

# 1.Parameters of servo motor

Stroke: 500mm

Speed: 3000 laps/min

Load: 700N

Lap: 50; When the motor runs for 1 laps, the electric actuator will extend by 10mm

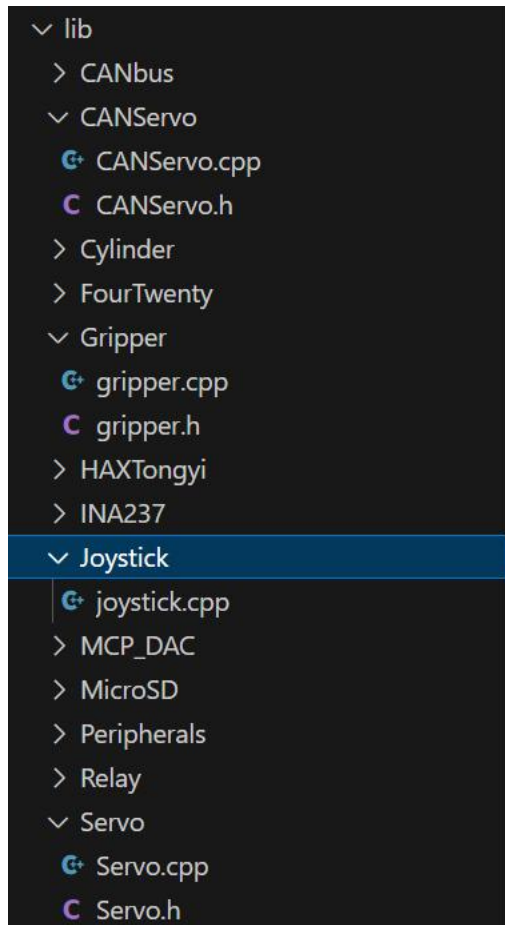
Communication frequency: 250k ; Because the communication frequency of the joystick is 250k, and the joystick and the motor use the same bus, the frequencies of the two must be kept consistent.

In order to change the communication frequency, prepare a RS485 to USB module in advance.



actuator

## 2.Description of lib



CANServo.h: It was written by Han Long, but I didn't use it.

Gripper.h: I wrote the code from line 89 to the end. `class Gripper` is used for the old machine.

HAXTongyi: It is an example provided by the manufacturer.

Servo: function of controlling servo motor

Joystick.cpp: `controlCylinders()` is used for testing

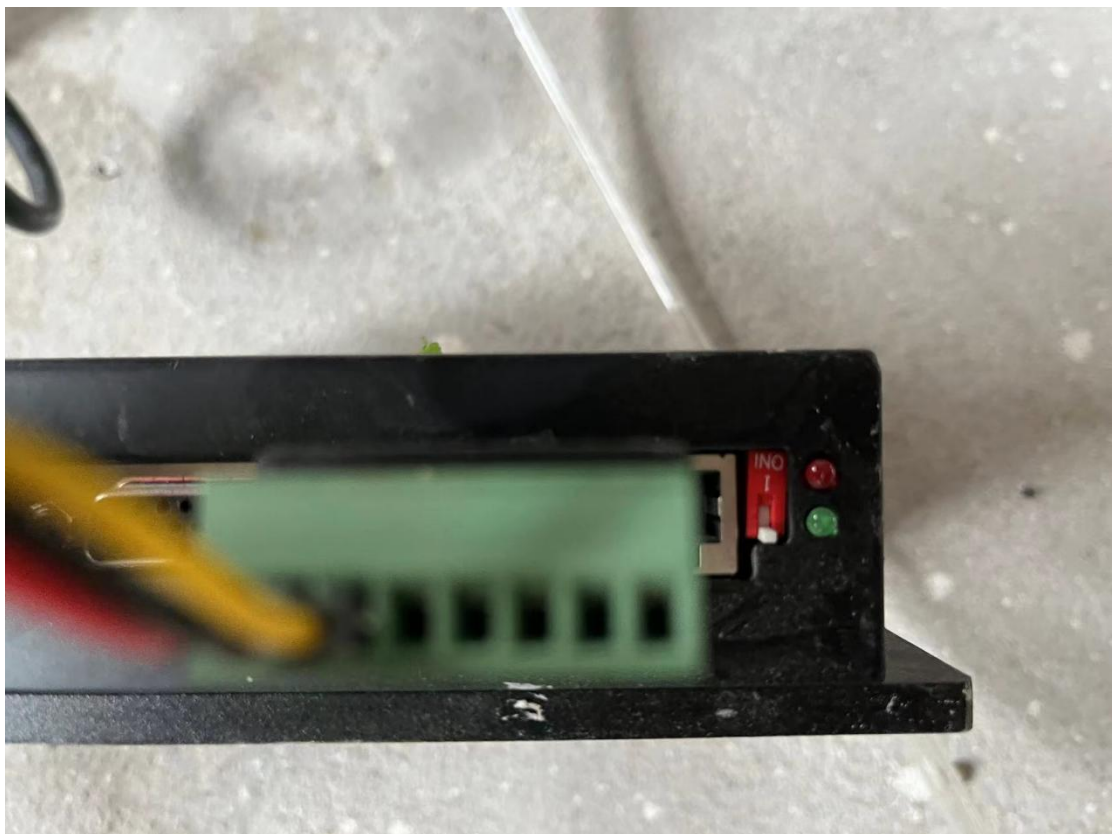
### 3.Process of controlling the motor

Step1: Turn on the motor power and then turn on the EE box power.

Note: The controller of the motor can only receive the NMT command from the PCB after it is started, and can only start CAN communication after successfully receiving the command.

Step2: Wait

Note: use the current code, after about twenty seconds, the motor will be enabled, and after another ten seconds, you can control the motor using the joystick.



The red LED is an alarm light. When it flashes, it indicates that the motor or controller is running in error. The current solution is to power off and restart.

The green LED is the controller operation indicator. When it is always on, it indicates that the motor is already in the enabled state.

Step3: control

### 6.8.6 Default PDO Mapping Parameter in Location Mode

The default configuration PDO mapping parameter of the driver is shown in the following table:

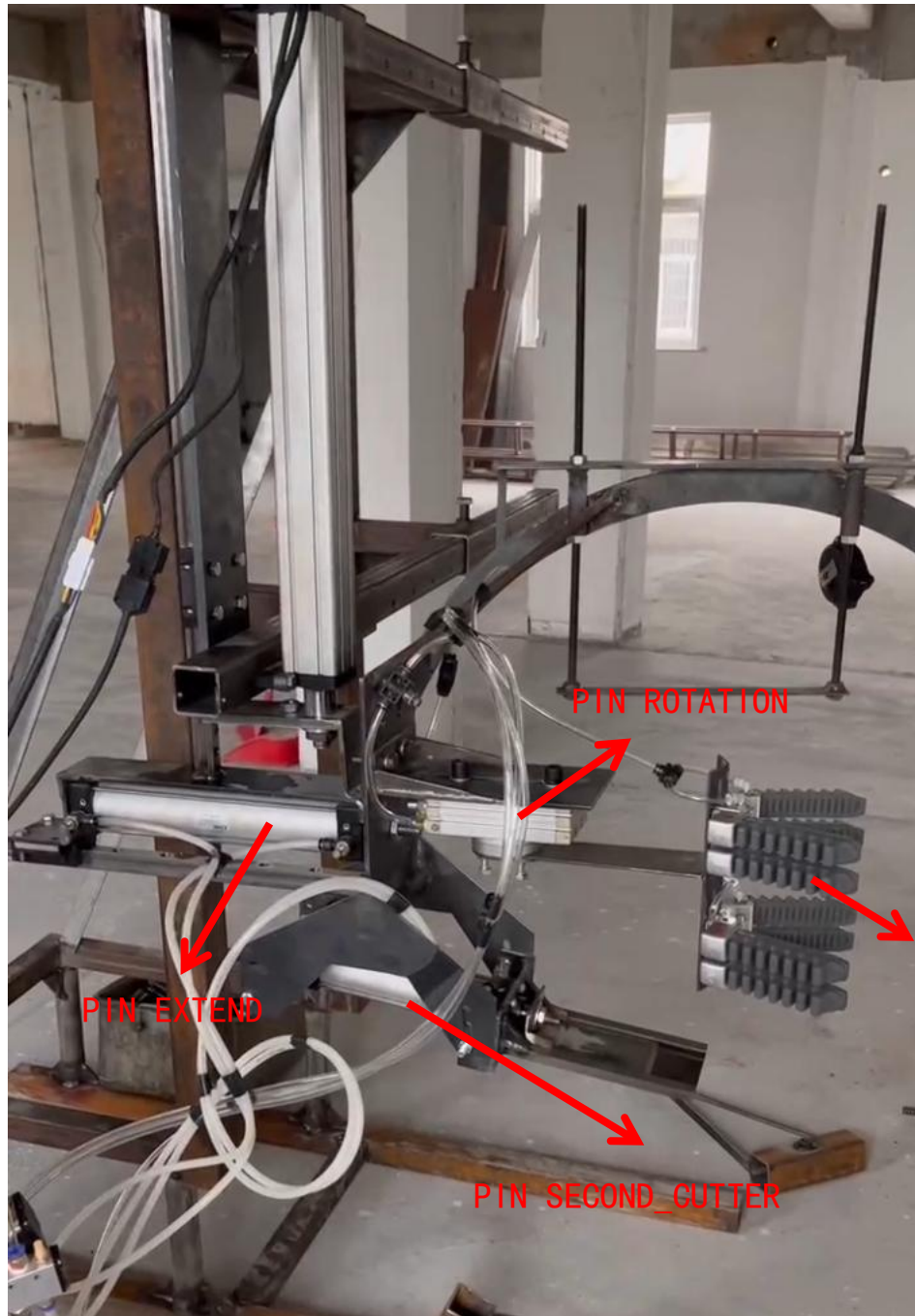
CANopen_Protocol_Software_V4_32												
1 CANopen 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000												
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Use PDO; position Mode

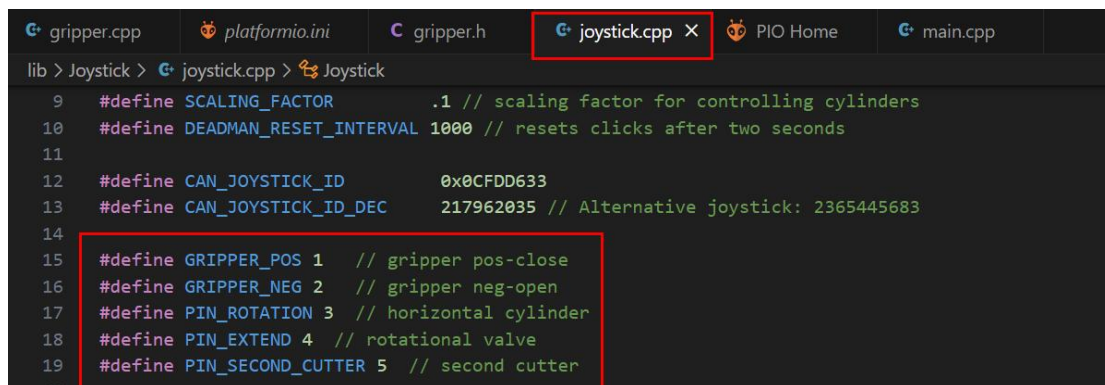
Step4: After operating the actuator to 0 position(Stroke: 500mm), turn off the power

Note: The motor currently used is a relative value motor.

## 4. code

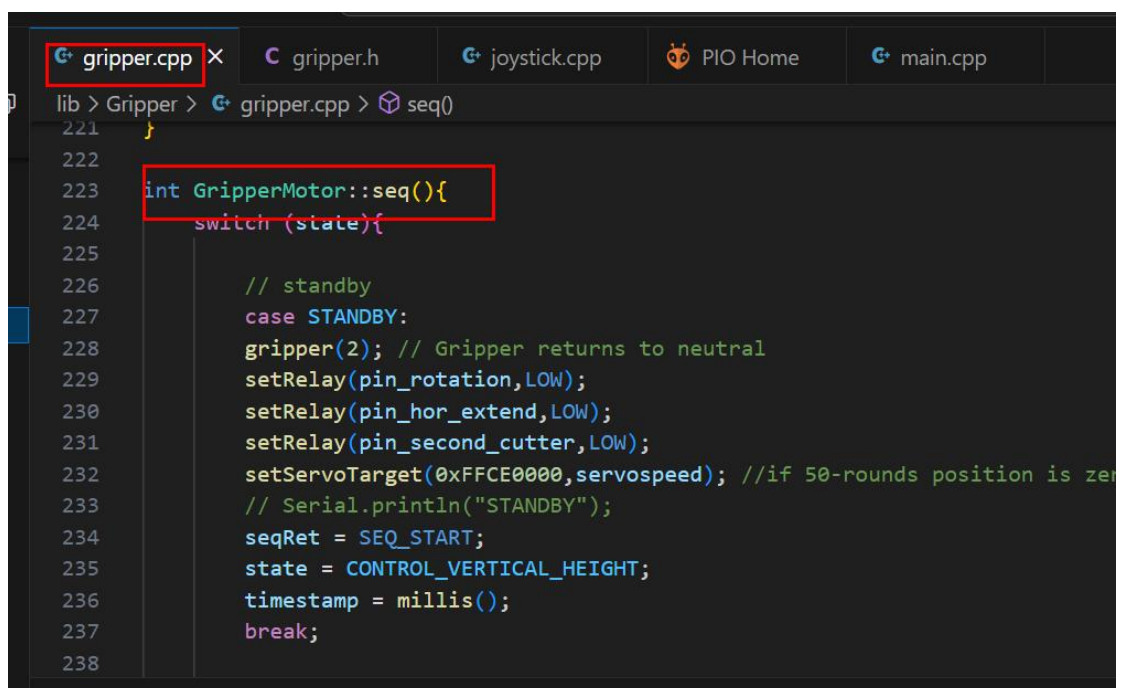


#### 4.1 definition of pin



```
gripper.cpp platformio.ini gripper.h joystick.cpp X PIO Home main.cpp
lib > Joystick > joystick.cpp > Joystick
9 #define SCALING_FACTOR .1 // scaling factor for controlling cylinders
10 #define DEADMAN_RESET_INTERVAL 1000 // resets clicks after two seconds
11
12 #define CAN_JOYSTICK_ID 0xCFDD633
13 #define CAN_JOYSTICK_ID_DEC 217962035 // Alternative joystick: 2365445683
14
15 #define GRIPPER_POS 1 // gripper pos-close
16 #define GRIPPER_NEG 2 // gripper neg-open
17 #define PIN_ROTATION 3 // horizontal cylinder
18 #define PIN_EXTEND 4 // rotational valve
19 #define PIN_SECOND_CUTTER 5 // second cutter
```

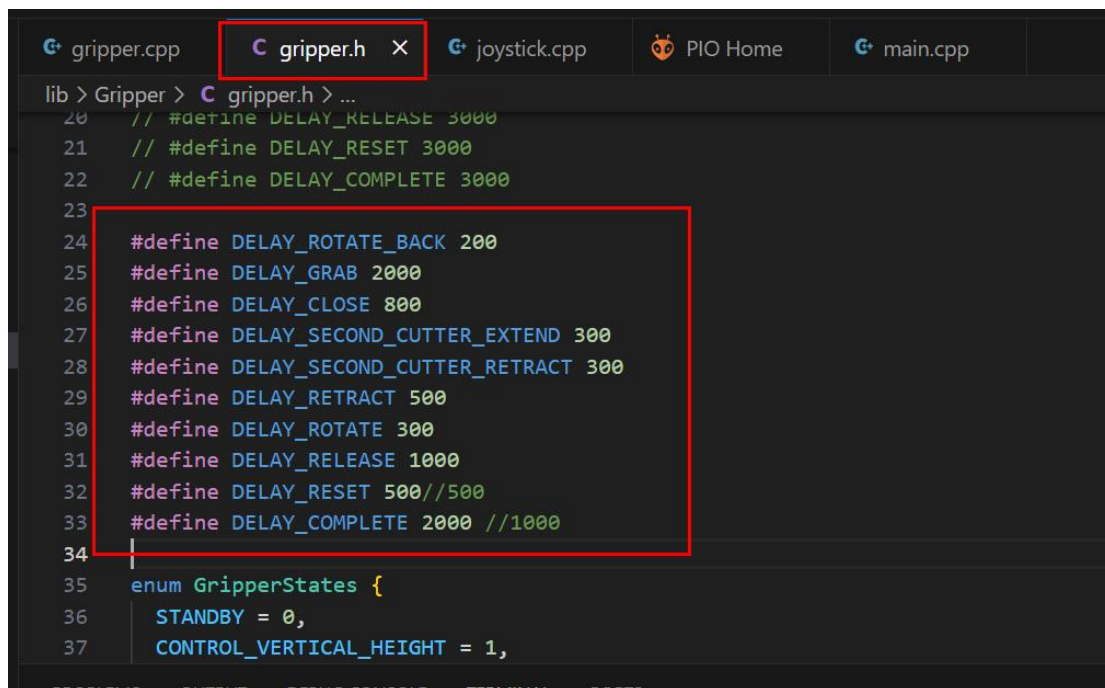
#### 4.2 Sequence



```
gripper.cpp X gripper.h joystick.cpp PIO Home main.cpp
lib > Gripper > gripper.cpp > seq()
221 }
222
223 int GripperMotor::seq(){
224     switch (state){
225
226         // standby
227         case STANDBY:
228             gripper(2); // Gripper returns to neutral
229             setRelay(pin_rotation, LOW);
230             setRelay(pin_hor_extend, LOW);
231             setRelay(pin_second_cutter, LOW);
232             setServoTarget(0xFFCE0000, servospeed); //if 50-rounds position is zero
233             // Serial.println("STANDBY");
234             seqRet = SEQ_START;
235             state = CONTROL_VERTICAL_HEIGHT;
236             timestamp = millis();
237             break;
238     }
```

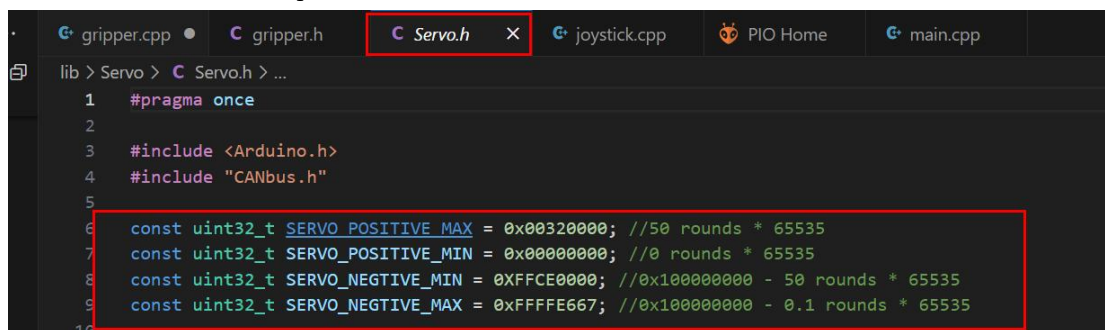


#### 4.3 Time control of sequence



```
lib > Gripper > C gripper.h > ...
20 // #define DELAY_RELEASE 3000
21 // #define DELAY_RESET 3000
22 // #define DELAY_COMPLETE 3000
23
24 #define DELAY_ROTATE_BACK 200
25 #define DELAY_GRAB 2000
26 #define DELAY_CLOSE 800
27 #define DELAY_SECOND_CUTTER_EXTEND 300
28 #define DELAY_SECOND_CUTTER_RETRACT 300
29 #define DELAY_RETRACT 500
30 #define DELAY_ROTATE 300
31 #define DELAY_RELEASE 1000
32 #define DELAY_RESET 500//500
33 #define DELAY_COMPLETE 2000 //1000
34
35 enum GripperStates {
36     STANDBY = 0,
37     CONTROL_VERTICAL_HEIGHT = 1,
```

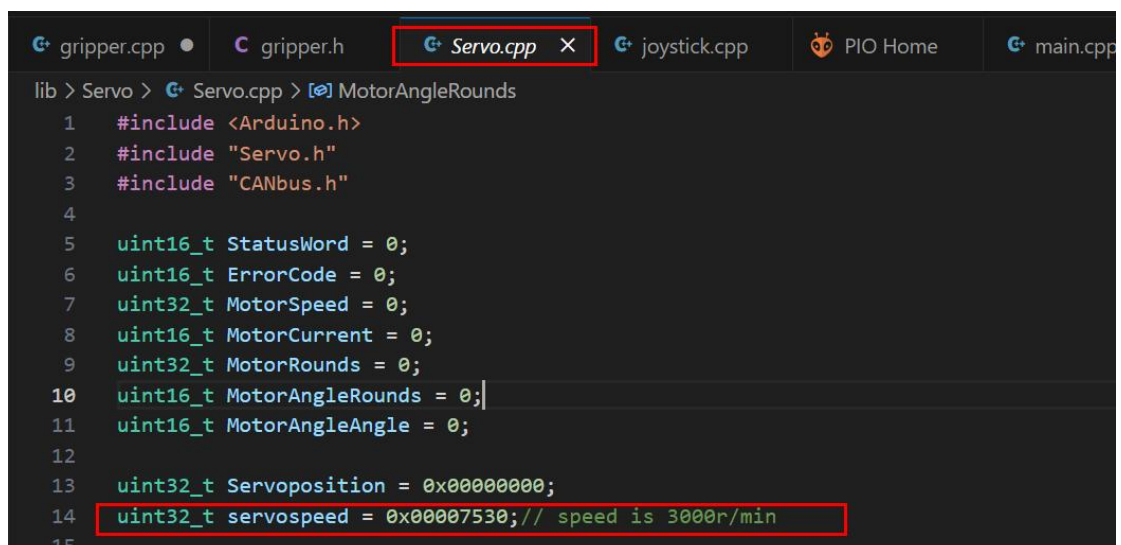
#### 4.4 Set the limit position of the motor



```
lib > Servo > C Servo.h > ...
1 #pragma once
2
3 #include <Arduino.h>
4 #include "CANbus.h"
5
6 const uint32_t SERVO_POSITIVE_MAX = 0x00320000; //50 rounds * 65535
7 const uint32_t SERVO_POSITIVE_MIN = 0x00000000; //0 rounds * 65535
8 const uint32_t SERVO_NEGTIVE_MIN = 0xFFCE0000; //0x100000000 - 50 rounds * 65535
9 const uint32_t SERVO_NEGTIVE_MAX = 0xFFFFE667; //0x100000000 - 0.1 rounds * 65535
10
```

#### 4.5 Set the speed of the motor

Generally set the motor to run at the fastest speed.



```
lib > Servo > C Servo.cpp > [O] MotorAngleRounds
1 #include <Arduino.h>
2 #include "Servo.h"
3 #include "CANbus.h"
4
5 uint16_t StatusWord = 0;
6 uint16_t ErrorCode = 0;
7 uint32_t MotorSpeed = 0;
8 uint16_t MotorCurrent = 0;
9 uint32_t MotorRounds = 0;
10 uint16_t MotorAngleRounds = 0;
11 uint16_t MotorAngleAngle = 0;
12
13 uint32_t Servoposition = 0x00000000;
14 uint32_t servospeed = 0x00007530; // speed is 3000r/min
15
```

#### 4.6 Feedback value of motor

```
gripper.cpp  gripper.h  Servo.cpp  joystick.cpp  PIO Home  main.cpp

lib > Servo > Servo.cpp > can_heartbeat_publish(HBSTATE)

125 void can_change_servo_mode() {
157 #endif
158 }
159 }
160
161 void CAN_TPDO_CALLBACK() {
162     twai_message_t can_receive_msg;
163     int16_t cmd_val;
164
165     int ret = twai_receive(&can_receive_msg, 0);
166     if (ret == ESP_OK) {
167         // #if SERIAL_DEBUG_SEND_FLG or SERIAL_DEBUG_AUTO_FLG or SERIAL_DEBUG_MANU_FLG or \
168         // SERIAL_GENERAL
169         Serial.print("tpdo read 0x");
170         Serial.print(can_receive_msg.identifier, HEX);
171         Serial.print(", [");
172         for (uint8_t idx = 0; idx < 8; idx++) {
173             Serial.print("0x");
```

	CAN 标识符	字节数	字节 1	字节 2	字节 3	字节 4	字节 5	字节 6	字节 7	字节 8
TPDO1	0x180+Node-ID	2	00	00						
			CANOPEN 控制状态反馈, SDO 地址: 0x6041							
			禁止时间: 20 (2ms);事件时间: 50ms							
TPDO2	0x280+Node-ID	2	00	00						
			错误代码反馈, SDO 地址: 0x603F							
			禁止时间: 20 (2ms);事件时间: 50ms							
TPDO3	0x380+Node-ID	6	00	00	00	00	00	00		
			电机速度反馈, 0x606C				电机电流反馈, 0x6078			
			禁止时间: 200 (20ms);事件时间: 50ms							
TPDO4	0x480+Node-ID	8	00	00	00	00	00	00	00	00
			电机圈数反馈, 0x60FB 02				电机实时角度反馈, 0x6064 (低 16 位角度+高 16 位圈数)			
			禁止时间: 200 (20ms);事件时间: 50ms							



## 5. Set the zero position

5.1 Currently, the position is set as the zero position when the stroke is 50cm. As shown in the picture.



There are two reasons for this setting. 1)The load of the motor is very heavy (about 20 kilograms), so when the power of the motor is turned off, the actuator will automatically slide to the bottom. 2)When the stroke is the maximum value, it is easier to calculate the command value for controlling the motor. For example, setting the stroke to 20cm means that the motor is retracted by 30 laps.

Note:The newly purchased backup motor is different from the one currently in use. The manufacturer said that the new motor has a "brake", which prevents the actuator from sliding to the bottom when the motor is powered off.

## 6. Set the zero return mode



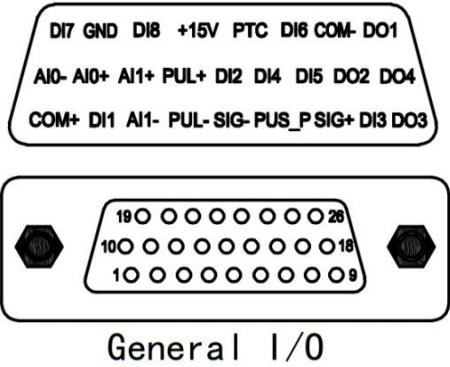
Connection:

P1 and P22 are short-circuited

P15 is connected to the brown wire

P20 is connected to the blue wire

Select zero return mode 1



01	IO_COM+	IO input power supply	Input Common Terminal
15	USRC_DI4	Digital input	NOT input
20	GND_DIG	Digital ground	
22	+15V_DIG	Power supply output	< 100mA

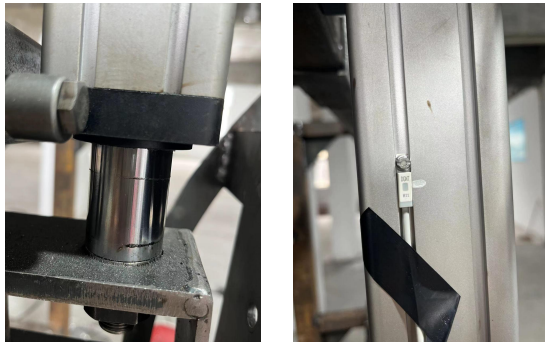
The zero return mode can only be enabled through the SDO communication mode

## 6.1 test process

Step 1 : Fix the sensor to the motor



Note: The position marked with a white mark in the picture is the highest fixed position of the sensor. If the sensor is fixed higher than this mark, the controller may give an alarm;



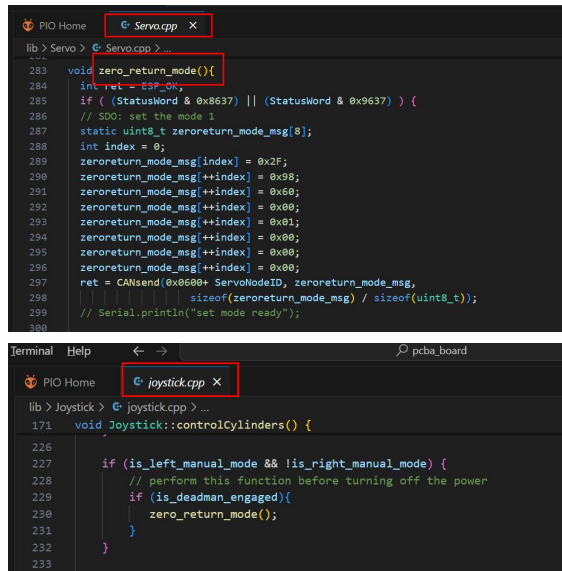
Current position

Step 2: Before executing the zero return mode, check the stroke of the motor

Note: After executing the zero return mode, the motor will continue to retract until the sensor signal is found. However, if the signal cannot be found during the retraction process, the controller will give an alarm;

In other words, the position of the sensor must be higher than the position of the magnet inside the motor;

### Step 3 : Execute zero return mode



The first screenshot shows the `Servo.cpp` file in a code editor. The `void zero_return_mode()` function is highlighted with a red box. The code defines a message array `zeroreturn_mode_msg` and sends it via CAN bus. The second screenshot shows the `joystick.cpp` file. The `void Joystick::controlCylinders()` function is highlighted with a red box. Inside this function, there is a call to `zero_return_mode()` when the deadman is engaged.

```
lib > Servo > Servo.cpp > ...  
283 void zero_return_mode(){  
284     int ret = 0;  
285     if ( (StatusWord & 0x8637) || (StatusWord & 0x9637) ) {  
286         // SDO: set the mode 1  
287         static uint8_t zeroreturn_mode_msg[8];  
288         int index = 0;  
289         zeroreturn_mode_msg[index] = 0x2F;  
290         zeroreturn_mode_msg[++index] = 0x98;  
291         zeroreturn_mode_msg[++index] = 0x60;  
292         zeroreturn_mode_msg[++index] = 0x00;  
293         zeroreturn_mode_msg[++index] = 0x01;  
294         zeroreturn_mode_msg[++index] = 0x00;  
295         zeroreturn_mode_msg[++index] = 0x00;  
296         zeroreturn_mode_msg[++index] = 0x00;  
297         ret = CANsend(0x0600+ ServoNodeID, zeroreturn_mode_msg,  
298                     sizeof(zeroreturn_mode_msg) / sizeof(uint8_t));  
299         // Serial.println("set mode ready");  
300     }  
301 }
```

```
lib > Joystick > joystick.cpp > ...  
171 void Joystick::controlCylinders() {  
226  
227     if (is_left_manual_mode && !is_right_manual_mode) {  
228         // perform this function before turning off the power  
229         if (is_deadman_engaged){  
230             zero_return_mode();  
231         }  
232     }  
233 }
```



Note: The zero return mode must be executed after the servo motor is enabled, the status word should be 0x8637(1000011000110111) or 0x9637(1001011000110111); I don't know the difference between them yet, I will inquire with the manufacturer later.

## 6.2 Some response messages of CAN communication

Set the mode 1 :

Command: 0x060A(ID) 0x2F 98 60 00 01 00 00 00

Return: 0x058A(ID) 0x60 98 60 00 00 00 00 00

Set the motor speed :

Command: 0x060A(ID) 0x23 99 60 00 D0 07 00 00

Return: 0x058A(ID) 0x60 99 60 00 00 00 00 00

Set the homing offset :

Command: 0x060A(ID) 0x23 7C 60 00 00 00 00 00

Return: 0x058A(ID) 0x60 7C 60 00 00 00 00 00

Execute zero return mode :

Command: 0x060A(ID) 0x2F FB 60 04 01 00 00 00

Return: 0x058A(ID) 0x60 98 60 00 00 00 00 00