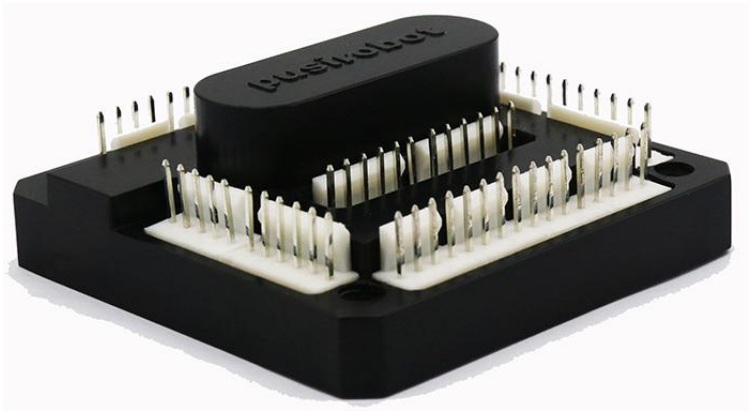
PUSIROBOT

CQPUSI ROBOT CONTROL SYSTEM

User Manual

PMC005xx Series

Five-axis Stepping Motor Controller



1. Version CONTROL

1） Update records

DATE	Author	Version	Remark
2017-6-25	yyj	V0.1.0	Initial
2017-7-19	hc	V0.1.1	Fix typo
2017-10-18	hc	V0.1.2	1、 Add instruction:p、j、J; 2、 Modify hardware interface J2;
2017-10-19	hc	V0.1.3	Add instruction:?4、$
2017-10-22	hc	V0.1.4	Modify parameter range
2017-10-31	hc	V0.1.5	Add instruction: ?aa、z、?2
2018-7-3	jiawei	V0.1.6	Modify LED status and pps range
2018-9-5	hc	V0.1.7	1、 Add startup speed(v) and stop speed(c) setting command. 2、 The “n” command adds the LED switch function. 3、 “V” command supports minimum speed to 1Hz.
2018-9-29	hc	V0.1.8	1、 Add B、C、E、W command 2、 Add baud rate command ‘b’ 3、 Add factory reset parameter function
2018-1-9	hc	V0.1.9	Adding aS instruction to support querying busy status of four motors at the same time
2019-3-29	hc	V0.1.10	1、Add closed-loop support, add instructions aE, aC, au,?8. 2、n instruction adds more modes to support closed-loop
2019-05-07	hc	V0.1.11	1、Add Global External Emergency Stop Function
2019-08-15	CY	V0.1.12	Supplementary note for command ?aa and ?a4
2019-09-19	hc	V0.1.13	1、Trigger mode setting instruction f for limits
2020-12-4	CY	V1.0.14	1、Add O(upper case) command
2021-10-9	yj	V1.0.15	1.Add some query commands
2021-11-10	liur	V1.0.16	Modify query commands
2022-01-06	Tony	V1.0.17	1. Add Y,K(upper case) command 2. Add locked rotor status bit
2022-04-19	Tony	V1.0.18	1. Add ?ao,o(lower case) command
2023-05-05	Tony	V1.0.19	1. Modify description for Z, J command

DATE	Author	Version	Remark
2023-06-29	Tony	V1.0.20	1. Update outline drawing 2. Modify output spec for Limit port
2024-1-12	Tony	V1.0.21	1. Added PMC005B4 feature introduction 2. Update 'L'/'I' instruction description

Catalog

1 Introduction

1.1 Statement of intellectual property right

PMC005XX series controller has been applied for the following national patent:

• Controller scheme and method have been applied for the protection of the invention patent.

• Controller circuit has been applied for the protection of utility model patent.

• Controller appearance has been applied for the protection of appearance patent protection.

PMC005XX series controller has embedded firmware code, it would be considered as a violation of intellectual property protection act and regulations that any behavior of trying to destroy the function of firmware code protection. If this behavior acquires the software or other achievements of intellectual property protection without authorization of CQPUSI, CQPUSI has the right to stop such behavior by filing a lawsuit according to the act.

1.2 Disclaimer

The using method of the device and other content in the description of this manual is only used to provide convenience for you, and may be update in future version. To ensure the application conforms to the technical specifications is the responsibility of your own. CQPUSI does not make any form of statement or guarantee to the information, which include but not limited to usage, quality, performance, merchantability or applicability of specific purpose. CQPUSI is not responsible for these information and the consequences result caused by such information. If the CQPUSI device is used for life support and/or life safety applications, all risks are borne by the buyer. The buyer agrees to protect the CQPUSI from legal liability and compensation for any injury, claim, lawsuit or loss caused by the application.

2 Overview

2.1 General Description

PMC005xx is a kind of micro five-axis stepping motor drive controller, which can be controlled by USB interface or RS485 network, and which has the characteristics of small volume, strong driving force, low calorific value and so on. PMC005xx stepping motor controller can provide parallel control of five-axis stepping motor. 0.1 ~ 4A continuously adjustable peak current per axis, maximum 128 microstepping, built-in acceleration and deceleration, sensor control, and abnormal protection functions, especially suitable for compact multi-axis automation instruments and equipment.

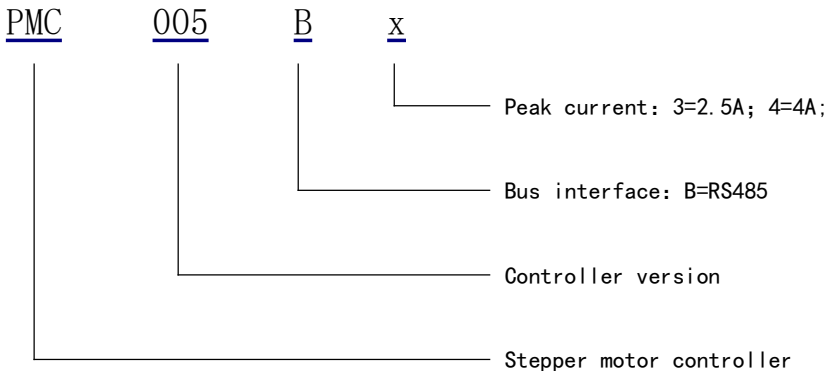
。

2.2 Features

- ✓ Wide range of 9-36V single voltage supply
- ✓ Parallel control of maximum five-axis stepping motor, or two-axis DC brush control + four-axis stepping motor
- ✓ Output current per axis 0.1A ~ 4A, continuously adjustable
- ✓ Ladder acceleration and deceleration, instruction adjustable
- ✓ Support 0/2/4/8/16/32/64/128 microstepping
- ✓ Support for 2 limit switches per axis
- ✓ Optional support for 2 solenoid valve controls (with automatic energy saving)
- ✓ Optional support for 2-axis DC brush motor control (with speed regulation function)
- ✓ With TSD, UVLO, OCP protection function
- ✓ Support 2-axis stepping motor closed-loop control (optional)
- ✓ Support for pre-stored procedures for offline or online execution

2.3 Production & Ordering Information

In order to serve you quicker and better, please provide the product number in following format when ordering PMC005XX:



3 Connector Description

3.1 Terminal port location

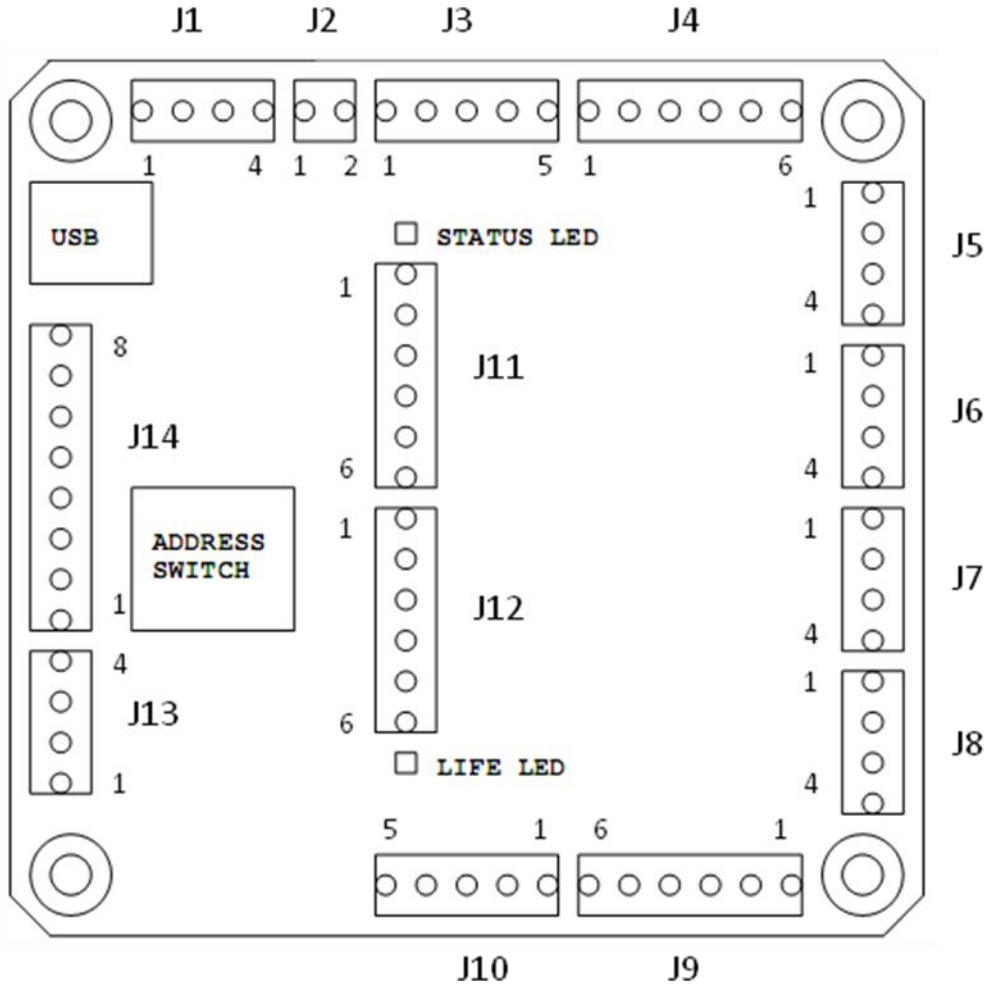


Figure 3-1

Note:

encoder J3, limiting J4 corresponding to shaft one J5;

Encoder J10, limiting J11 corresponding to shaft two J6,

Limit J12 corresponds to shaft three J7,

Limit J9 corresponds to shaft four J8

3.2 Power Connection J1

Pin no	1	2	3	4
Designator	VCC	GND	485_B	485_A

Description:

VCC: Supply voltage, 9 ~ 36 V;

GND: Supply voltage ground;

485_A: RS485 signal A;

485_B: RS485 signal B;

3.3 Power connection J2

Pin no	1	2
Designator	VCC	GND

Description:

VCC: Supply voltage, 9 ~ 36 V;

GND: Supply voltage ground;

3.4 Encoder signal interface J3

Pin no	1	2	3	4	5
Designator	GND	ENC_Z	ENC_A	+5V	ENC_B

Description:

GND: encoder source;

+5V: encoder power supply 5V;

ENC_Z: encoder Z phase (retained);

ENC_A: Phase A of encoder;

ENC_B: Phase B of encoder;

3.5 Motor limit interface J4

Pin no	1	2	3	4	5	6
Designator	+5V	UP_LIM	GND	+5V	LOW_LIM	GND

Description:

GND: limit sensor ground;

+5V: limit sensor power supply 5V (200ohm current limiting resistance connected internally);

UP_LIM: upper limit sensor input;

LOW_LIM: lower limit sensor input;

Note: the maximum output current of all 5V power supplies is limited to 250Ma.

3.6 Motor interface J5

Pin no	1	2	3	4
Designator	A+	A-	B+	B-

Description:

A+: motor phase A;

A-: motor phase A-;

B+: motor phase B;

B-: motor phase B-;

3.7 Motor interface J6

Pin no	1	2	3	4
Designator	A+	A-	B+	B-

Description:

A+: motor phase A;

A-: motor phase A-;

B+: motor phase B;

B-: motor phase B-;

3.8 Motor interface J7

Pin no	1	2	3	4
Designator	A+	A-	B+	B-

Description:

A+: motor phase A;

A-: motor phase A-;

B+: motor phase B;

B-: motor phase B-;

3.9 Motor interface J8

Pin no	1	2	3	4
Designator	A+	A-	B+	B-

Description:

A+: motor phase A;

A-: motor phase A-;

B+: motor phase B;

B-: motor phase B-;

3.10 Motor limit interface J9

Pin no	1	2	3	4	5	6
Designator	+5V	UP_LIM	GND	+5V	LOW_LIM	GND

Description:

GND: limit sensor source;

+5V: limit sensor power supply 5V (200ohm current limiting resistance connected internally);

UP_LIM: upper limit sensor input;

LOW_LIM: lower limit sensor input;

Note: the maximum output current of all 5V power supplies is limited to 250mA.

3.11 Encoder signal interface J10

Pin no	1	2	3	4	5
Designator	GND	ENC_Z	ENC_A	+5V	ENC_B

Description

GND: encoder source;

+5V: encoder power supply 5V;

ENC_Z: encoder Z phase (retained);

ENC_A: Phase A of encoder;

ENC_B: Phase B of encoder;

3.12 Motor limit interface J11

Pin no	1	2	3	4	5	6
Designator	+5V	UP_LIM	GND	+5V	LOW_LIM	GND

Description:

GND: limit sensor source;

+5V: limit sensor power supply 5V (200ohm current limiting resistance connected internally);

UP_LIM: upper limit sensor input;

LOW_LIM: lower limit sensor input;

3.13 Motor limit interface J12

Pin no	1	2	3	4	5	6
Designator	+5V	UP_LIM	GND	+5V	LOW_LIM	GND

Description:

GND: limit sensor source;

+5V: limit sensor power supply 5V (200ohm current limiting resistance connected internally);

UP_LIM: upper limit sensor input;

LOW_LIM: lower limit sensor input;

3.14 Solenoid valve interface J13

Pin no	1	2	3	4
Designator	DRV1-	DRV1+	DRV2-	DRV2+

Description:

DRV1+: solenoid valve (or DC brush 1, or stepping motor A);

DRV1-: solenoid valve-(or DC brush 1, or stepping motor A -);

DRV2+: solenoid valve (or DC brush 2, or stepping motor B);

DRV2+: solenoid valve (or DC brush 2, or stepping motor B);

3.15 Digital IO interface J14

Pin no	1	2	3	4	5	6	7	8
Designator	BOOTRES	FSET	TMSRES	UART_RX	UART_TX	GPIO	ADC1	ADC2

Description:

BOOTRES: factory retains pin 1;

FSET: Factory reset input;

TMSRES: Reserved, should be keep floating;

UART_TX: UART TX signal;

UART_RX: UART RX signal;

GPIO: universal IO pin;

ADC1: analog input 1, input voltage range 0 ~ 3.3 V, 10 bit accuracy;

ADC2: analog input 2, input voltage range 0 ~ 3.3 V, 10 bit accuracy;

3.16 USB connection interface

PMC005xx supports MICRO USB connection. When connected to the computer through USB cable, the system enumerates the serial port device, which can be used as the RS485 HOST terminal to control one or more PMC005xx.

3.17 Address selector

Each PMC005xx has a unique RS485 address that can be selected by the on-board 16-bit rotating coding switch. Note that the address selection will only take effect before the system is powered on.

3.18 Pilot Lamp

The PMC005xx has two LED indicators. The STATUS and LIFE indicators are respectively, and when the controller receives the upper computer command, the STATUS indicator light is on; when the controller is working normally, the LIFE indicator light flashes. (The two lights are turned off by default and the software can be turned on).

4 Interface Connection

4.1 RS485 network connection

The network scheme composed of multiple (up to 16) PMC005xx controllers can be connected by RS485 bus, and the maximum communication distance can reach 1200 meters. A twisted pair is used to connect all nodes. When the distance is more than 50 meters, each end of the network needs to be connected with a 120 ohms terminal resistance to prevent signal reflection and overshoot. At the same time, the RS485 on the host side needs to be shared with the controller of each node.

The PMC005xx controller can choose the four baud rate settings of 9600 ~ 19200 ~ 38400 ~ 57600. All the controllers in the same network must adopt the same baud rate. Because RS485 can only support half-duplex networking, there can only be one RS485 host in the network.

Note: the upper and lower limits of the signal threshold defined by the RS-485 standard are ±200mV. That is, when A -B > 200mV, the bus state should be represented as "1", and when A - B <-200mV, the bus state should be represented as "0". However, when A - B is between ±200mV, the bus state is uncertain, so in the actual networking, it is suggested that the user should set up a pull-down resistance on the A and B lines in order to avoid this uncertain state as far as possible.

4.2 Limit sensor connection

PMC005xx can support the input of two limit switches per axis. The limit switches can be ordinary opposite optical coupling, micro reflective optical coupling, optical coupling with Schmitt shaping pair, or photoelectric proximity switch. When using the ordinary pair photocoupling as the limit input, the reference connection diagram is as follows.

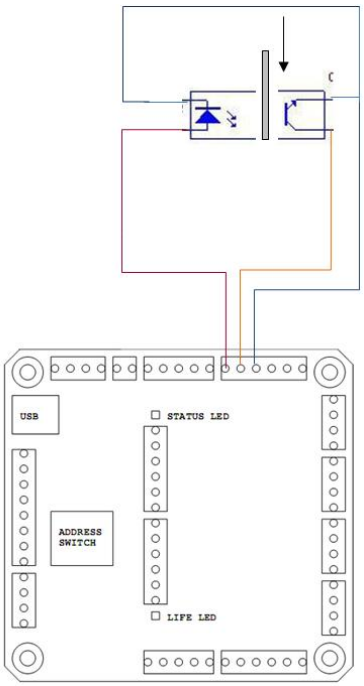


Figure 4-1

In order to improve the limit accuracy, it is necessary to limit the output slew rate of optical coupling to an acceptable range. It is recommended to use optical coupling with Schmitt shaping, such as OPB99 series.

4.3 Step motor connection

PMC005xx has four stepping motor interfaces, J5, J6, J7 and J8, which can connect four two-phase stepping motors with a maximum driving current of 4A. When the motor on one of the interfaces has faults such as undervoltage, short circuit and so on, the controller automatically closes the output of the interface and sets the corresponding state mark bit.

When the motor on the four interfaces works at the same time, the maximum pulse rate supported by the controller is 32 Kpps per axis, and when a single interface works alone, the maximum pulse rate supported by the controller is 64 kpps.

4.4 Solenoid valve connection

PMC005xx provides two sets of solenoid valve connections, or two groups of brushed DC motor connections, or a stepping motor connection, the maximum driving current of the interface 4A, built-in reverse EMF protection diode circuit

When the solenoid valve is connected, the automatic energy saving and cooling control of the solenoid coil is supported (optional software function).

When the brush DC motor is connected, the motor can be controlled by forward and backward rotation and speed regulation (optional software function).。

When the two-phase stepping motor is connected, the ultra-low vibration and mute software algorithm is used to realize the low speed noise-free control of the stepping motor (optional software function).

Note: do not connect the sum of the drive interface directly to the power supply or to the ground.

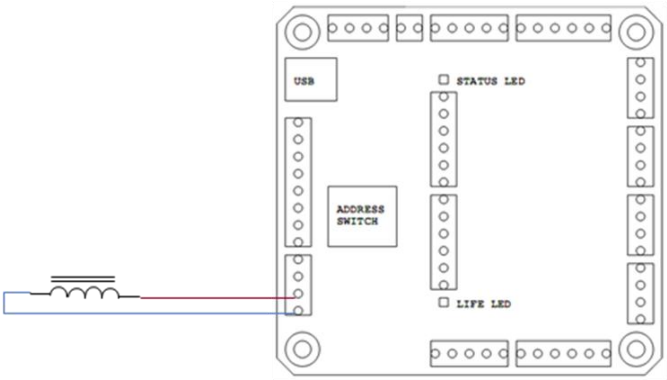


Figure 4-2

4.5 Digital IO interface connection

The PMC005xx controller has 8 digital IO interfaces, which are currently reserved.

4.6 Encoder interface

PMC005xx supports the closed-loop control of two-axis stepping motor, which can be controlled by incremental photoelectric rotary encoder or straight-line grating ruler. The resolution 200~4000cpr. PMC005xx closed-loop control adopts digital PID algorithm to realize three loop control of current, position and speed.

5 Command set

The PMC005xx controller uses a string-based DT communication protocol, which consists of a Alpha character that represents the command and a number that then represents the parameter value. When the controller receives the command, it returns a response packet, and the format of the command response package is described in 5.1.

5.1 Command response structure

5.1.1 Command structure

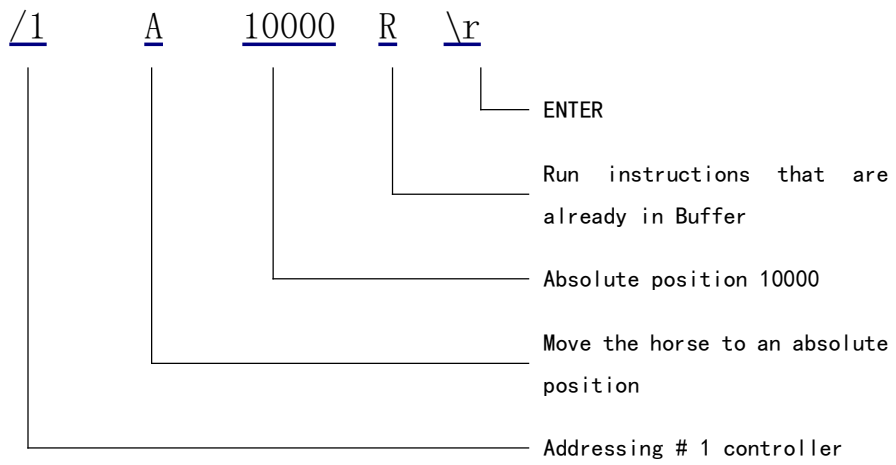
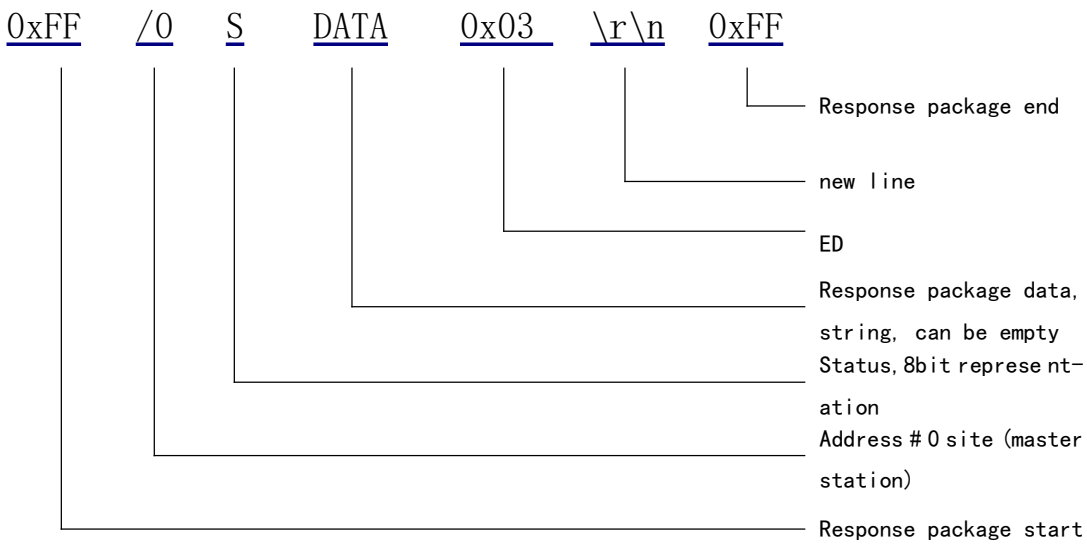


Figure5-1

Multiple commands can form a string that can be sent to the controller at once, which can loop a complex command. The command Buffer to write to the controller in one transfe

5.1.2 Response package structure



The 8 bits of the state in the response package are defined as follows:

The 8-bit definition of the status in the response packet is as follows:

Bit7: Axis 2 stalled rotor flag (effective in encoder correction mode)

Bit6: Axis 1 stall flag (effective in encoder correction mode)

Bit5: Prepare bit, this bit is 1 to indicate that it is ready to receive new commands

Bit4: Global external emergency stop flag

Bit3-0: error code

Error code	Code description
0	No error
1	Initialization error
2	Error command
3	Error operands
5	Communication error
7	Uninitiated
9	Overload error
15	Command overflow (command string length exceeds 256)

E.g. Send instruction:/1?0\r(hex: 2F 31 3F 30 0D),

Controller response (hexadecimal): FF 2F 30 40 32 33 33 33 03 0D 0A FF, response status 0x40, indicating that the controller is ready to receive a new command. 32 33 34 35 33 30 indicates that the position of the currently selected motor is 234530.

NOTE:1. When an instruction is sent, a enter key is added (ASCII code is 0 D, the string is represented as \r)

2. The above instruction response message is analyzed miniUSB communication, and the controller response is FF 2F 30 when using RS485 communication 40 32 33 34 35 33 30 03 0D,0D is the end of the message.

5.2 Supported commands

The commands supported by PMC005xx are listed below(The value in brackets in the sequence of operations is the default value).

Related Setup Instructions

Command	Operand	Description
A	(-2^31)-(2^31-1)	The motor moves to the absolute position, and waits for the shaft motor to run after it is completed, and then you can send other shaft running commands e.g. /1aM1A10000R (if you don't specify an axis, it will be the last time you specified the shaft run)
B	(-2^31)-(2^31-1)	The motor moves to an absolute position, and when the instruction is executed, the motor returns immediately after starting, and does not wait for the motor to rotate. E.g./1B10000R
P (upper case)	(-2^31)-(2^31-1)	Move motor relative in positive direction. A value of zero will cause an endless forward move at speed V. E.g./1P10000R
C (upper case)	(-2^31)-(2^31-1)	Turn the horse in the positive direction to reach the relative position, write a value of 0 to enter the forward speed mode, and return immediately after the motor starts when the instruction is executed, and will not wait for the motor to rotate.

		E.g./1C10000R
D	(-2^31)-(2^31-1)	Turn the horse in the opposite direction to reach a relative position, write a value of 0 to enter the reverse speed mode, E.g./1D10000R same as the 'P' command
E	(-2^31)-(2^31-1)	Turn the horse in the opposite direction, write a value of 0 to enter the reverse speed mode, and return immediately after the motor starts when the instruction is executed, and will not wait for the motor to rotate. E.g./1E10000R same as the 'C' command
W	1 – 4	Wait for the rotation of the motor on the specified shaft to complete, and generally return to the command immediately. E.g./1W1R
Z (upper case)	0-(2^31-1) (400)	According to the f command and whether to connect the upper and lower limit signals, the number of steps set will be relatively run. After firmware v37, the 'Z' command will be returned immediately. Multi-axis synchronous operation is possible. When the f command is 0, the motor runs the specified number of steps in reverse until the zero optocoupler (lower limit) is triggered to set the motor position and encoder position to 0. If it returns to zero at the origin, that is, the optocoupler has been blocked, the motor will turn forward and away from the optocoupler, stop and reverse the limit when the level of the limit interface changes, and set the motor position and encoder position to 0 after triggering. If the specified number of steps is not touched after running, the motor position and encoder position will also be set to 0. E.g./1Z300000R generally recommends that the Z command value is greater than or equal to the number of steps of the entire trip.
V (upper case)	1-64000 (16000)	Set max/slew speed (velocity) of default or selected motor. (positioning mode) 。Units are pps when it at open-loop,Units are cps when it at closed-loop, E.g./1V32000R
L	0-65000 (100)	Set the acceleration factor, the relation to acceleration: pps^2= L * (400000000/65536), e.g. since t=V/a, the command /1L1R means to accelerate to 100000pps in 16.384 seconds The parameters affect the acceleration and deceleration process, as well as the deceleration process of the stop level. In versions later than V1.0.41, you can modify the acceleration and deceleration process in which the limit takes effect and stops immediately without affecting normal operation. Parameters can be saved after power-off

g		Enter the start sign of the repeating cycle, e.g. /1gP10000M1000G10RE.g./1gP10000M1000G10R
G	0-30000	End of loop marker and repeat designator. A value of 0 causes the loop to repeat until terminated. E.g./1gP10000M1000G10R NOTE: Loops can be nested up to 4 levels.
s (lower case)	0-15	Stores a program to specified EEPROM.Program 0 is executed on power-up. E.g./1s1A10000A0R
e	0-15	Execute a pre-stored program with a specified sequence number, e.g. /1e1R
R		Instructions running in the command Buffer. E.g./1R
m	0-125 (25)	B3 sets the percentage of the working current to the calibration current (2A), for example: /1aM1m125R Set the working current of b3 axis 1 to 2.5A; B4 sets the percentage of the working current to the calibration current (4A), and the command of b4 only supports 0-100 at most, and sets 100 according to 100 if it exceeds 100, for example: /1aM2m75R sets the working current of B4 axis 2 to 3A Parameters can be saved after power-off
h	0-62 (10)	Sets hold current within a scale of 0 to 50% of max current. 100% = 2A E.g./1h62R the hold current is set to 1.24A
M	0-(2^30)	The program waits for M milliseconds
aM	1 – 5	Designate target axis for command. From then on, all commands are sent to this Axis. E.g./1aM1R
T		Terminate the current command or loop, for example: /1T Note: It can be used to abort the operation of the motor, and /1T1 specifies the shaft 1 motor to stop;
$		Reports the command string currently executing
n		Bit0:LED switch, 0:turn LED off,1:turn LED on. Bit1:enable limits, 0:turn limit off,1turn limit on; Bit2:Not used Bit3:enables Encoder Position Correction mode, with the two encoder (AB) inputs being used for feedback. Axes 1 and 2 only. Bit4:Enables Encoder Overload Report mode. Axes 1 and 2 only. Bit5-8:Not used Bit9-10:These bits will execute one of the stored recovery script programs 13, 14 or 15 whenever the position correction feedback shuts down the drive due to an overload. (That is,

		the number of retries specified by the au command has been exhausted. See Position Correction Commands in this table.) Axes 1 and 2 only. Position Correction must run concurrently.
Y	1,2	Clear the stall mark, parameter 1 clears axis 1, parameter 2 clears axis 2 To take effect, you need to turn on the encoder correction mode in advance. Example: /1Y1R (v1.0.34--)
p (lower case)	0-65000	Ping Command Sends a numeric message back to the host E.g./1aM2gA1000p3333A0G0R
j	0,2,4,8,16,32,64,128 (16)	Set microsteps can be saved after power-off B3 can be configured with 0-32 B4 can be configured from 0-128
J	0-6579203 （0）	Solenoid valve switch Bit0: solenoid valve 1 switch, range value (0-1); bit1: solenoid valve 2 switch, range value (0-1); bit[15:8]: solenoid valve 1 duty cycle, range value (0-100); bit[23:16]: solenoid valve 2 duty cycle, range value (0-100); Calculate the value that needs to be set for each solenoid valve, solenoid valve 1 duty cycle * 256, solenoid valve 2 duty cycle * 65536, solenoid valve 2 switch value * 2, solenoid valve 1 switch value * 1, and then add up all the numbers as the command value input. For example: /1J3289603R, that is, 50*65536+50*256+2*1+1*1*1, that is, both channels are 50% duty cycle, and the command is to open the two solenoid valves and let the solenoid valves supply power for 50% of the current. /1J3R, that is, 0*65536+0*256+2*1+1*1*1, open the two solenoid valves but the output is 0, and the two solenoid valves are still closed. v1.0.36 takes effect, and lower versions only have bit0/1 switches.
K (upper case)	0-3 （3）	Solenoid valve/DC brushed motor direction switch 0: Two-way reversal 1: The first way is forward, and the second way is reversed 2: The first way is reversed, and the second way is forward 3: Two forward turns Example: /1J3R, two forward rotation (v1.0.34--)
z (lower case)	(-2^31)-(2^31-1)	sets zero point to current motor position. E.g., /1aM2z0R sets zero point to current motor position. Absolute positions are computed in reference to this point.
v	0-900	Set start velocity for selected motor.

(lower case)	(0)	Units are pps when it at open-loop,Units are cps when it at closed-loop,E.g./1v500R
c (lower case)	0-900 (0)	Set stop velocity for selected motor. Units are pps when it at open-loop,Units are cps when it at closed-loop, E.g./1c500R
b	9600-115200 (9600)	Set bound rate, E.g./1b38400R Parameters can be saved after power-off
aC	1-64999 (50)	Set position correction value (deadband). When in position correction mode, position correction is performed if the error exceeds this value. E.g./1aM2aC100R,The allowable position error of instruction shaft 2 is 50
aE	1-10^6 (1000)	Set encoder ratio,This sets the ratio between the encoder counts/rev and the microsteps/rev for the specified motor E. g. /1aM2aE12500R（Axis 2 specified） Encoder ratio = (motor microsteps per rev/quadrature encoder counts per rev) X 1000.
au	1-64999 (10)	Set overload timeout. This sets the number of times the move is retried in case a move stalls. E. g. /1aM2au10000R（Axis 2 specified) When the au retries are exhausted, the drive will drop out of position correction mode (n8) and report Error 9 (overload).
I	0-3	Set the global external emergency stop parameters. It is represented by two digits of data, ten bits represent the switch (0 off and 1 on), and the low bit indicates the mode of emergency stop signal input, with values of 0-3, which respectively represent the following meanings: 0: The rising edge is triggered, and the internal pull-up 1: The rising edge is triggered, and the internal pull-down is triggered 2: The falling edge is triggered, and the internal pull-up 3: Falling edge triggers, internal pull-down For example: /1I12R, turn on the global external emergency stop, set it to the falling edge to trigger, and the internal pull-up After V1.0.41, the 100-digit control emergency stop was added (0 off and 1 on)
X		Clear the global external emergency stop flag, write 1 clear. The global external emergency stop flag can be queried with the Q command, and the bit4 of the status byte indicates whether it is valid or not, e.g. /1X1R
f	0-3 （0）	Set the emergency stop signal input mode of the current motor, with values ranging from 0 to 3, which represent the following meanings: 0: The rising edge is triggered, and the internal pull-up

		1: The rising edge is triggered, and the internal pull-down is triggered 2: The falling edge is triggered, and the internal pull-up 3: Falling edge triggers, internal pull-down For example: /1aM1f0R, set the signal port level of axis 1 to high, and the rising edge trigger parameter can be saved when the power is off After V1.0.41, you can control the trigger configuration by using single digits, the lower limit of 10 digits, the upper limit of 100 digits, and the lower limit of 1,000 digits. Example: /1aM1f1023R means that the upper limit is stopped with L deceleration, the initial level is low, and the falling edge is triggered, and the lower limit is stopped immediately, the initial level is high, and the falling edge is triggered
O (upper case)	0-1	Enable motor of specified axis , 0: motor doesn't enable 1::motor enabled E.g: /1aM1O0R，the motor of axis 1 doesn't enabled；
!		Power-off save parameter command, e.g. /1! You can save the parameters after power-off
o （lower case）		Clear the 1-axis overload state Example: /1o1R (v1.0.35---)
U (upper case)		To change the command to clear the fault state of the specified axis, you need to write 1 and then 0, and the B4 unique command

5.2.1 Related Read Commands

&		Returns the current firmware version and date, e.g. /1&
?aa		Reads two analog input values, the return value order is -1, GLIM, ADC2, ADC1. GLIM is the global limit state, the value is 16384 in the high state and 0 in the low level. E.g. /1?aa
?aa	1-4	Read the digital level value of the specified limit switch, for example: /1?aa1 returns the digital level status of the #1 limit switch, e.g. /1?aa1
?aS		Read the busy status of the 4 motors, and the corresponding digits in the return value represent the status of each motor. bit0: motor 1 is busy Bit1: Motor 2 is busy Bit2: Motor 3 is busy Bit3: Motor 4 is busy For example, if you send the command /1?aS and the return data is 2, the second motor is busy

?aA		Get the current location of the 4-way motor
?aV		Get the set maximum speed of the 4-way motor
?0 (? zero)		Return the motor position of the current drive motor, e.g. /1?0
?2		Returns the maximum speed of the current drive motor
?4		The lower 16 bits are the normal I/O port status, and the upper 16 bits are the limited port status. Defined as: Bit0:J14 Pin6 Bit1:J14 Pin5 Bit2:J14 Pin4 Bit3-15: Reserved Bit16: Channel 1 upper limit Bit17: Lower limit of channel 1 Bit18: Channel 2 upper limit Bit19: Lower limit of channel 2 Bit20: The upper limit of channel 3 Bit21: The lower limit of channel 3 Bit22: Channel 4 upper limit Bit23: The lower limit of channel 4 Bit24: Global limit Bit25-31: Reserved
?1		Read the starting speed of the 4-way motor
?3		Read the stop speed of the 4-way motor
Q		Query the current status of the controller, the returned data contains the start character and host address/0, followed by 5 bit status bytes, bit5 is the idle indicator bit, bit3~0 represents the error code: 0: No errors; 1: Initialization error; 2: Invalid command; 3: The operands of the last command are out of range;
?5		Reads the idle current of the current motor
?6		Read the current operating current of the motor
?7		Read the current attenuation coefficient of the current motor
?8		Reads the current axis encoder position
?9		Reads the acceleration value of the 4-way motor
?a9		Read the deceleration value of the 4-way motor
?a8		Read the microstepping settings of the current motor
?aE		Read the encoder ratio
?aC		Reading the encoder allows for error values
?ao		Query the overload status of axis 1 and axis 2, where bit0 indicates axis 1 and bit1 indicates axis 2, and the response value of the read back is only valid for bit0~bit1, and the other bits are meaningless. For

		example, 31 represents axis 1 overload. E.g. /1?ao (v1.0.35---)
? a0 (? a zero)		Query the fault status of 4 axes: 3: over temperature, 2: over current, 1: motor line is not connected, 0: no fault, B4 unique command

5.3 Encoder position correction mode

1、Motor direction confirmation

Use /1aM1P20000R to turn the motor forward, use the /1?8 command to view the encoder count when the rotation is complete, and if the encoder count does not increase positively, the encoder needs to exchange AB lines. Or switch the one-phase line sequence of the stepping motor so that the encoder count direction is consistent with the motor direction.

2、Encoder ratio calculation

Encoder ratio = 1000 * number of microstep per revolve/(encoder line number * 4), take 1000 line encoder, controller default setting microstep 16 as an example, should set the encoder line number to:1000*(200*16)/(1000*4) = 800.

3、Set correction mode parameters

The aC instruction sets the position correction allowed position error, and the au instruction sets the position correction retry number.

4、Start encoder correction mode

E.g./1aM1V20000aE800aC1000au100n8R,Axis 1 will start the position correction mode

5、Start automatic recovery encoder correction mode

E.g./1aM1V20000aE800aC1000au100n520R,Axis 1 will start the position correction mode, block it and run out of retries, and the script instruction for position 13 will be executed

6 Electrical characteristics and technical specifications

Parameter	Condition	Min	Typical	Max	Unit
Supply Power Voltage	Normal 25℃	9	24	36	V
Operation Temperature	24V Input Voltage	-40		85	℃
Maximum current of signal interface	source/sink current	0		20	mA
Output current per axis	Normal 25℃	0		4	A
+5V output current	Normal 25℃	0		250	mA

7 Dimensions