the flow rate
	Air bubbles in the chamber	Continuously run the metering pump until bubbles are fully expelled
Droplet	Metering pump not reset	Reset the metering pump and retest the flow rate
	Incorrect operational sequence of the pump	Correct sequence: aspiration → dispensing → aspiration/rotation
Backflow	Metering pump not reset	Reset the metering pump and retest the flow rate
Pump Stalling	Optocoupler not triggered	Check the optocoupler wiring (refer to the optocoupler wiring

		instructions)
	Burnt optocoupler	Replace the optocoupler
	Motor wiring reversed	Swap any two phases of the motor wiring
Motor Overheating	Excessive drive voltage	Adjust the voltage (refer to motor electrical parameters)
	Excessive drive current	Adjust the current (refer to motor wiring instructions)
Abnormal Operation	Motor running too fast	Adjust motor speed to an appropriate level

7. Safety precautions

For the personal safety of you and other users and to prevent damage caused by improper operation, please read the safety precautions carefully.

This manual uses the following symbols. Please fully understand what they represent before continuing.

Warning	Where the content with the mark is related to the safe use of the product and the personal safety of the user, it must be operated in strict accordance with the requirements, otherwise it may cause damage to the product or endanger the personal safety of the user.
Caution	The content with the mark is the part that users must pay attention to, otherwise it will cause product damage or other losses due to improper operation.

Caution
Confirm the specification: Please fully consider the use, fluid, environment and other conditions of use, and use within the scope of the specification to avoid damage to the product;
Material selection: For the media tolerance is not clear, first do the corresponding experiment to confirm the material, and then confirm whether the selected model is suitable;
The electromagnetic coil of this product has no waterproof function. If water or liquid drops accidentally splash on the solenoid valve during use, please wipe it as soon as possible to avoid water penetrating into the coil and causing short circuit. If you need to contact with water frequently, please configure waterproof protective devices;
Special fluorinated rubber and perfluorinated rubber are greatly affected by temperature, please avoid high frequency use at low temperatures;

Warning
1. Installation position: Do not put the inlet and outlet of the valve towards the position where the human body may contact, to avoid high pressure air impact on the human body after the solenoid valve is accidentally loosened;
2. Installation operation: The rotation of the coil assembly of this product will cause poor product performance. Do not use hands or tools to twist or rotate the proportional valve coil when installing this product;
3. Installation environment: Avoid using the solenoid valve near the heat source with high temperature;
4. Maintenance and repair: For abnormal occurrence, please contact the manufacturer first, do not directly disassemble and assemble, to avoid irreparable damage, and avoid failure to confirm the cause of the abnormal.

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