# Automatic Focusing Cutting Head Electric Manual

Apply to: NC12
NC30
NC30B
NC60
NC60B

Shenzhen Worthing Technology Co., Ltd

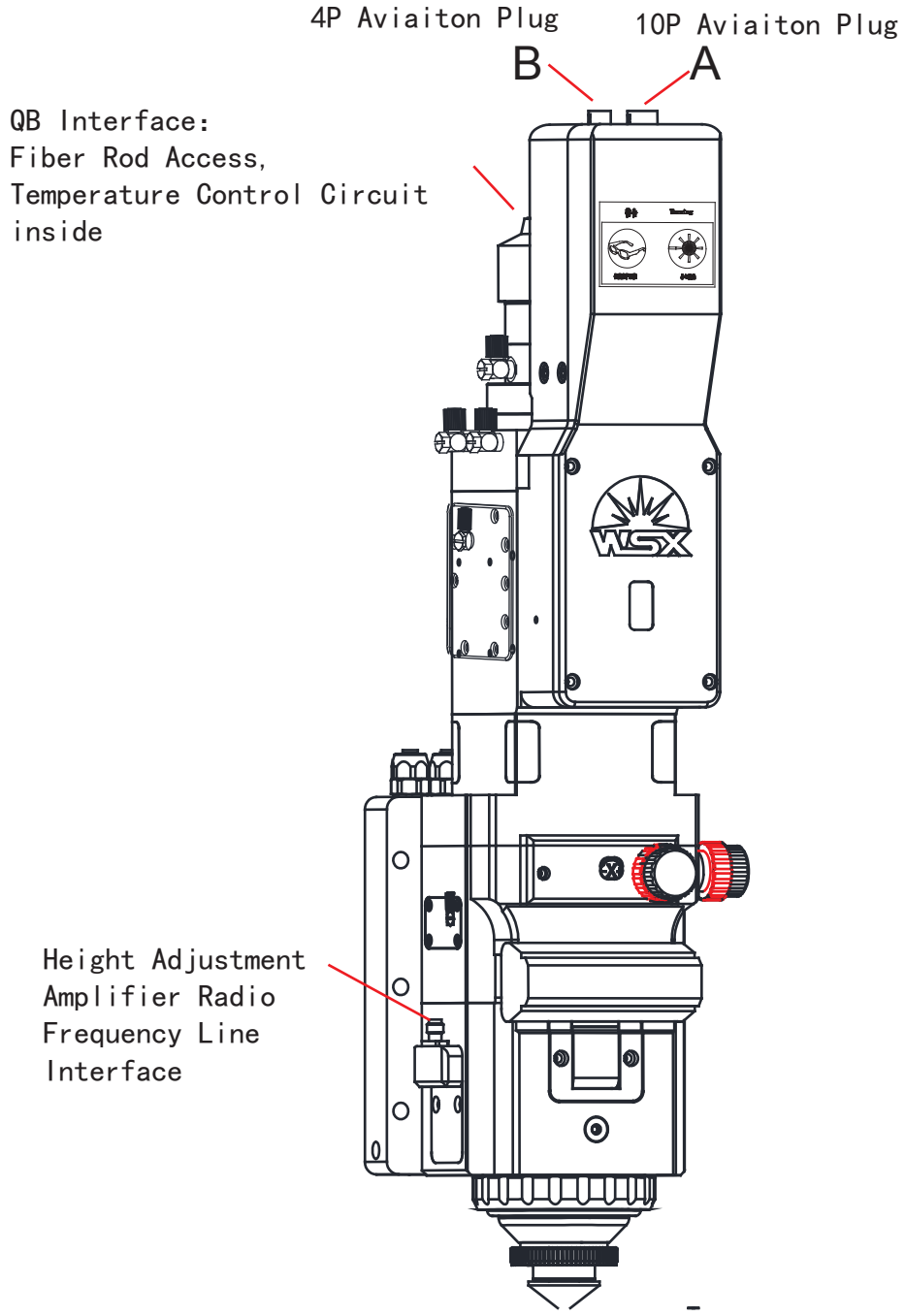
# Test Condition

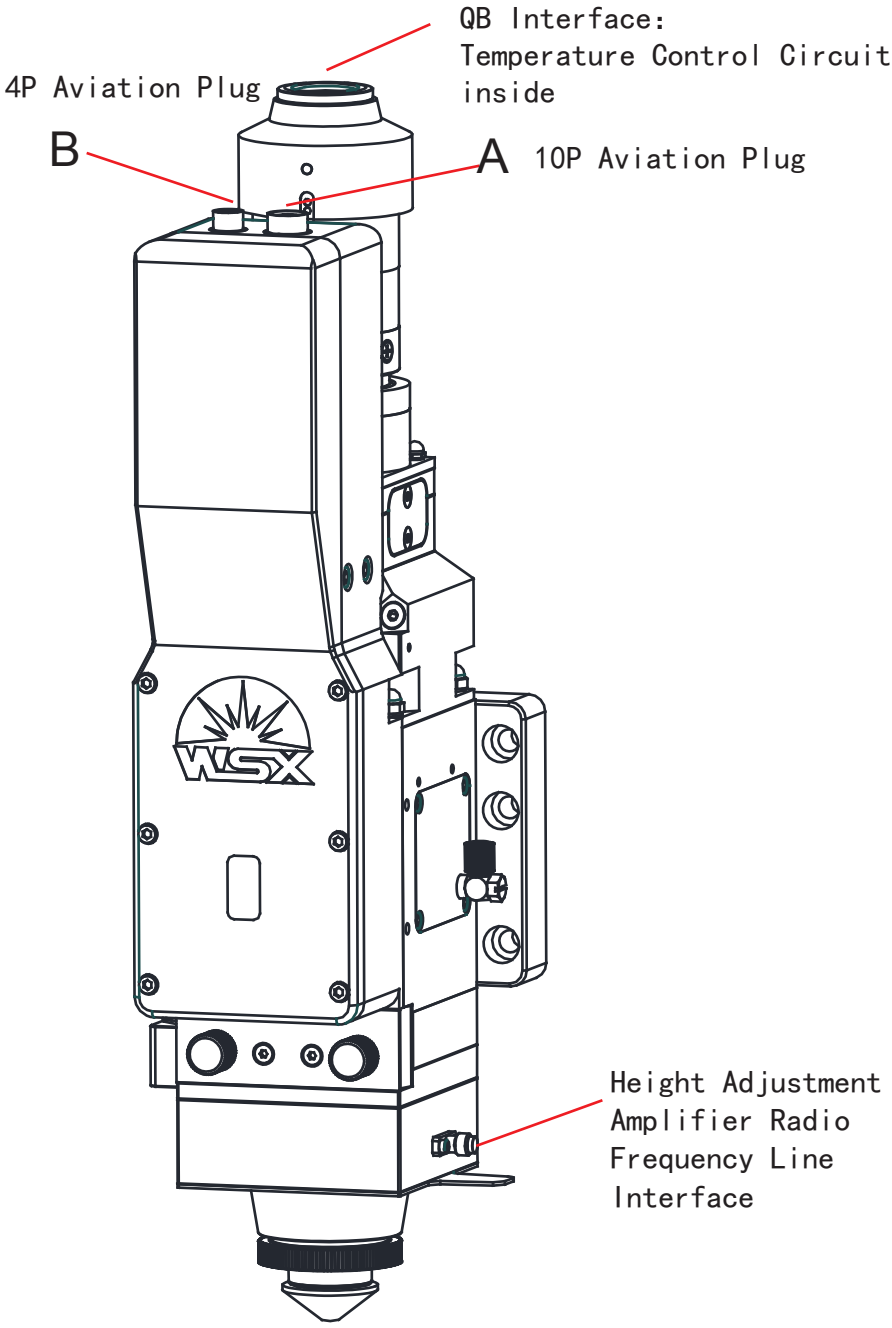
1. Read this manual carefully.
2. Correct wiring.
3. Smoothing and voltage stabilizing circuit.
4. Good earthing.
5. Correct software parameter setting.

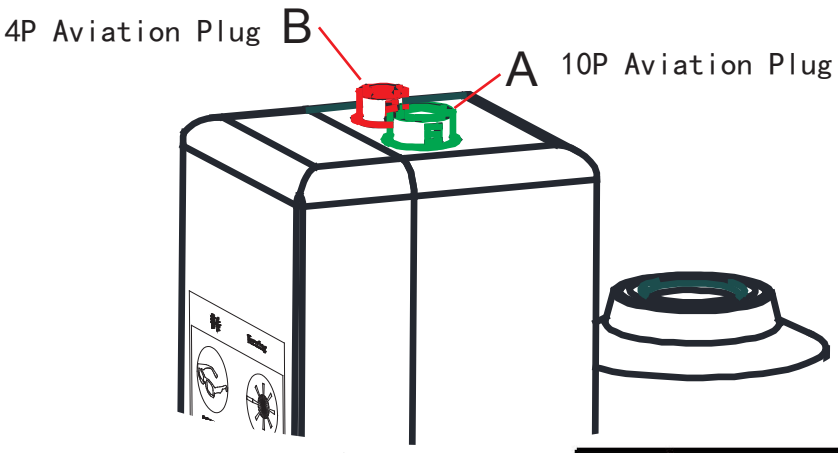
# Steps

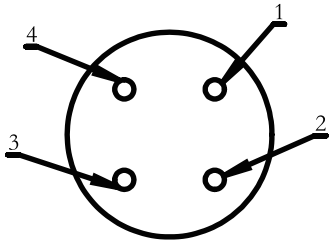
1. Adjust soft limitation to -100~100
2. Set inching speed to 1mm/s
3. Inching at positive direction until reach positive limitation
4. Inching at negative direction until reach negative limitation
5. After confirming effectiveness of positive & negative limitation, set back to origin
6. Restore soft limitation & inching speed to origin

# NC30,NC60


4P Aviaiton Plug
10P Aviaiton Plug
B
A
QB Interface:
Fiber Rod Access,
Temperature Control Circuit
inside
Height Adjustment
Amplifier Radio
Frequency Line
Interface

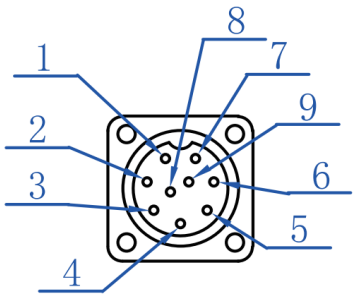

QB Interface:
Temperature Control Circuit
inside
4P Aviation Plug
B
A
10P Aviation Plug
Height Adjustment
Amplifier Radio
Frequency Line
Interface



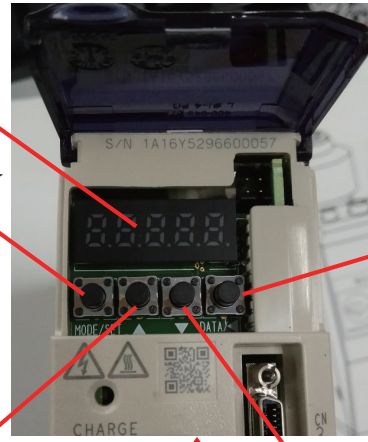

| | |
|---|---|
| 1 | W |
| 2 | U |
| 3 | V |
| 4 | FG (Earthing) |

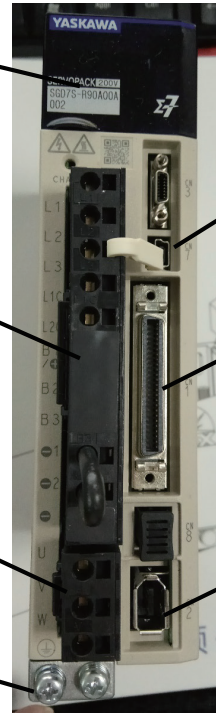
Servo Motor Power Supply Interface (Red)




| | | |
|---|---|---|
| 1 | FG | (Shield Wire) |
| 2 | -D | (Encoder Signal Data-) |
| 3 | +D | (Encoder Signal Data+) |
| 4 | SG | (Signal Ground Wire) |
| 5 | VCC | (Encoder Power +5V) |
| 6 | +24V | (Approach Switch Power Line) |
| 7 | 0V | (Approach Switch Power Line) |
| 8 | W+ | (Approach Switch Signal Line) |
| 9 | W- | (Approach Switch Signal Line) |

Servo Motor Encoder & Approach Switch Interface (Green)

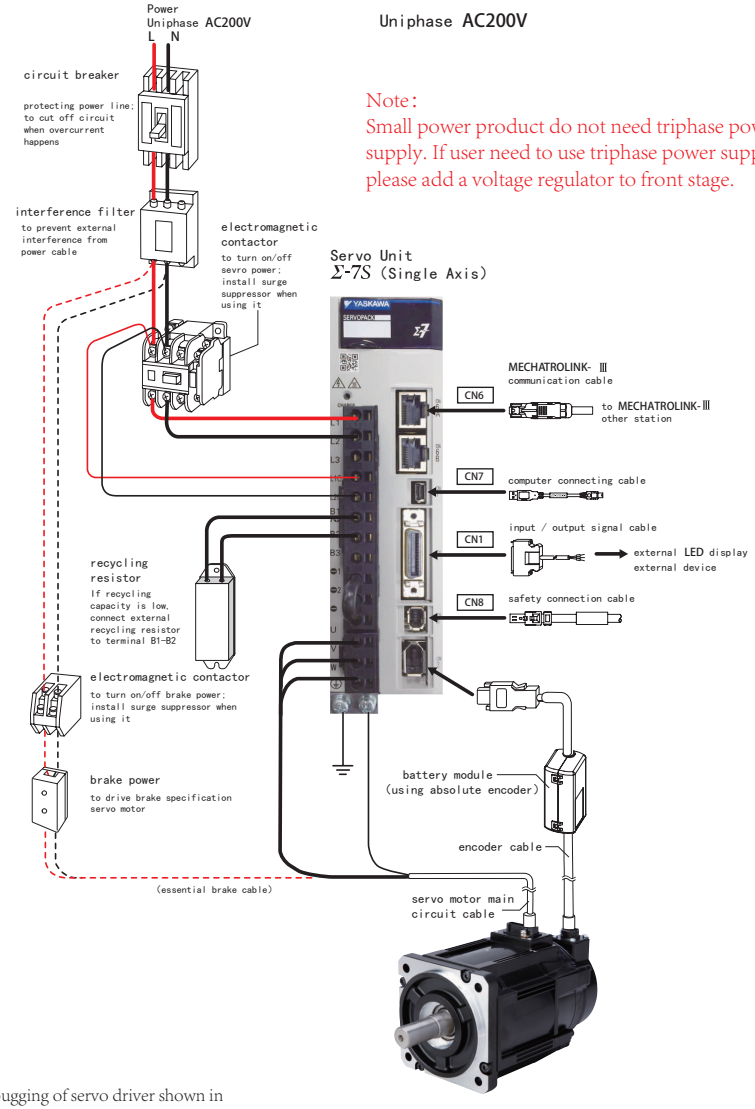

Display Screen
Menu Key
Set/Save
Downward Key
Upward Key
S/N 1A16Y5296600057
CHARGE


Servo Panel
YASKAWA
USB Interface
Uniphase 220V
Power Interface
50P Interface
Motor Triphase Power
Encoder Interface
Ground Wire

## Servo Driver Connects to Motor

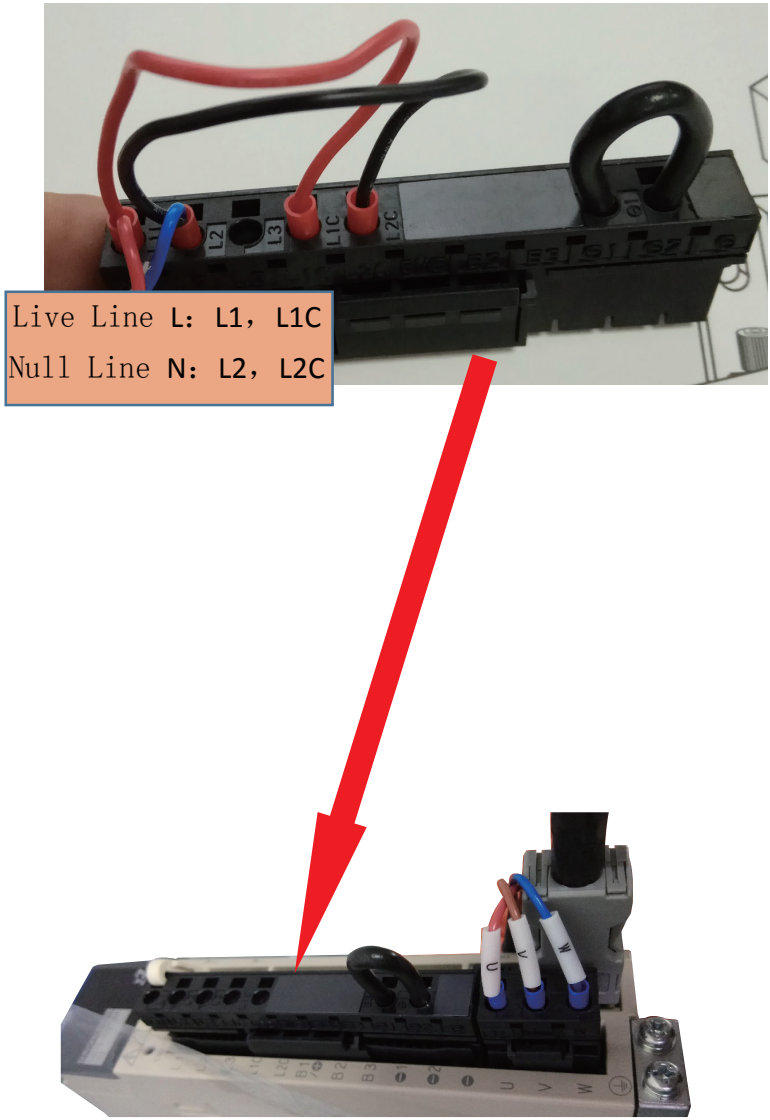
## YASKAWA-7 System Construction Example

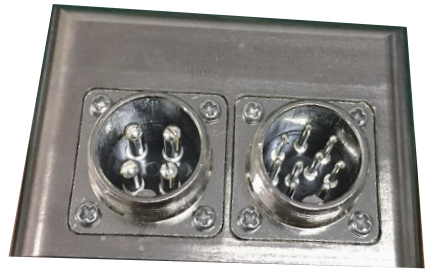
**Σ-7S Servo Unit & Rotary Servo Motor**

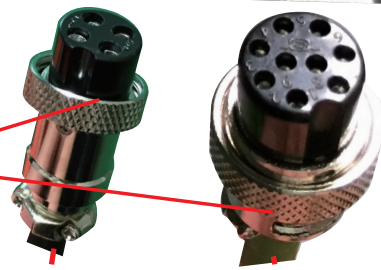



Note:
Small power product do not need triphase power supply. If user need to use triphase power supply, please add a voltage regulator to front stage.

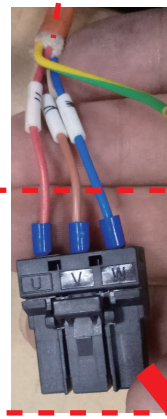
Note: Debugging of servo driver shown in YASKAWA Σ-7 instruction


Live Line L: L1, L1C
Null Line N: L2, L2C
L2
L3
L1C
L2C
U
V
W

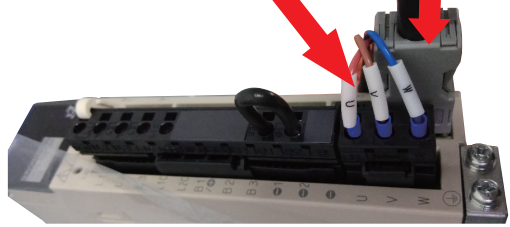




Lock it tight to
prevent loosenees



Sequence of U V W
must be correct



# Check Method of Connection between Laser Head and Driver

1. Check the tags on the UVW Cables, which should be corresponding to the UVW on the Plugs.
2. There shall not be breakover between UVW and ground wire & shell; value of resistance between UVW and shell shall be higher than 5 MΩ.

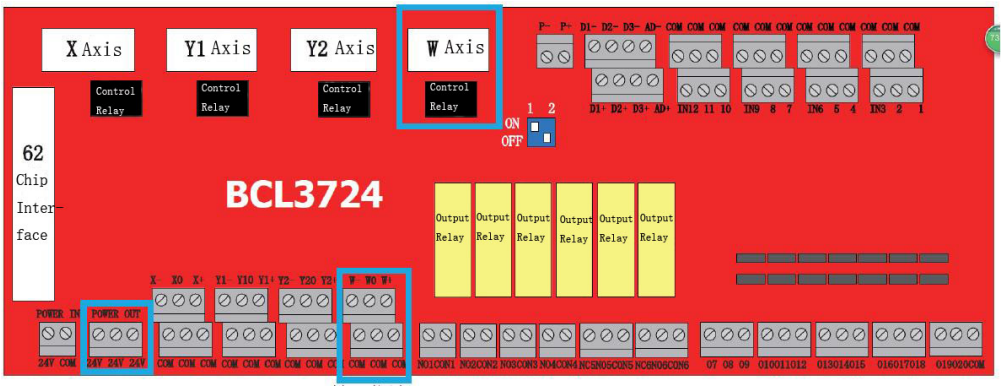
Test condition: connect the end to the cutting head; disconnect the end to the driver.

3. UVW interelectrode resistance is about 20 Ω. If the resistance is 0 (short circuit), or the multimeter shows infinity (open circuit), all are considered abnormal.

Test condition: connect the end to the cutting head; disconnect the end to the driver.

4. Ground connection (extremely important).

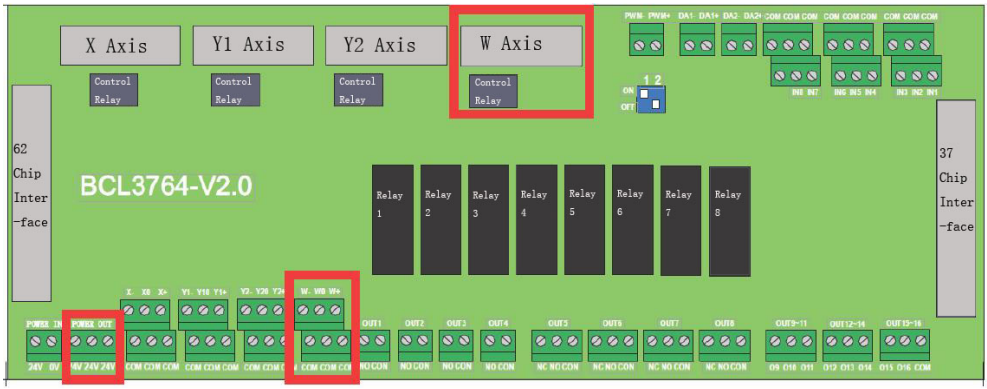
Friendess Closed-loop Expansion Board




DC24V Output Port

W Axis Limit Port

Friendess Open-loop Expansion Board



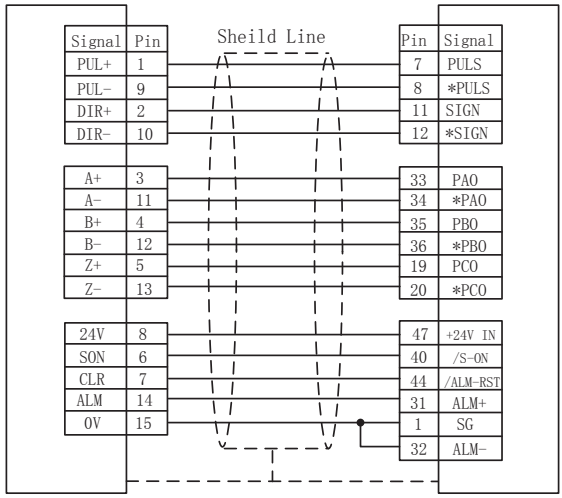

DC24V Output Port

W Axis Limit Port

Friendess FSCUT2000A laser cutting control system BCL3764 port plate Axis W DB15 servo control interface connect with YASKAWA servo driver 50P interface definition

Friendess DB15 Servo Control Interface

YASKAWA Σ-V Servo 50P Interface




Parts of parameter list, subject to actual using and YASKAWA servo instruction.

## NC30 Parameter

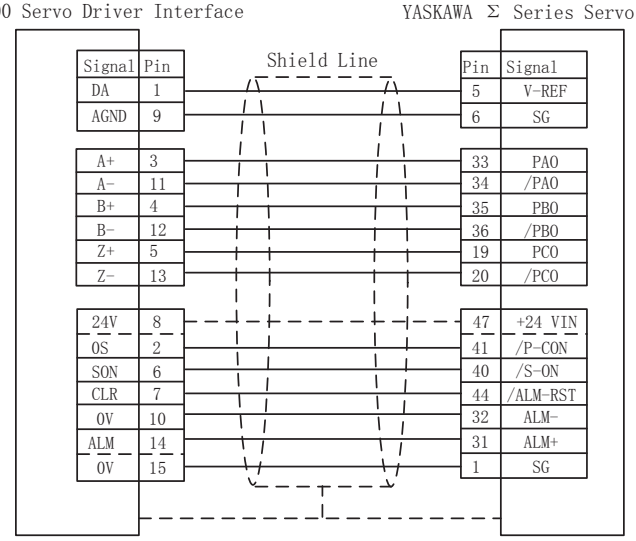
| Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|
| PN000 | 0010 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |

## NC60 Parameter

| Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|
| PN000 | 0011 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |

Note：1.Definition of servo driver and servo motor connection shown in YASKAWA servo driver instruction;
2.Please use uniphase power, L connects to L1 & L1C; N connects to L2 & L2C.

Friendess FSCUT4000A laser cutting control system BCL3724 port plate Axis W DB15 servo control interface connect with YASKAWA servo driver 50P interface definition




Parts of parameter list, subject to actual using and YASKAWA servo instruction.

## NC30 Parameter

| Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|
| PN000 | 0000 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |

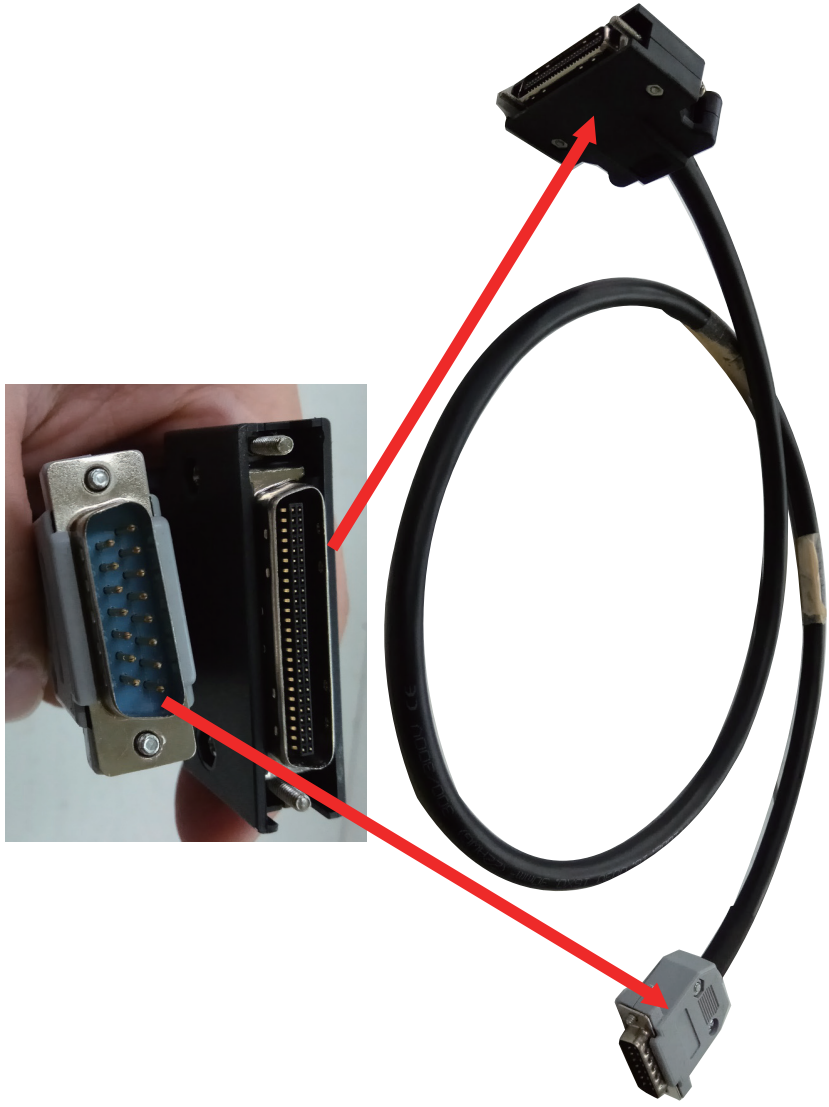
## NC60 Parameter

| Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|
| PN000 | 0001 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |

Note: 1.Definition of servo driver and servo motor connection shown in YASKAWA servo driver instruction;
2.Please use uniphase power, L connects to L1 & L1C; N connects to L2 & L2C.

50Pin Interface

connects to Driver CN1



15Pin Interface W Axis

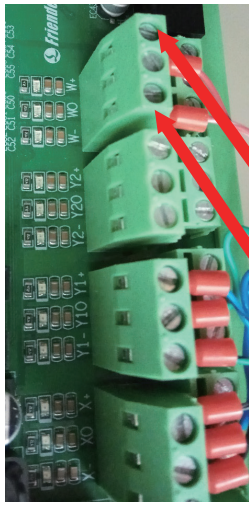

CN1
W Aixs
BCL3724 V2.1
WWW.FSCUT.COM

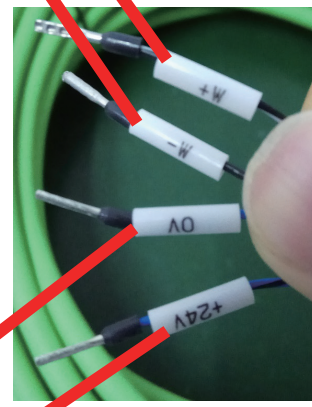
W

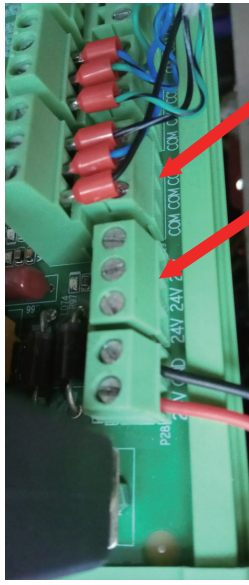
Y2

Y1

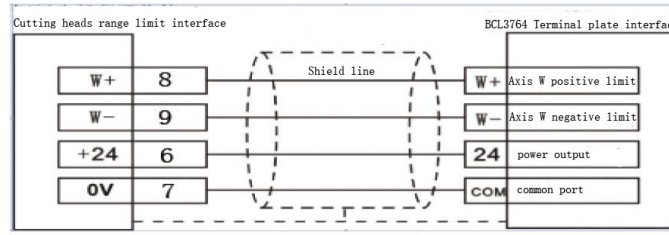
X





Definition of laser focusing djustment range limitation switch connector



# Check method of Limit Signal

## Test Condition

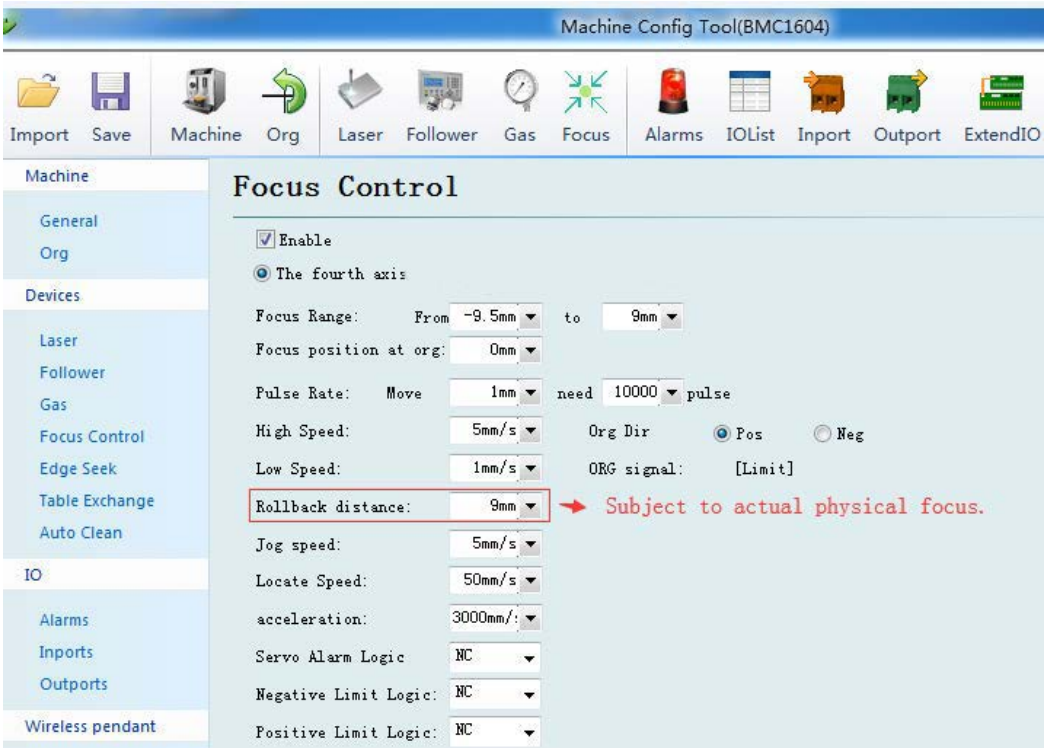
1.Connect to DC24 power

2.Do Not connect W+ W- first

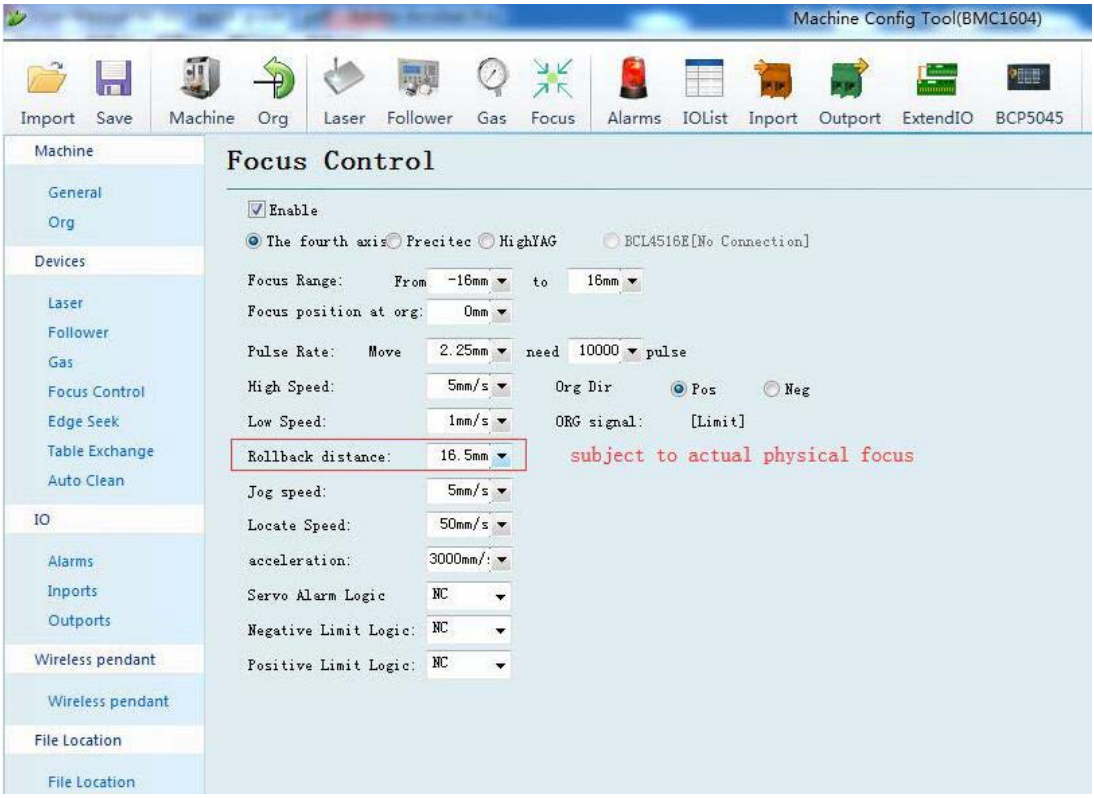
3.Laser head scale 0 should be at the middle of the window

## Steps

1.Choose “Direct Voltage” on multimeter, 200V or high position.
2.Connect the red probe to DC24V end, connect the black probe to W+ end (laser head wire side).
3.Displayed voltage higher than 18V is normal (theoretical value is 24V); displayed voltage higher than 14V is abnormal (theoretical value is 0V).
4.Inch at the positive direction, if voltage changes, and the differential voltage is higher than 12V, it is normal.
5.Connect the red probe to DC24V end, connect the black probe to W- end (laser head wire side).
6.Displayed voltage higher than 18V is normal (theoretical value is 24V); displayed voltage higher than 14V is abnormal (theoretical value is 0V).
7.Inch at the positive & negative direction successively, if voltage changes, and the differential voltage is higher than 12V, it is normal.
8.Connect W+ & W- to corresponding ports on the system expansion card.
9.Open the control software, set limit logic to normal closed. Inch to positive & negative limit, observe whether the system can detect the limits.
10.Above is the check method of normal closed limit switch; for checking normal open limit switch is on the contrary.




Note: 1.This parameter is default value; when user changes it, please avoid hard ware damage;
2 . Please contact technicist to get specific parameters of different lens combinations.




Note: 1.This parameter is default value; when user changes it, please avoid hard ware damage;
2. Please contact technicist to get specific parameters of different lens combinations.

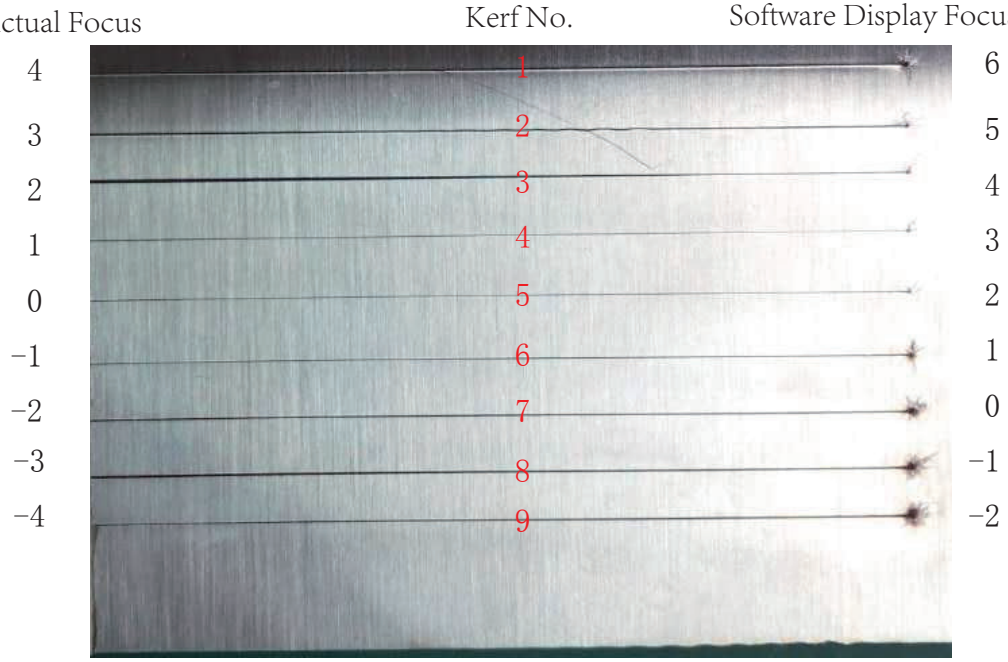
Purpose: To revise “Rollback distance”, and make actual physical focus coincided with software focus which as standard of follow-up technological adjustment.

Method:1.With cutting kerf method, judge the focus position by the width of cutting kerf. The cutting kerf at the focus position is the narrowest.
2.Revise “Rollback distance”, and make actual physical focus coincided with software focus which as standard of follow-up technological adjustment.

For example: 1. Platform setting: 

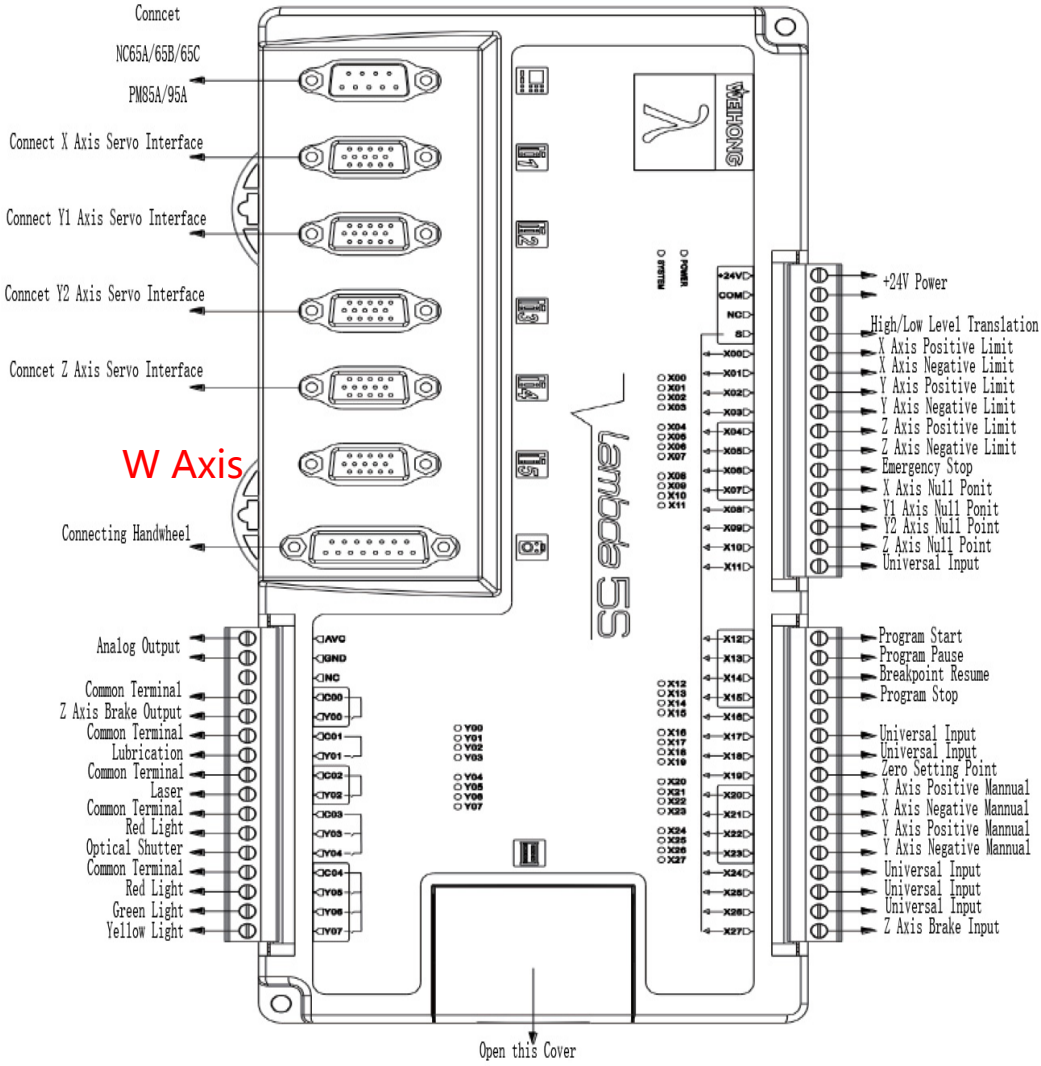

2.Start cutting from software focus +6 with an interval of 1mm, keep cutting to focus -2. If the 5th kerf is the narrowest, the actual focus 0 is at the position of current software displayed focus +2.
3.Revise: If actual focus is higher than software displayed focus, then
Rollback distance (correct) = Rollback distance (setting) - value difference
Rollback distance = 9 - 2 = 7
Vice versa.

Cutting kerf Method



## Weihong Expansion Board 1

# Terminal Board Wiring Diagram




Connect Expansion Terminal Board EX30A5

Fig 4-1 Laser Cutting System (Double Y) Lambda Controller Connection Diagram

## Weihong Expansion Board 2

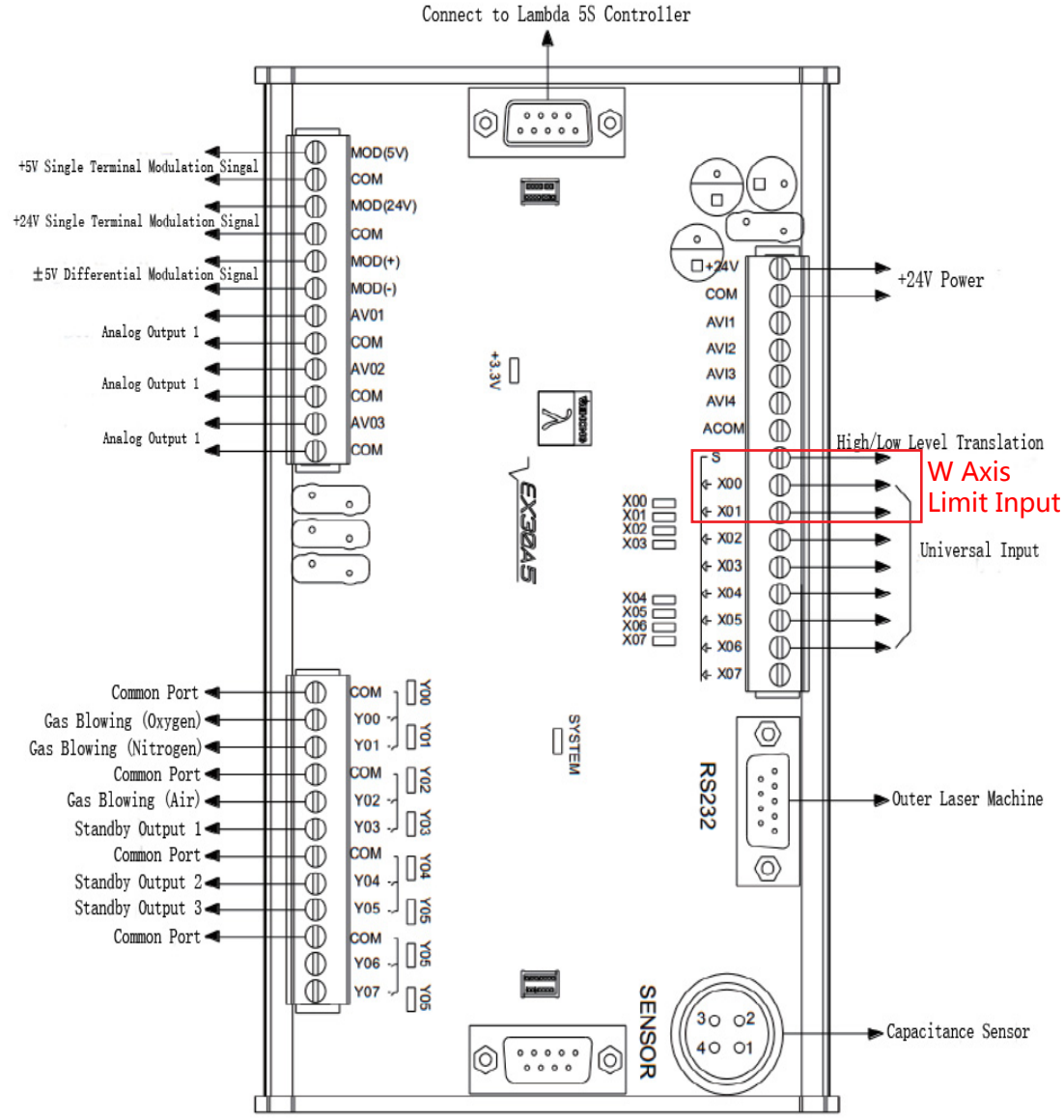
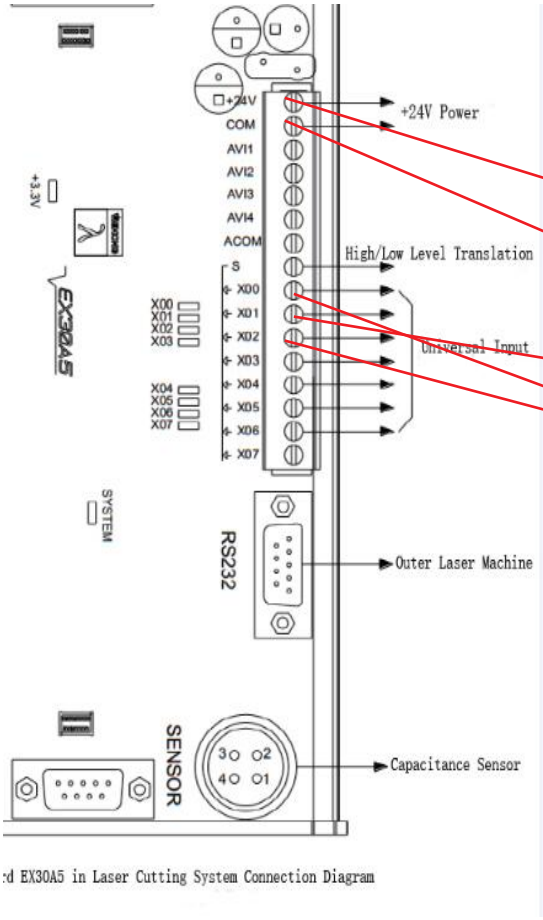
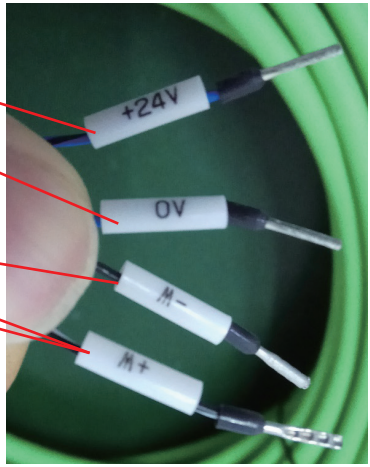



Fig 4-2 Expansion Terminal Board EX30A5 in Laser Cutting System Connection Diagram




:d EX30A5 in Laser Cutting System Connection Diagram

Connect +24V Cable to "+24V" Port & S Port on the Board




Connect W- to "x01" Port;
Connect W+ to "x00" & "x02"

## Limit Logic Parameter Setting

| | | | | |
|---|---|---|---|---|
| EX00 | P | 00072 | E,F:16ms S:4ms | W Axis Pos Limit |
| EX01 | P | 00073 | E,F:16ms S:4ms | W Axis Neg Limit |
| EX02 | P | 00074 | E,F:16ms S:4ms | W Axis Null Point |

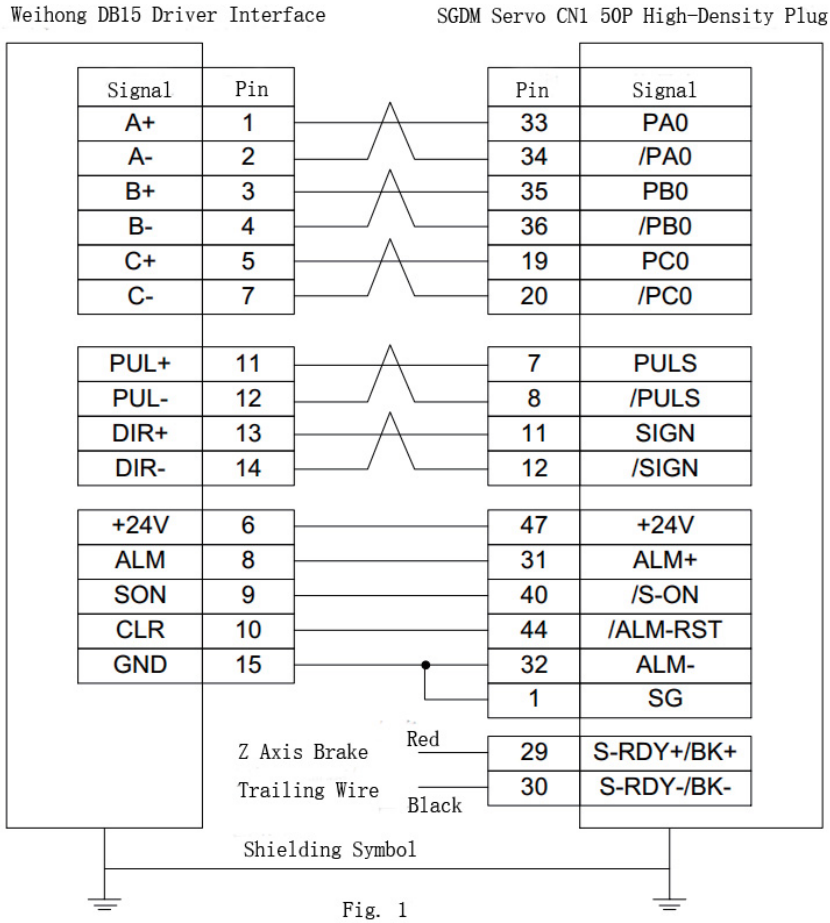



Fig. 1

| Parameter | Value | Parameter | Value | Parameter | Value |
|---|---|---|---|---|---|
| PN000 | 0010 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |

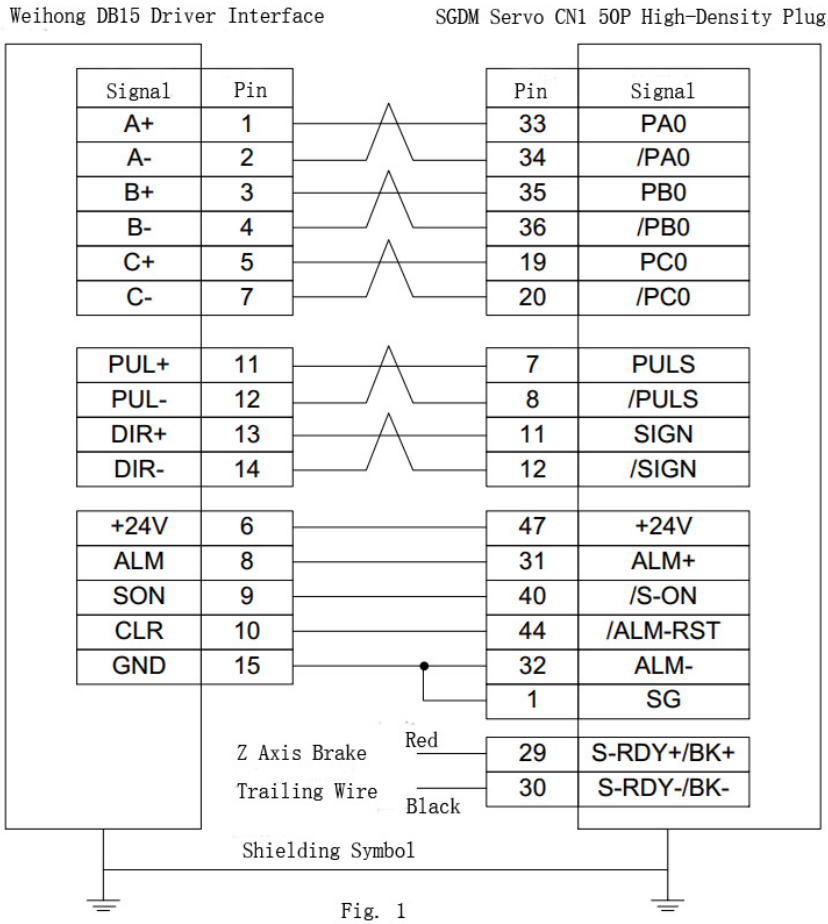



Fig. 1

| Parameter | Value | Parameter | Value | Parameter | Value |
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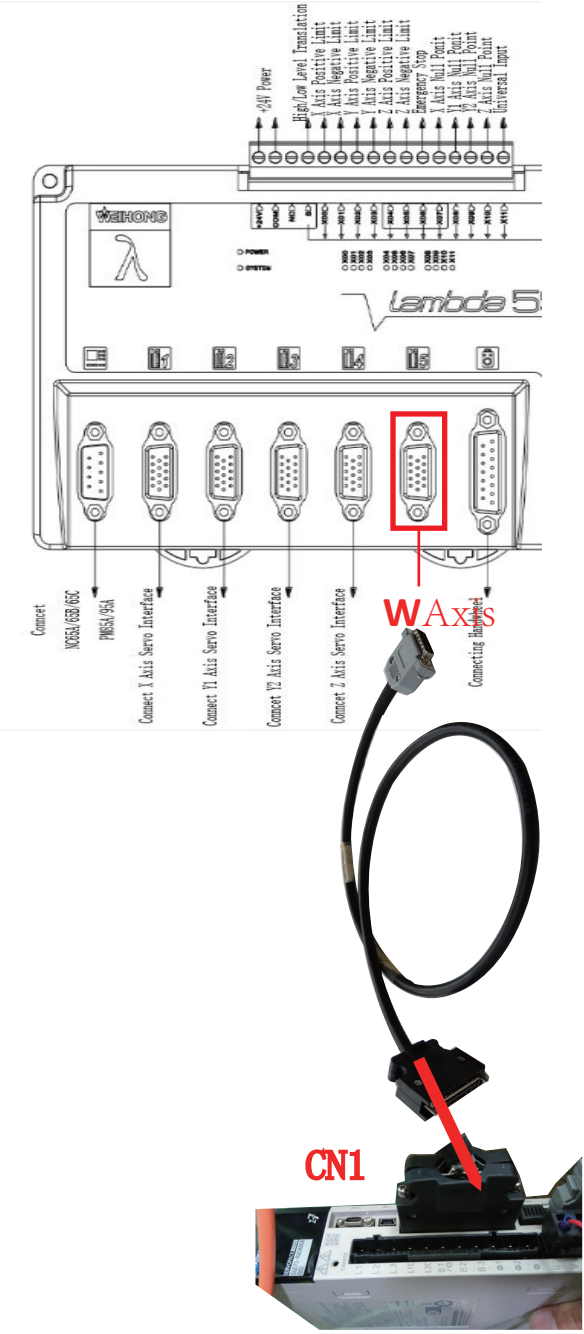
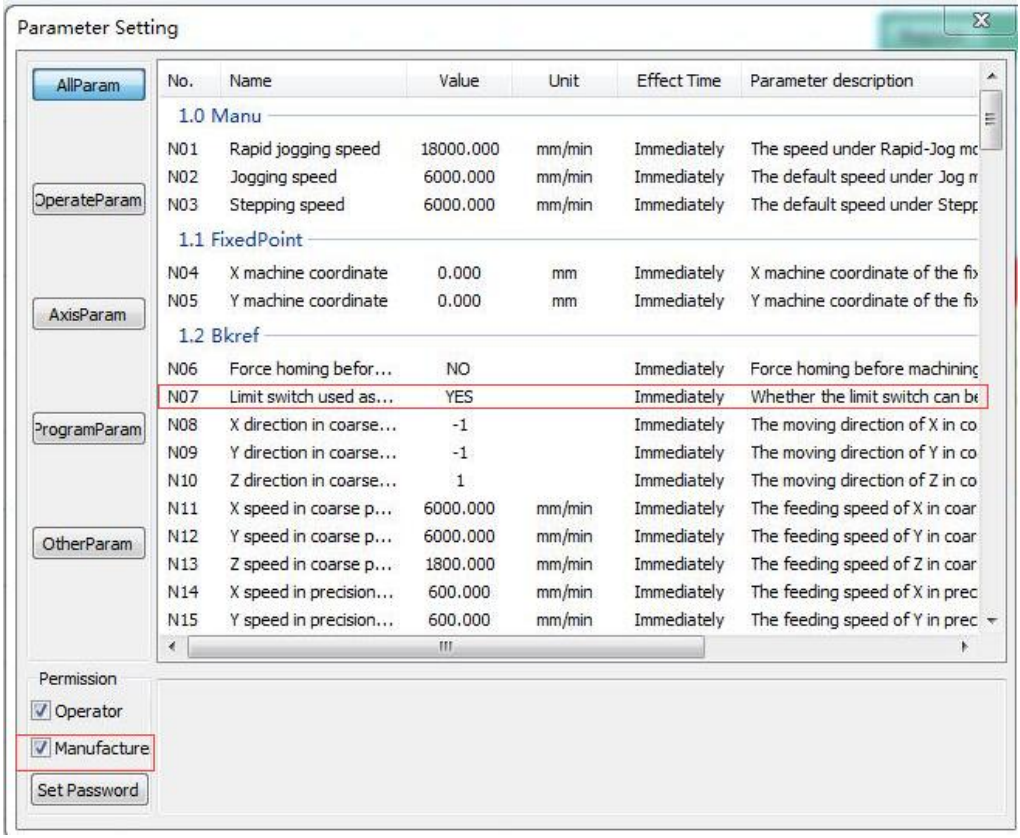
| PN000 | 0011 | PN170 | 1400 | PN402 | 50 |
| PN00B | 0101 | PN200 | 0000 | PN403 | 50 |
| PN100 | 120 | PN20E | 4194304 | PN406 | 100 |
| PN102 | 180 | PN210 | 2500 | PN50A | 8100 |
| PN103 | 100 | PN212 | 2500 | PN50B | 6548 |


+24V Power
High/Low Level Translation
X Axis Positive Limit
X Axis Negative Limit
Y Axis Positive Limit
Y Axis Negative Limit
Z Axis Positive Limit
Z Axis Negative Limit
Emergency Stop
X Axis Null Point
Y1 Axis Null Point
Z Axis Null Point
Universal Input
WEIHONG
POWER
SYSTEM
lambda 5
Connect
MODBUS/USB/485
PMSM/BSM
Connect X Axis Servo Interface
Connect Y1 Axis Servo Interface
Connect Y2 Axis Servo Interface
Connect Z Axis Servo Interface
Connecting Handwheel
W Axis
CN1

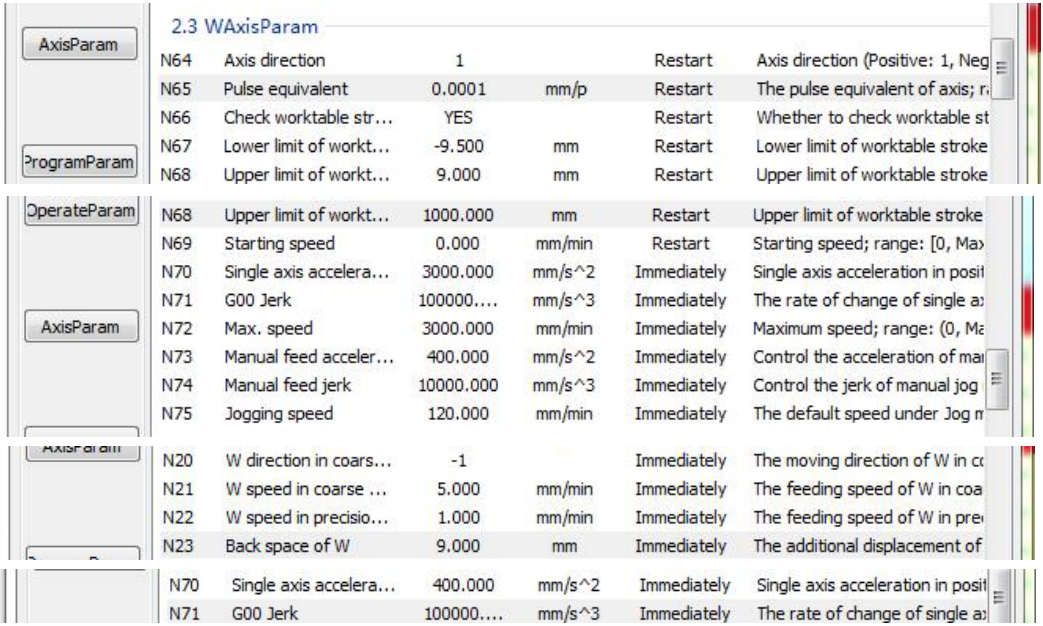


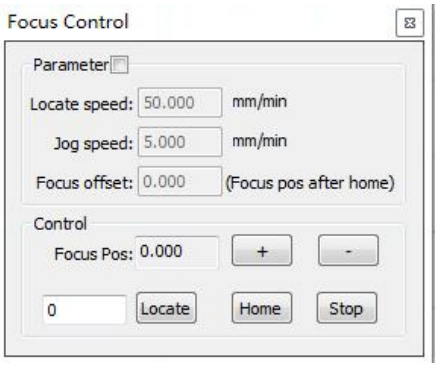

## Limit Logic Parameter Configuration

## W Axis Configuration (NC30)

1. Default direction of N59 & N20 are opposite, when N59 is 1, N20 should be -1.

2. Default rollback direction is positive direction.

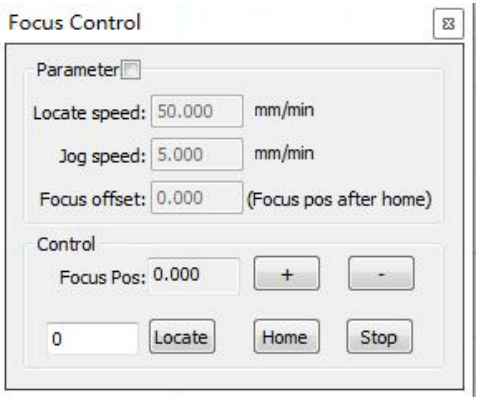


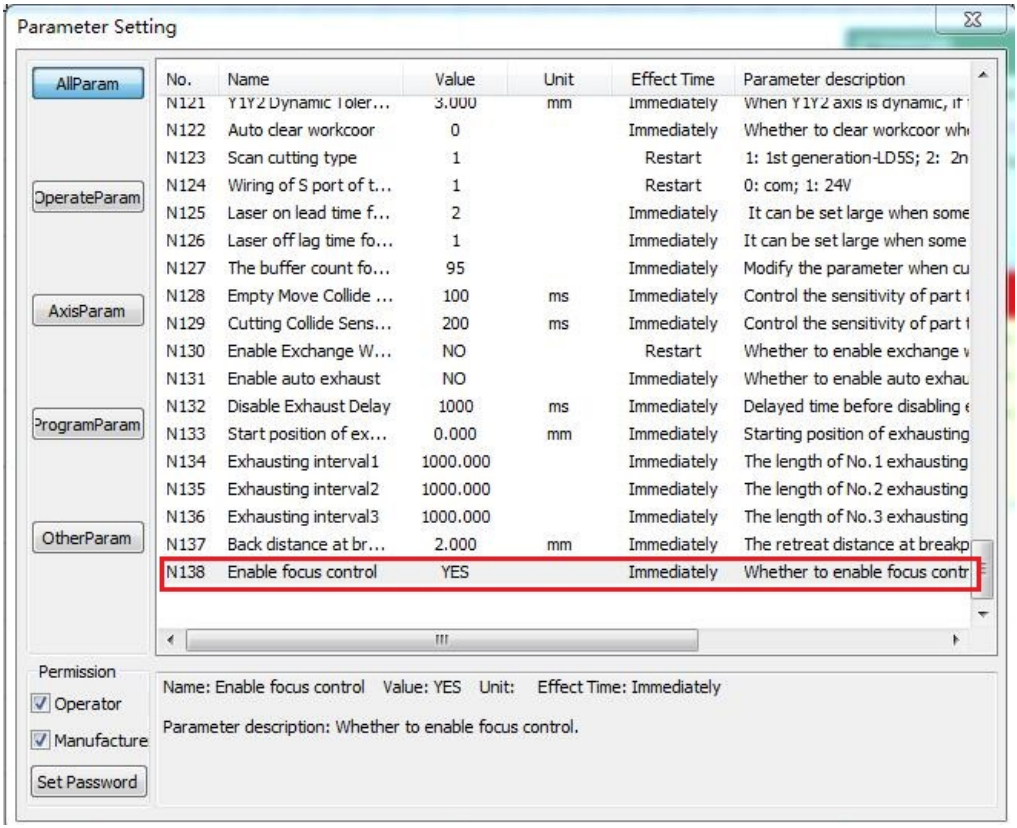



## W Axis Configuration (NC60)

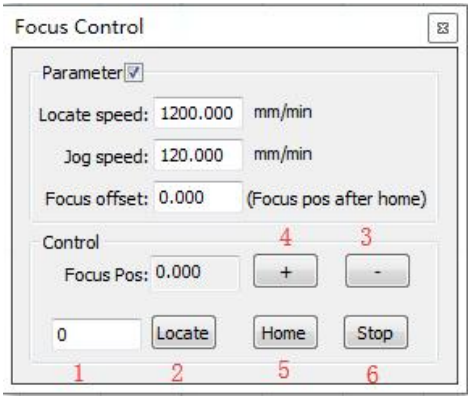
1. Default direction of N59 & N20 are opposite, when N59 is 1, N20 should be -1.

2. Default rollback direction is positive direction.

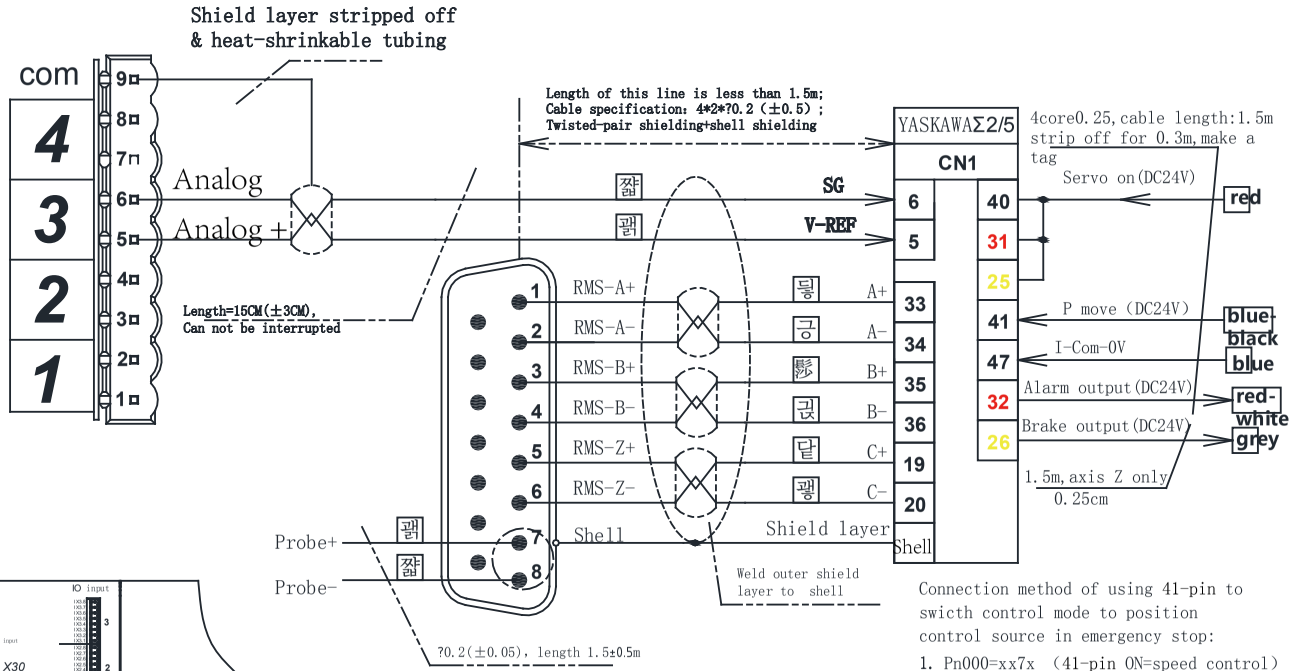



Choose YES for N138;then the Forth Axis(W) will be enable.



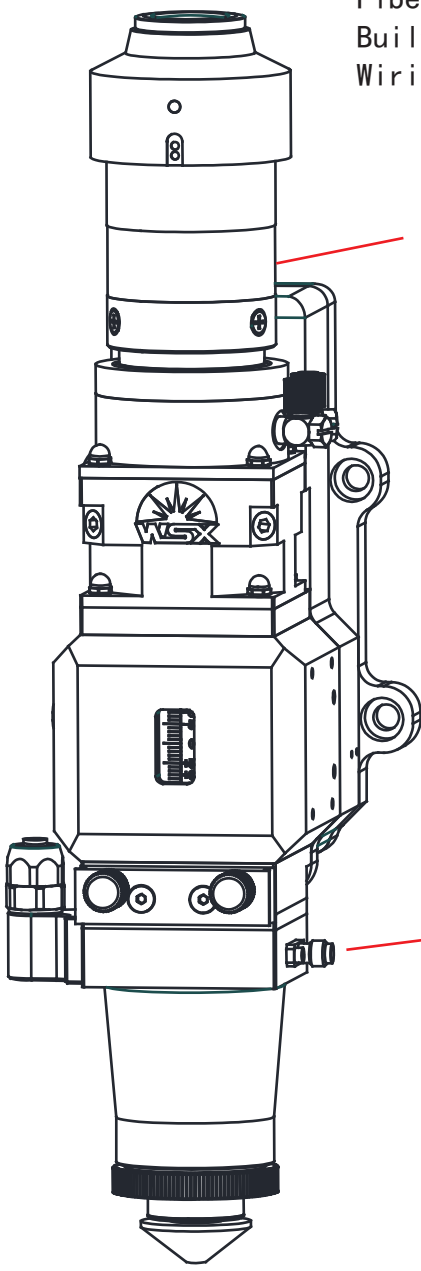

1. Target Focus Input Box & Focus Position Display Box
2. Execute Button
3. Negative Focus Moving
4. Positive Focus Moving
5. Rollback
6. Stop

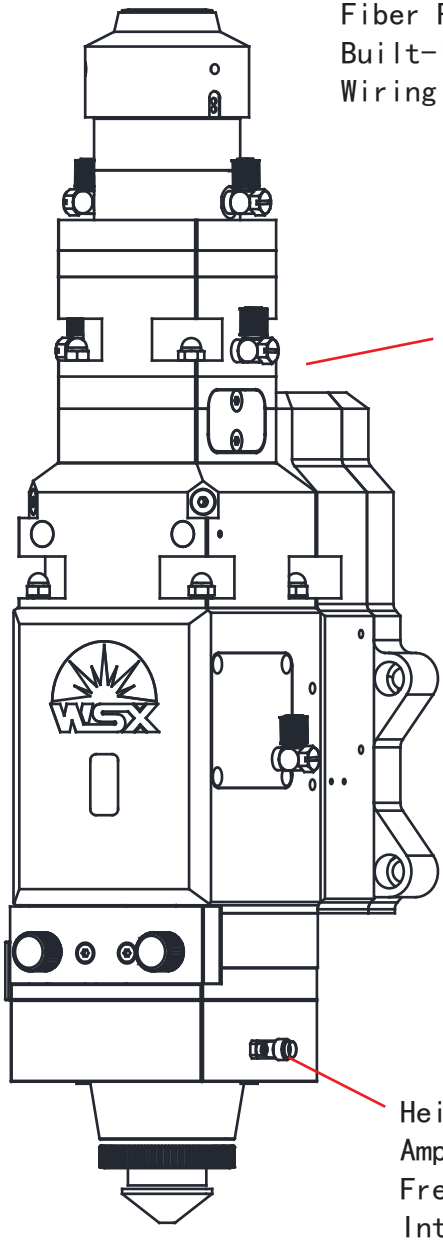
| Malfunction | Reason Analysis | Method |
|---|---|---|
| A.0b0 | Servo ON instruction invalid alarm, after executing auxiliary function of electrifying the motor, servo NO input (/S-ON) signal is inputted from host device. | Electrify again |
| A.100 | 1.Check whether it is short circuited between U V W, check whether it is short circuited between U V W to ground (outer shell)<br>2.U V W phase sequence is incorrect. | 1.If short circuited, replace cables or send it to factory for repair.<br>2.Adjust phase sequence.<br>Check according to P8. |
| A.410 | 1.L1C / L2C has not connect to AC power supply.<br>2.Abnormal voltage, or driver damaged by short circuited. | 1.Wiring according P6.<br>2.Send it to factory for repair. |
| A.710 | Overload, limit invalided or disconnected make the mechanical parts get to the end. | Check limit signal according P14 & P21. |
| A.840 | 1.Encoder data alarm<br>2.Abnormal voltage leads to encoding module damage. | 1.Check whether encoding cable connection is normal.<br>2.Send it to factory for repair. |
| A.C90 | Encoder and servo unit can not communicate. | 1.Check whether encoding cable connection is normal.<br>2. Replace cable.<br>3. Send it to factory for repair. |
| Positive & negative limit both alarm | 1.Software logic is incorrect.<br>2.Limit signal cable connection is incorrect. | 1.Reverse limit logic.<br>2.Check according P14 & P21. |




| |
|---|
| 15P plastic shell side-stripped 2±0.2cm, twine with insulated tape for 10 circle, twine tool setting gauge 8 circle |
| 15P plastic shell side-stripped 2±0.2cm, twine with insulated tape for 10 circle, twine tool setting gauge 8 circle |
| 50P plug side-stripped 3±0.2cm, twine with insulated tape for 17 circle |
| 50P specification of plug fly line is 1*?0.2(±0.05), length is 1.5±0.5m |
| Among all cables there shall not be any break or welding |
| Axis Z kit must be welded to brake and probe connection |

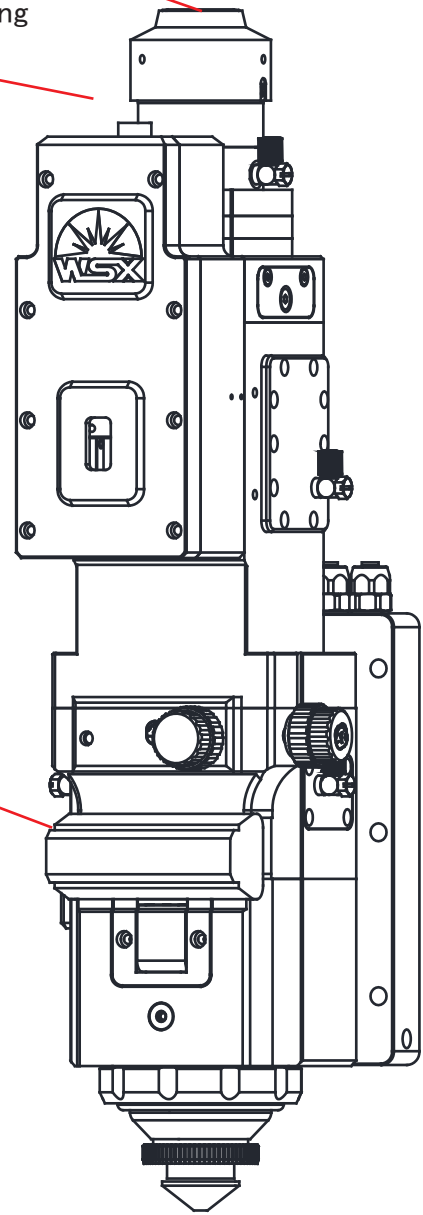
# NC12,NC30B,NC60B


QB Interface:
Fiber Rod Access;
Built-in Terminal Board
Wiring Diagram
10P Aviation Plug
Height Adjustment
Amplifier Radio
Frequency Line Interface


QB Interface:
Fiber Rod Access;
Built-in Terminal Board
Wiring Diagram
10P Aviation Plug
Height Adjustment
Amplifier Radio
Frequency Line
Interface

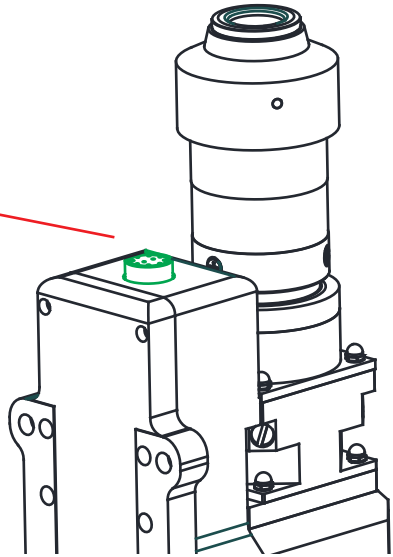
QB Interface:
Fiber Rod Access;
Built-in Terminal Board Wiring Diagram

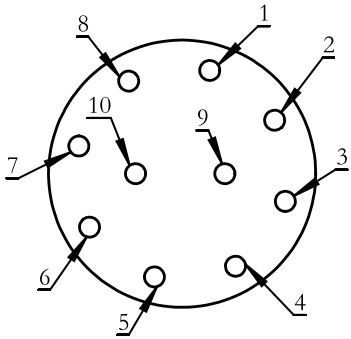
10P Aviation Plug



Height Adjustment
Amplifier Radio Frequency Line Interface

10P Aviation Plug






| 10P Aviation Plug | |
|---|---|
| Pin | Signal |
| 1 | Null |
| 2 | A+(Stepper Motor A Phase Power Line) |
| 3 | A-(Stepper Motor A Phase Power Line) |
| 4 | B+(Stepper Motor B Phase Power Line) |
| 5 | B-(Stepper Motor B Phase Power Line) |
| 6 | +24V(Approach Switch Power Line) |
| 7 | 0V(Approach Switch Power Line) |
| 8 | W+(Approach Switch Signal Line) |
| 9 | W-(Approach Switch Power Line) |
| 10 | Null |

Motor Power Supply & Approach Swicth Interface (Green)

## Friendess

Friendess D15 Servo Control Interface

| Signal | Pin |
|---|---|
| PUL+ | 1 |
| PUL- | 9 |
| DIR+ | 2 |
| DIR- | 10 |
| | |
| A+ | 3 |
| A- | 11 |
| B+ | 4 |
| B- | 12 |
| Z+ | 5 |
| Z- | 13 |
| | |
| | |
| 24V | 8 |
| SON | 6 |
| CLK | 7 |
| ALM | 14 |
| 0V | 15 |

Electric Control Box

| Pin |
|---|
| PUL+(CW+) |
| PUL-(CW-) |
| DIR+(CW+) |
| DIR-(CW-) |
| |
| Null |
| Null |
| Null |
| Null |
| Null |
| Null |
| |
| Null |
| Null |
| Null |
| Null |
| GND |

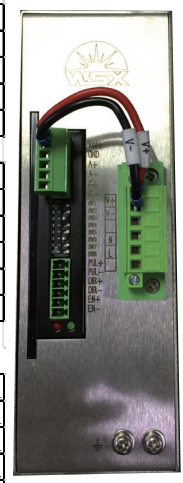
## Weihong

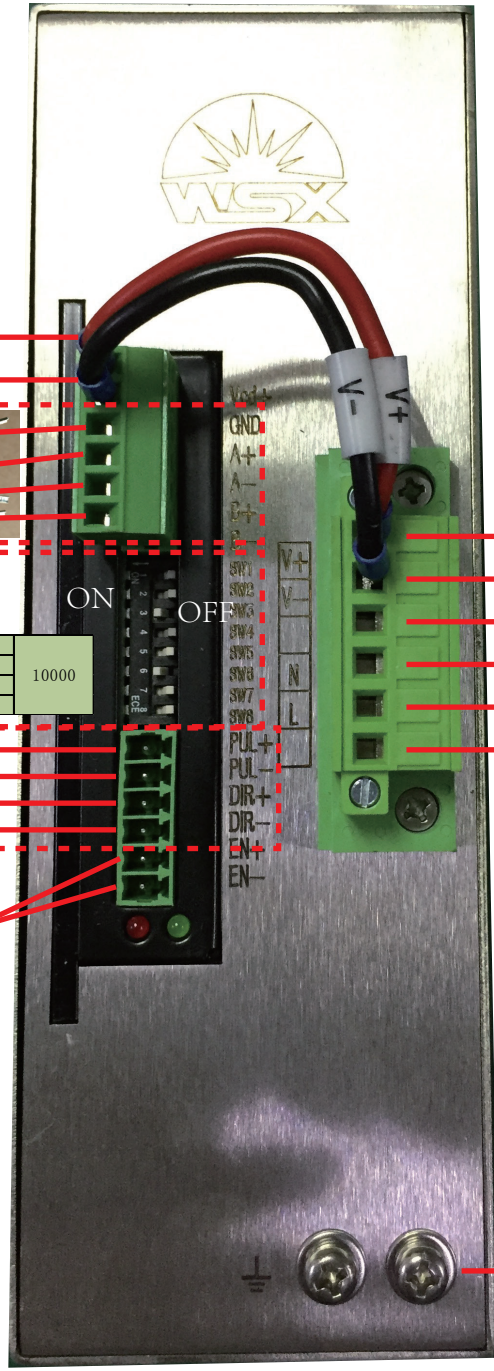
Weihong D15 Servo Control Interface

| Signal | Pin |
|---|---|
| PUL+ | 11 |
| PUL- | 12 |
| DIR+ | 13 |
| DIR- | 14 |
| | |
| A+ | 1 |
| A- | 2 |
| B+ | 3 |
| B- | 4 |
| Z+ | 5 |
| Z- | 7 |
| | |
| | |
| 24V | 6 |
| SON | 9 |
| CLK | 10 |
| ALM | 10 |
| 0V | 15 |

Electric Control Box

| Signal |
|---|
| PUL+(CW+) |
| PUL-(CW-) |
| DIR+(CW+) |
| DIR-(CW-) |
| |
| Null |
| Null |
| Null |
| Null |
| Null |
| Null |
| |
| Null |
| Null |
| Null |
| Null |
| GND |

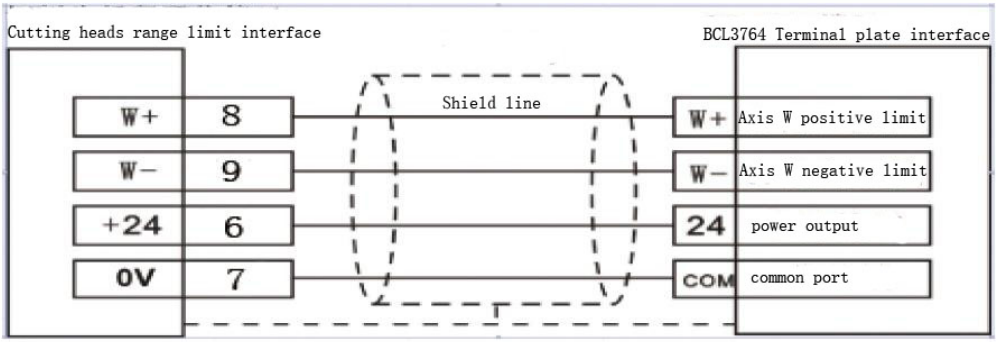




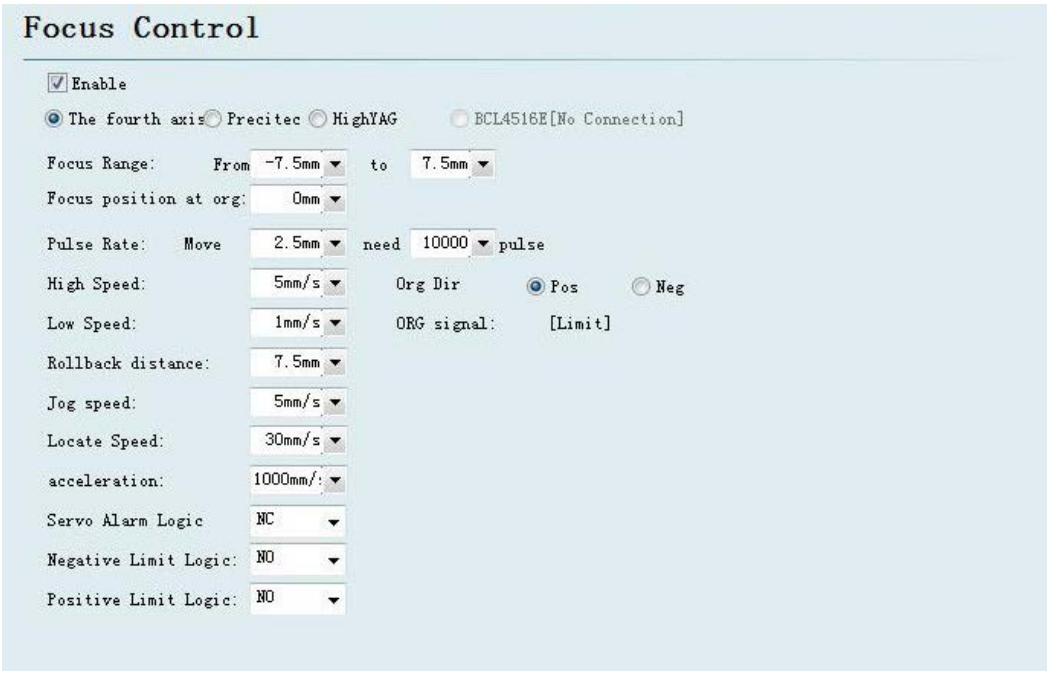

| | | | | | |
|---|---|---|---|---|---|
| SW1 | OFF | 1. 4A | SW5 | OFF | 10000 |
| SW2 | OFF | | SW6 | ON | |
| SW3 | ON | | SW7 | OFF | |
| SW4 | OFF | | SW8 | OFF | |

Note:
1.Definition of driver and motor interface shown in instruction of Moons' Driver MD-2422.
2.Upper GND must be connected to GND of this electric control box.
3.Line inside red dotted box can be not connected; default dangling is enabling.

Definition of laser focusing adjustment range limitation swicth connector

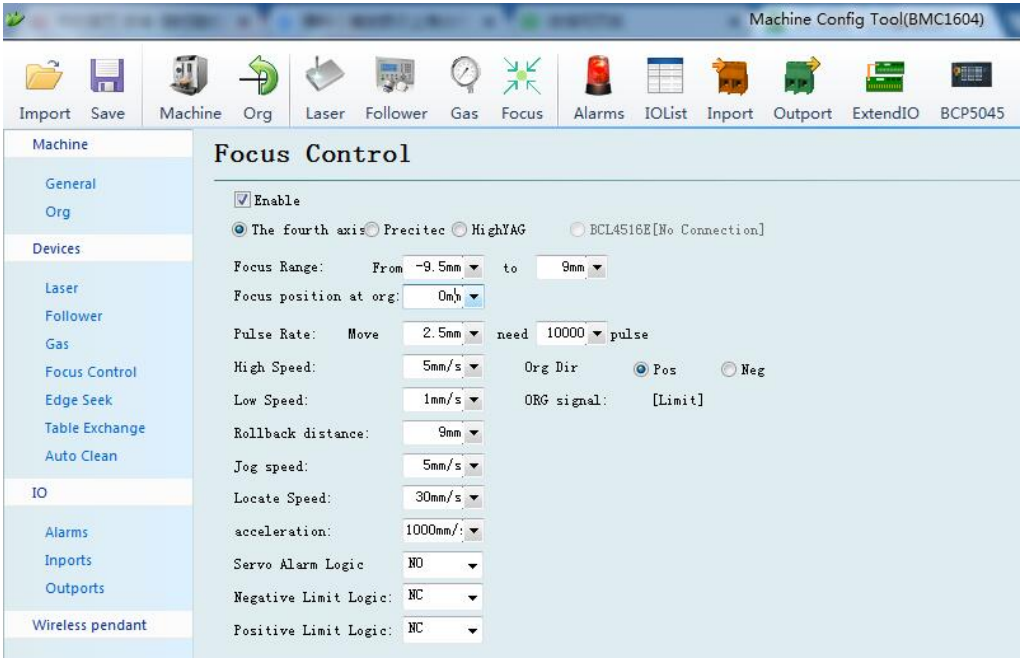



Connection of Limit Signal shown in Page 14 & Page 21

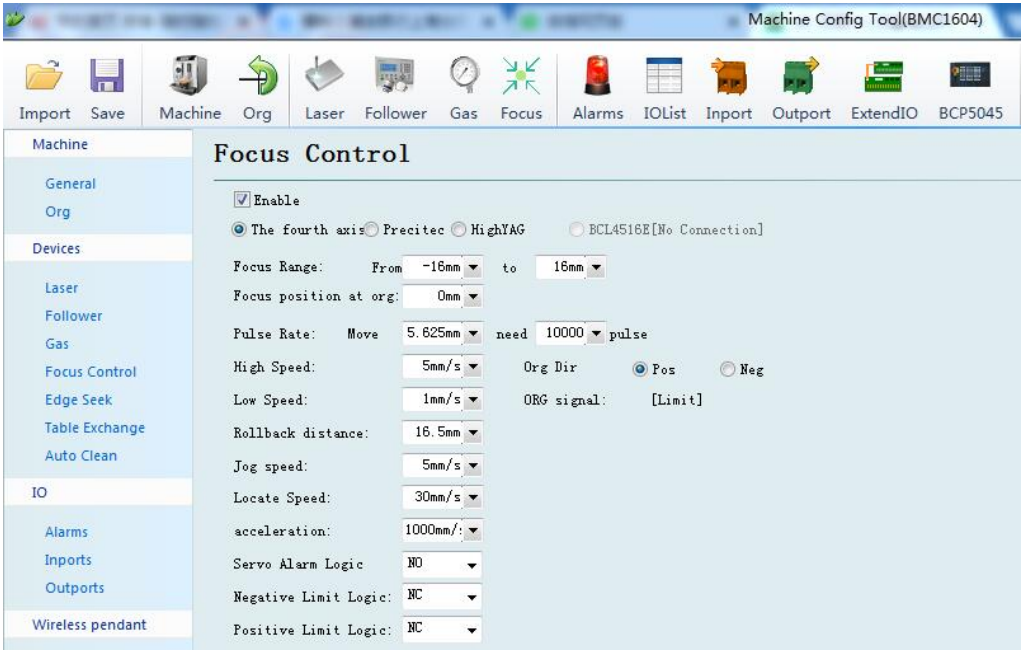



Note: 1.This parameter is default value; when user changes it, please avoid hard ware damage;

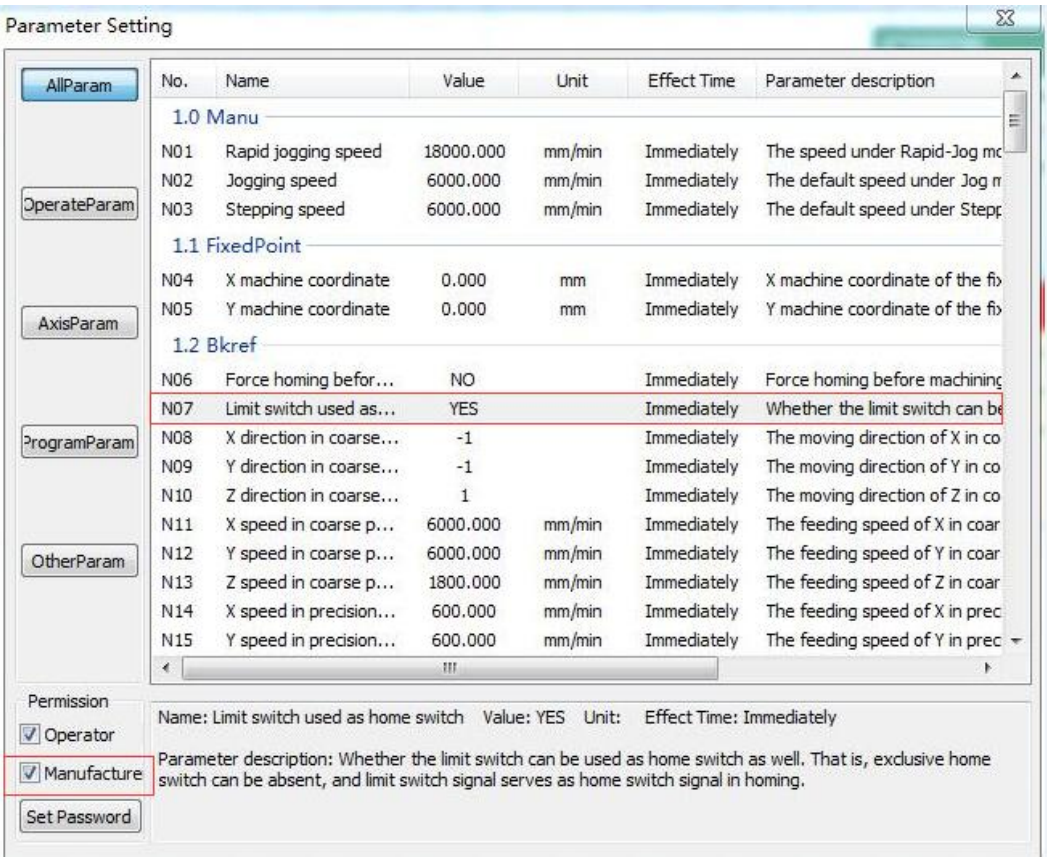
2. Please contact technicist to get specific parameters of different lens combinations.



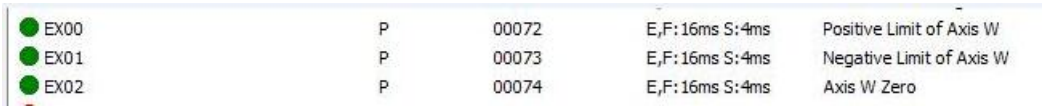

Note: 1.This parameter is default value; when user changes it, please avoid hard ware damage;
2. Please contact technicist to get specific parameters of different lens combinations.




Note: 1.This parameter is default value; when user changes it, please avoid hard ware damage;
2. Please contact technicist to get specific parameters of different lens combinations.

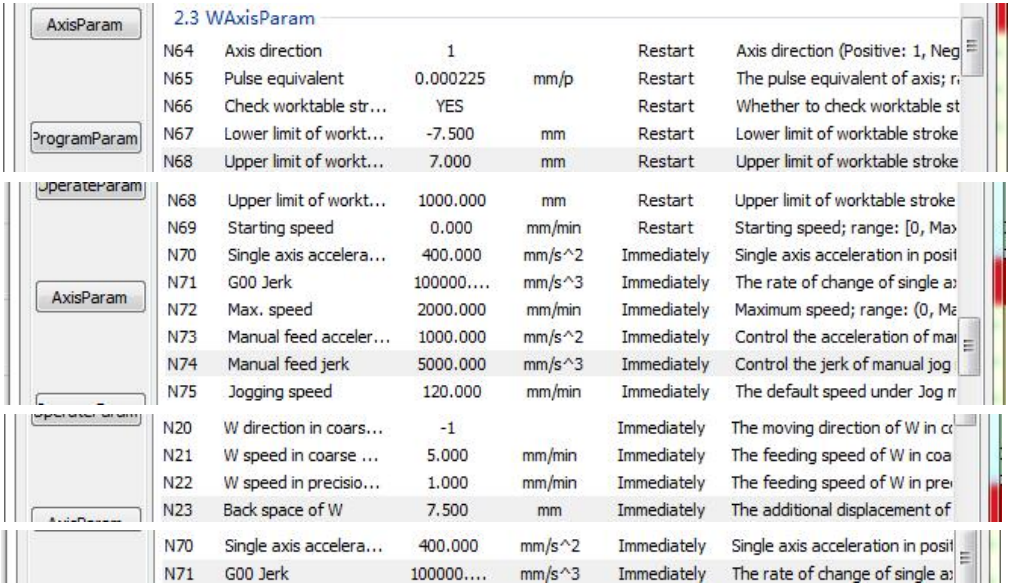


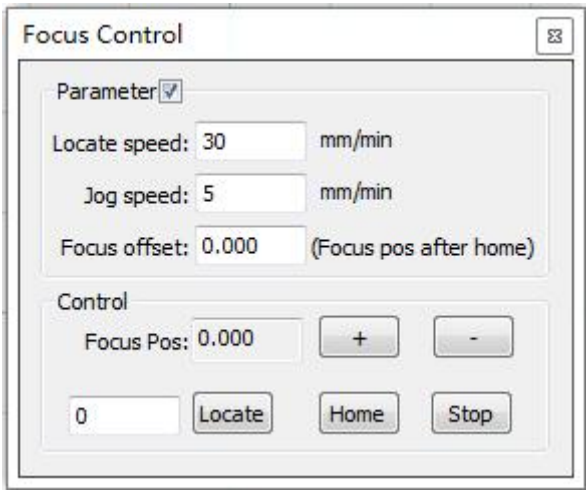

## Limit Logic Parameter Configuration



## W Axis Configuration (NC12)

1. Default direction of N59 & N20 are opposite, when N59 is 1, N20 should be -1.
2. Default rollback direction is positive direction.



## W Axis Configuration (NC30B)

1. Default direction of N59 & N20 are opposite, when N59 is 1, N20 should be -1.
2. Default rollback direction is positive direction.

2.3 WAxisParam

| | | | | | |
|---|---|---|---|---|---|
| N64 | Axis direction | 1 | | Restart | Axis direction (Positive: 1, Neg |
| N65 | Pulse equivalent | 0.000225 | mm/p | Restart | The pulse equivalent of axis; r |
| N66 | Check worktable str... | YES | | Restart | Whether to check worktable st |
| N67 | Lower limit of workt... | -9.500 | mm | Restart | Lower limit of worktable stroke |
| N68 | Upper limit of workt... | 9.000 | mm | Restart | Upper limit of worktable stroke |

OperateParam

| | | | | | |
|---|---|---|---|---|---|
| N68 | Upper limit of workt... | 1000.000 | mm | Restart | Upper limit of worktable stroke |
| N69 | Starting speed | 0.000 | mm/min | Restart | Starting speed; range: [0, Max |
| N70 | Single axis accelera... | 400.000 | mm/s^2 | Immediately | Single axis acceleration in posit |
| N71 | G00 Jerk | 100000.... | mm/s^3 | Immediately | The rate of change of single ax |
| N72 | Max. speed | 2000.000 | mm/min | Immediately | Maximum speed; range: (0, Ma |
| N73 | Manual feed acceler... | 1000.000 | mm/s^2 | Immediately | Control the acceleration of ma |
| N74 | Manual feed jerk | 5000.000 | mm/s^3 | Immediately | Control the jerk of manual jog |
| N75 | Jogging speed | 120.000 | mm/min | Immediately | The default speed under Jog m |

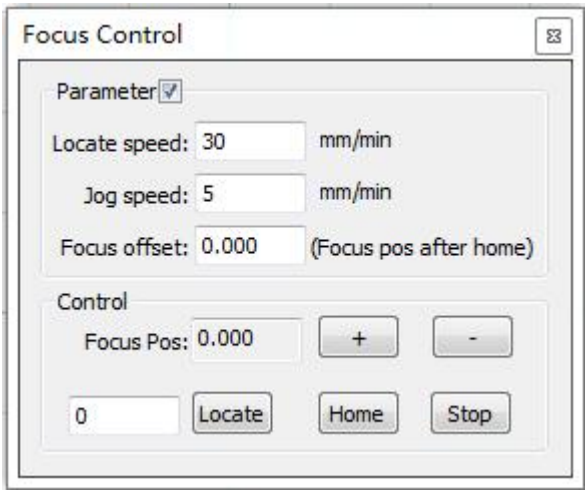
OperateParam

AxisParam

| | | | | | |
|---|---|---|---|---|---|
| N20 | W direction in coars... | -1 | | Immediately | The moving direction of W in co |
| N21 | W speed in coarse ... | 5.000 | mm/min | Immediately | The feeding speed of W in coa |
| N22 | W speed in precisio... | 1.000 | mm/min | Immediately | The feeding speed of W in pre |
| N23 | Back space of W | 9.000 | mm | Immediately | The additional displacement of |

OperateParam

| | | | | | |
|---|---|---|---|---|---|
| N70 | Single axis accelera... | 400.000 | mm/s^2 | Immediately | Single axis acceleration in posit |
| N71 | G00 Jerk | 100000.... | mm/s^3 | Immediately | The rate of change of single ax |



## W Axis Configuration (NC60B)

1. Default direction of N59 & N20 are opposite, when N59 is 1, N20 should be -1.
2. Default rollback direction is positive direction.

2.3 WAxisParam

OperateParam

| | | | | | |
|---|---|---|---|---|---|
| N64 | Axis direction | 1 | | Restart | Axis direction (Positive: 1, Neg |
| N65 | Pulse equivalent | 0.0005625 | mm/p | Restart | The pulse equivalent of axis; r |
| N66 | Check worktable str... | YES | | Restart | Whether to check worktable st |
| N67 | Lower limit of workt... | -16.000 | mm | Restart | Lower limit of worktable stroke |
| N68 | Upper limit of workt... | 16.000 | mm | Restart | Upper limit of worktable stroke |

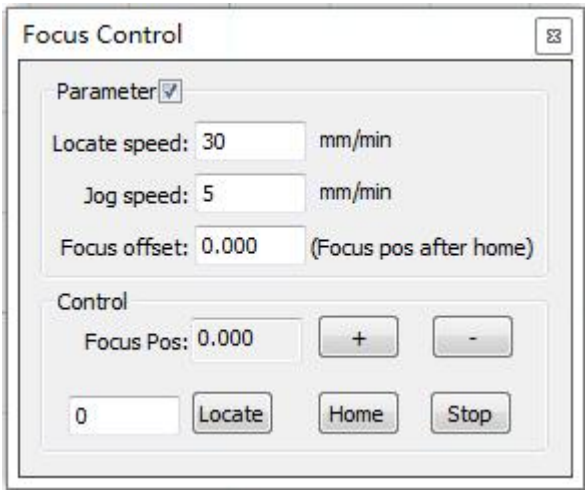
OperateParam

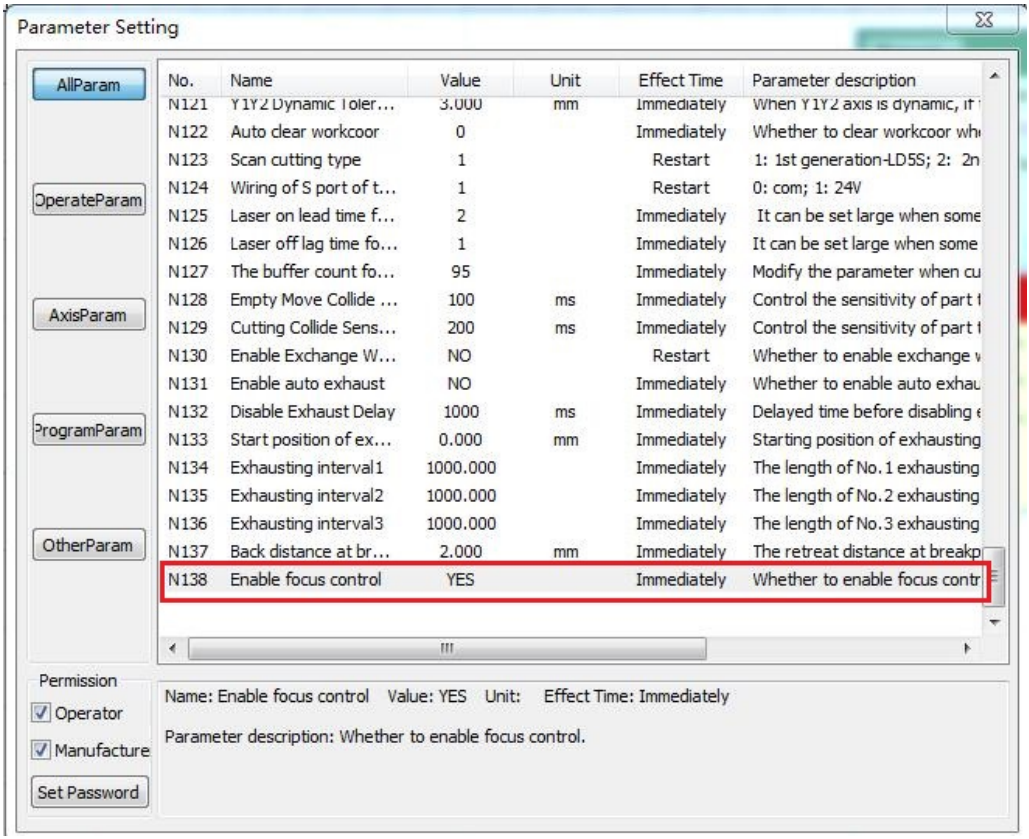
| | | | | | |
|---|---|---|---|---|---|
| N68 | Upper limit of workt... | 1000.000 | mm | Restart | Upper limit of worktable stroke |
| N69 | Starting speed | 0.000 | mm/min | Restart | Starting speed; range: [0, Max |
| N70 | Single axis accelera... | 400.000 | mm/s^2 | Immediately | Single axis acceleration in posit |
| N71 | G00 Jerk | 100000.... | mm/s^3 | Immediately | The rate of change of single a |
| N72 | Max. speed | 2000.000 | mm/min | Immediately | Maximum speed; range: (0, Ma |
| N73 | Manual feed acceler... | 1000.000 | mm/s^2 | Immediately | Control the acceleration of ma |
| N74 | Manual feed jerk | 5000.000 | mm/s^3 | Immediately | Control the jerk of manual jog |
| N75 | Jogging speed | 120.000 | mm/min | Immediately | The default speed under Jog m |

AxisParam

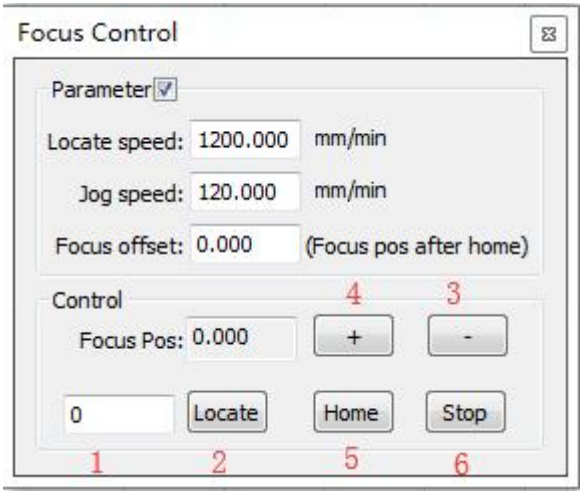
| | | | | | |
|---|---|---|---|---|---|
| N20 | W direction in coars... | -1 | | Immediately | The moving direction of W in c |
| N21 | W speed in coarse ... | 5.000 | mm/min | Immediately | The feeding speed of W in coa |
| N22 | W speed in precisio... | 1.000 | mm/min | Immediately | The feeding speed of W in pre |
| N23 | Back space of W | 16.500 | mm | Immediately | The additional displacement of |

| | | | | | |
|---|---|---|---|---|---|
| N70 | Single axis accelera... | 400.000 | mm/s^2 | Immediately | Single axis acceleration in posit |
| N71 | G00 Jerk | 100000.... | mm/s^3 | Immediately | The rate of change of single a |






Choose YES for N138;then the Forth Axis(W) will be enable.




1. Target Focus Input Box & Focus Position Display Box
2. Execute Button
3. Negative Focus Moving
4. Positive Focus Moving
5. Rollback
6. Stop

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