Service Manual

TM5S / TM7S / TM12S / TM14S

Hardware Version: 5.02

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TECHMAN ROBOT INC.

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Menu

1. Handling components that are sensitive to electrostatic discharge (ESD)

To prevent ESD-sensitive components (e.g., printed circuit boards) from being damaged, please handle the components in the following steps:

- Wear an anti-static wrist strap before replacing ESD sensitive components and make sure the bracket is always connected to ground when replacing components.
- Hold the protective cover for the component's edge connect and avoid touching any exposed part.
- Drop the replaced component into an antistatic bag.

2. Safety information

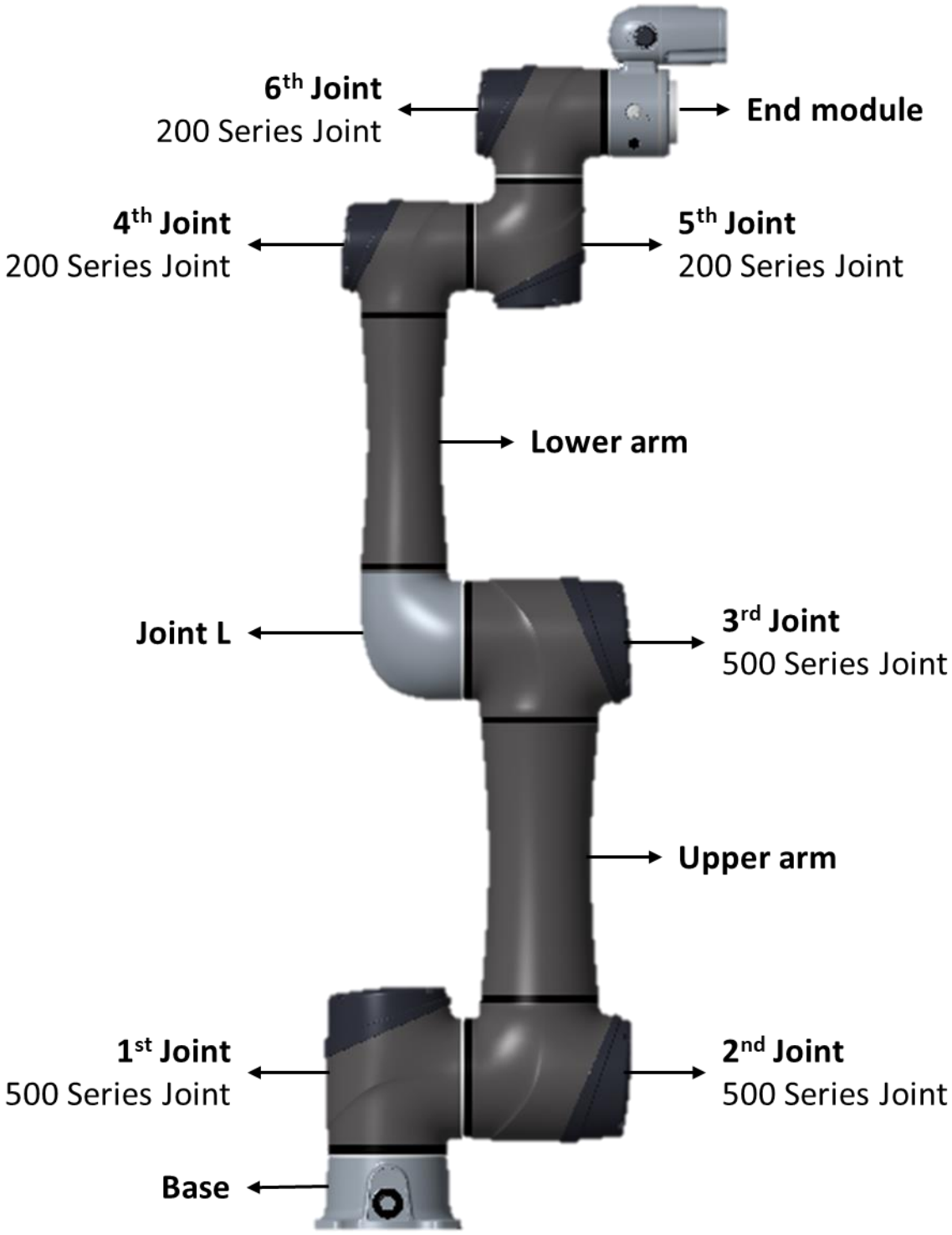
DNAGER：
Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in death or severe property damage.

WARNING:
Identifies a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, and might result in serious injury, death, or significant property damage.

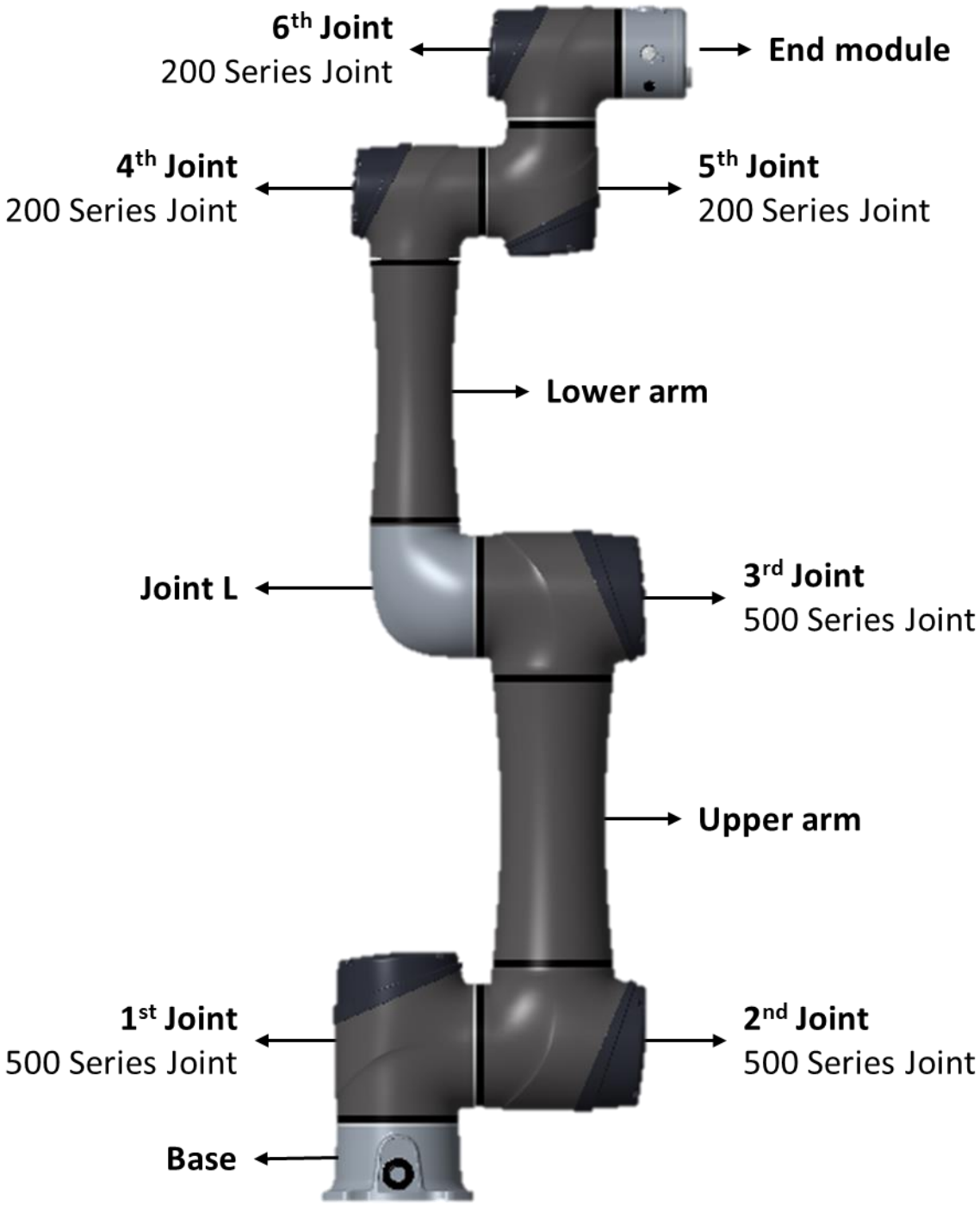
CAUTION:
Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.

3. Description of arm and control box parts

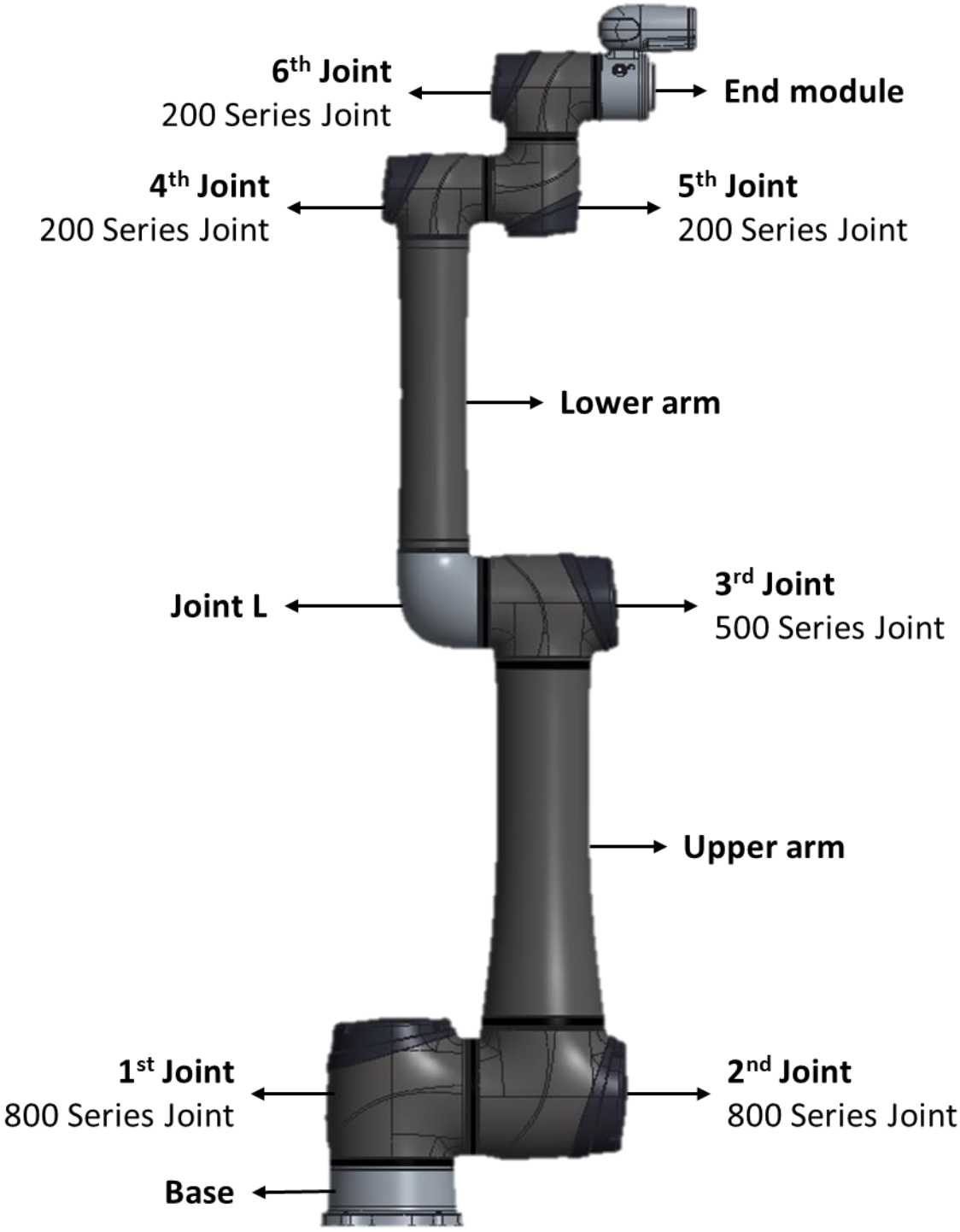
3.1 TM5S、TM7S



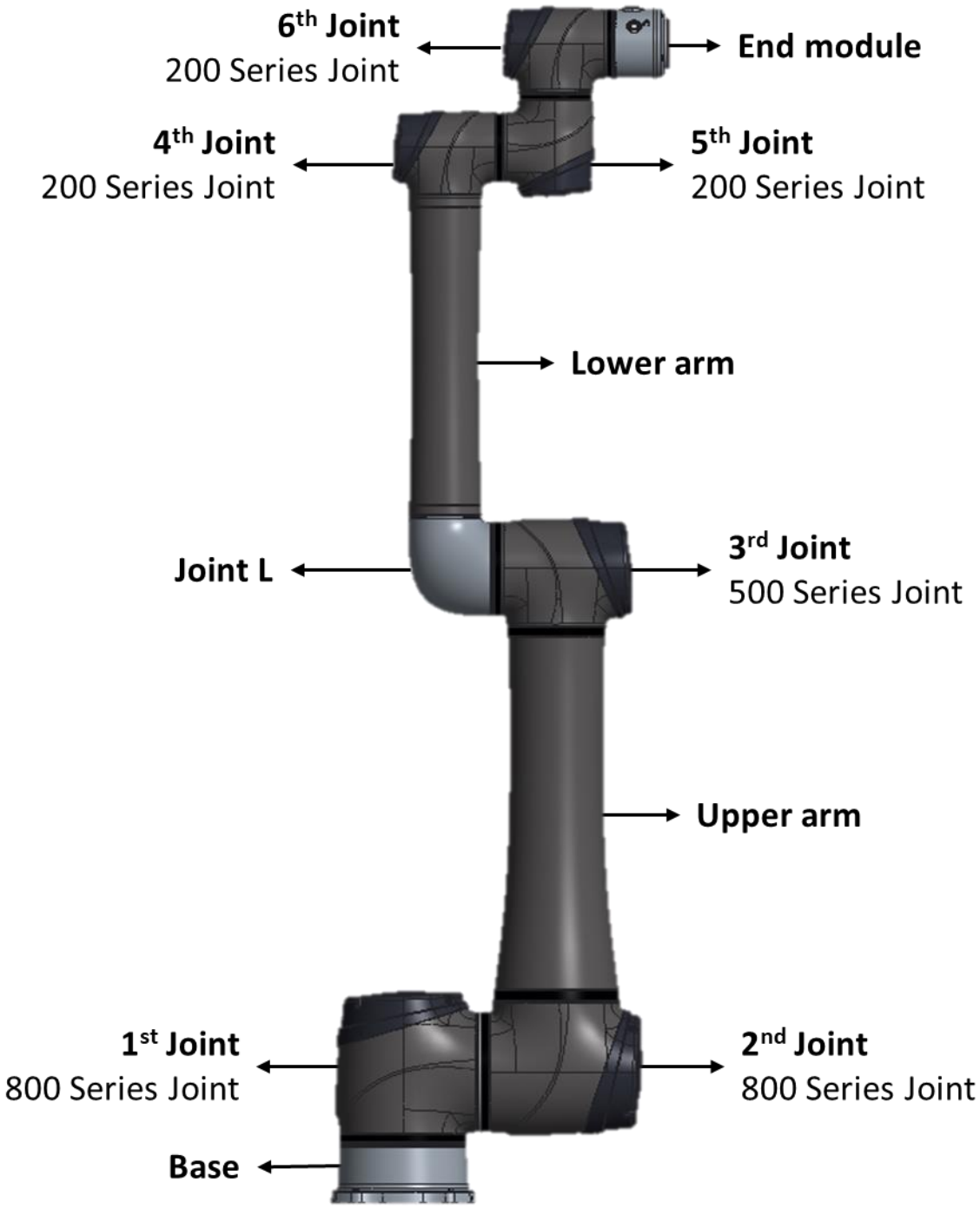
3.2 TM5SX、TM7SX



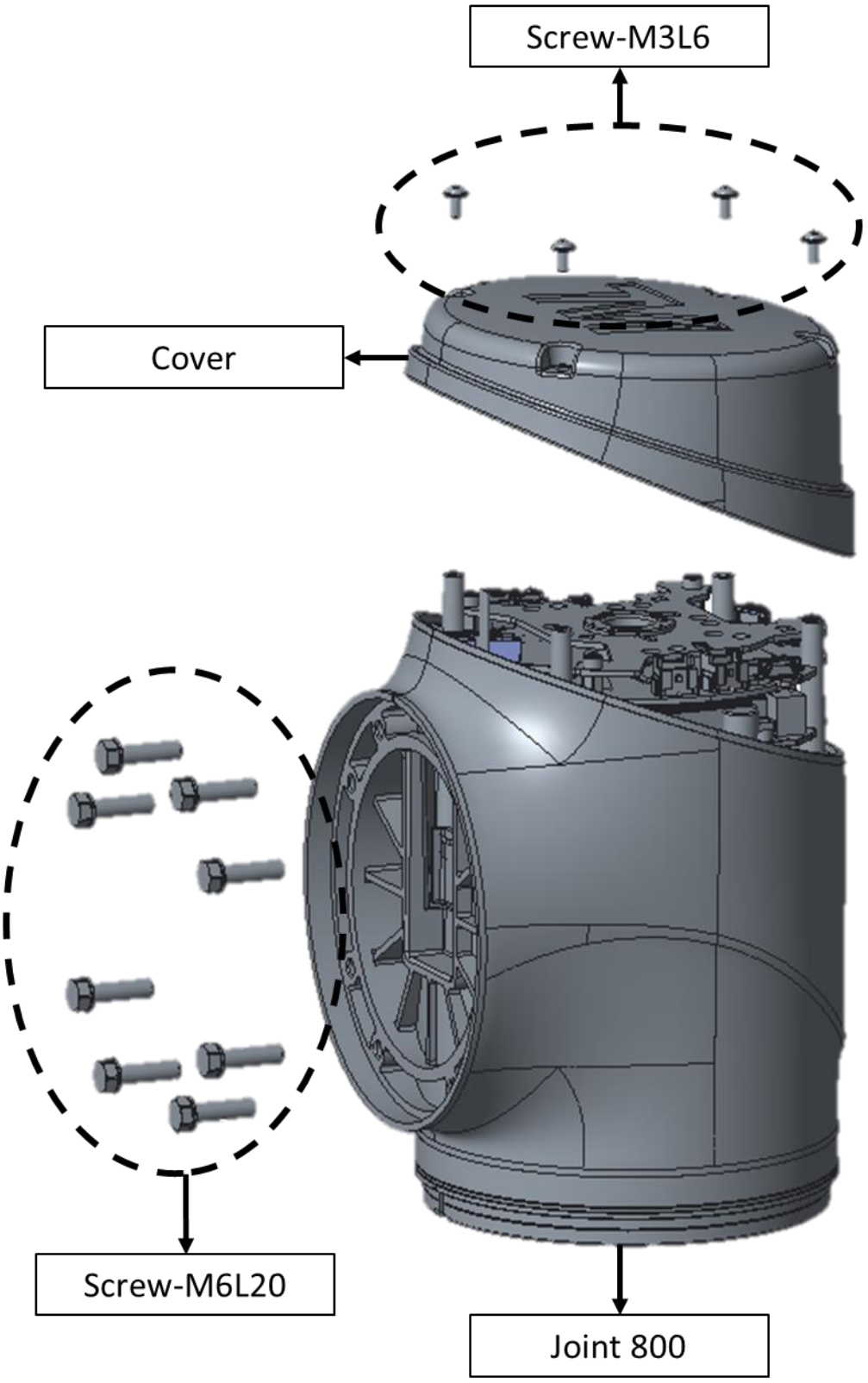
3.3 TM12S/TM14S



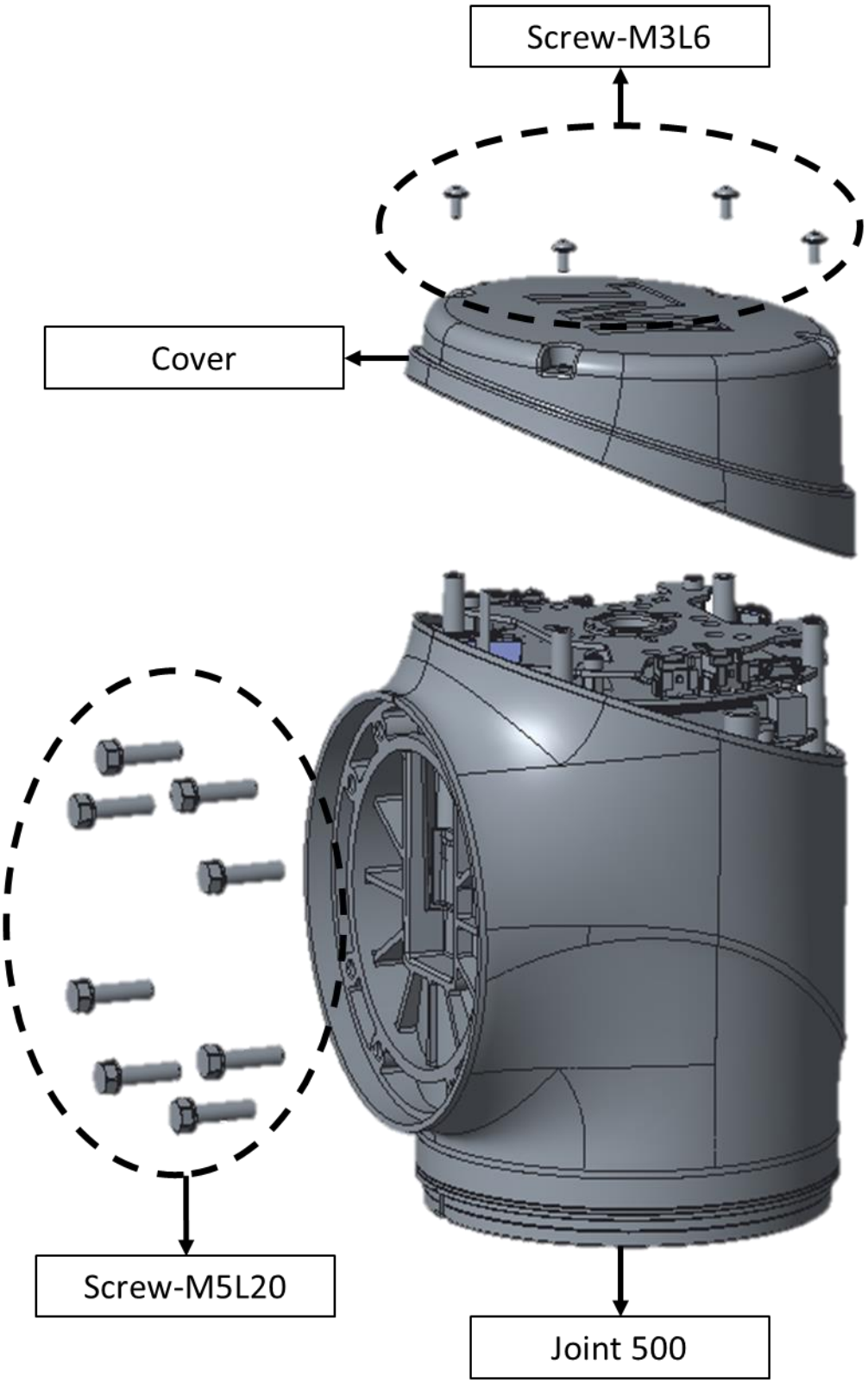
3.4 TM12X/TM14X



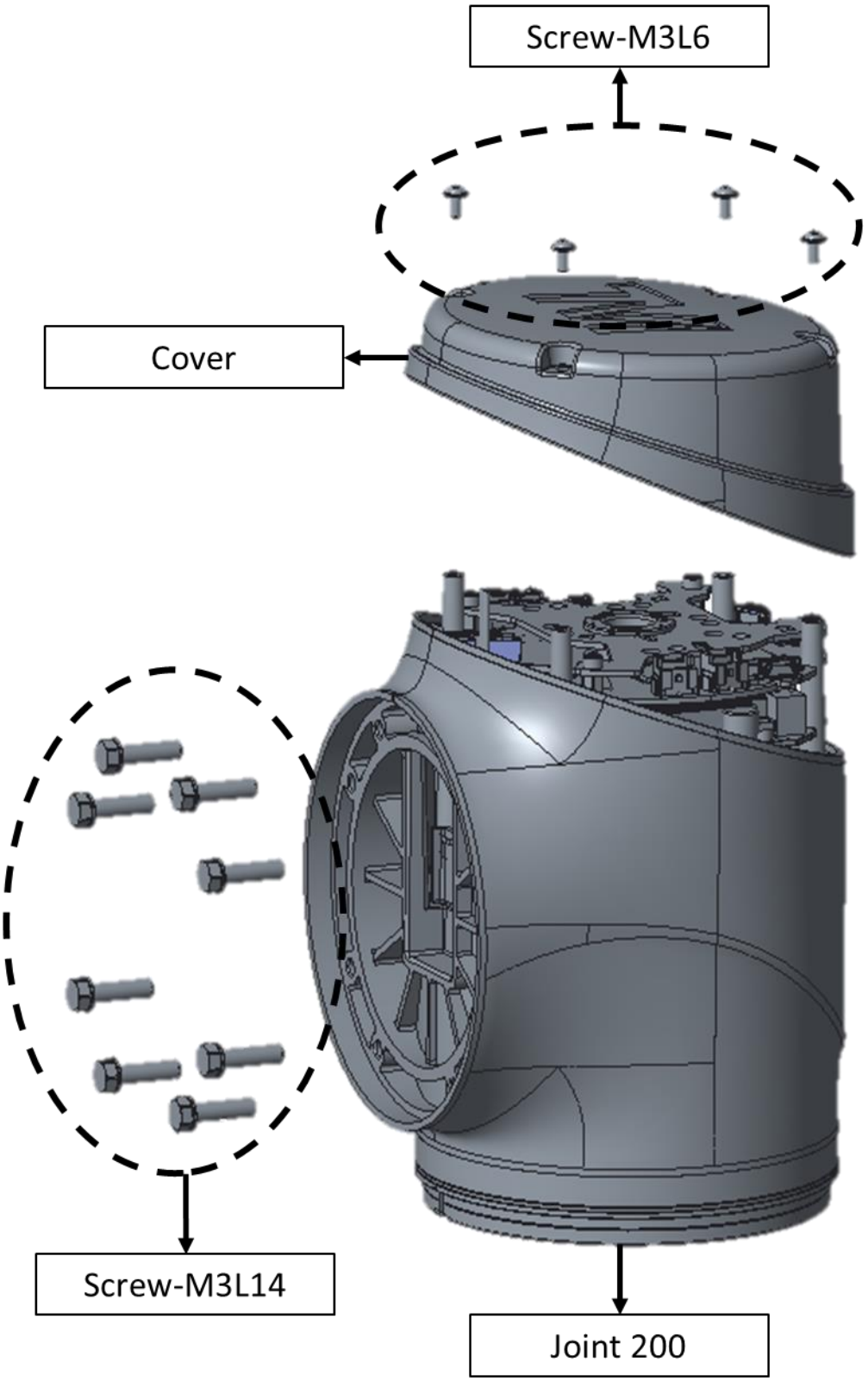
3.5 800 Series Joint



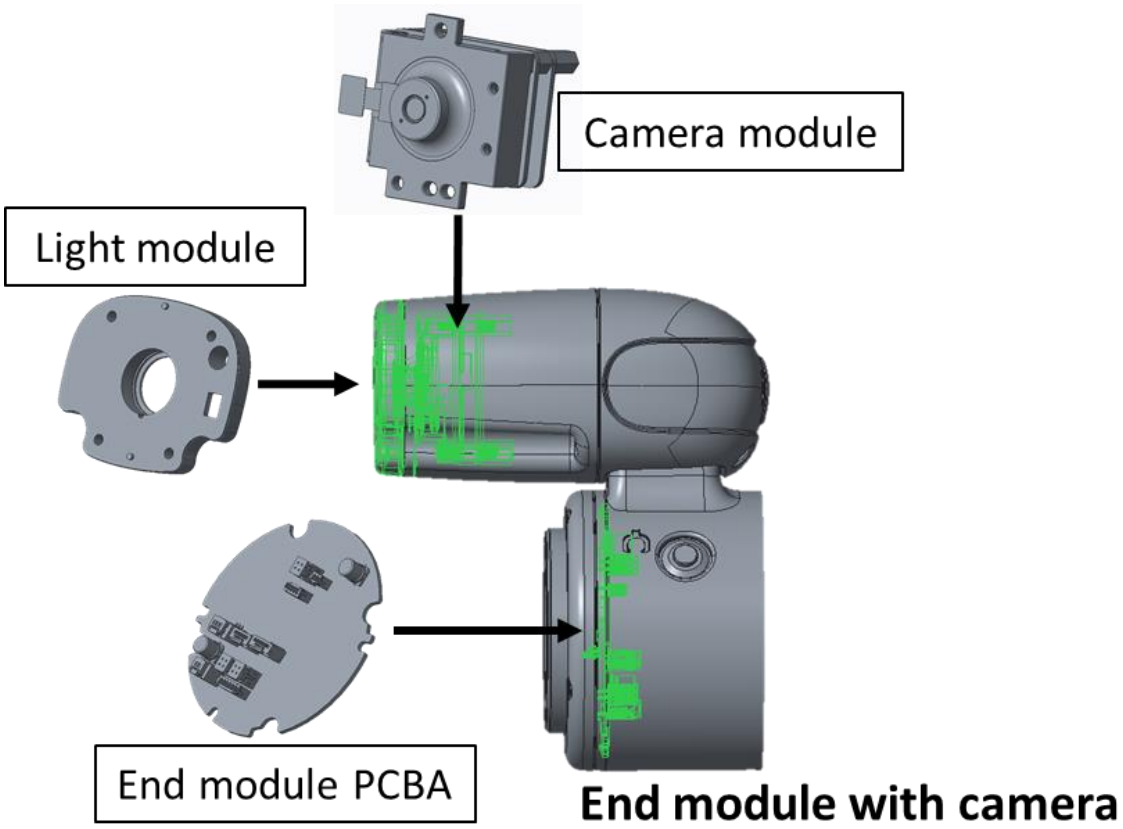
3.6 500 Series Joint

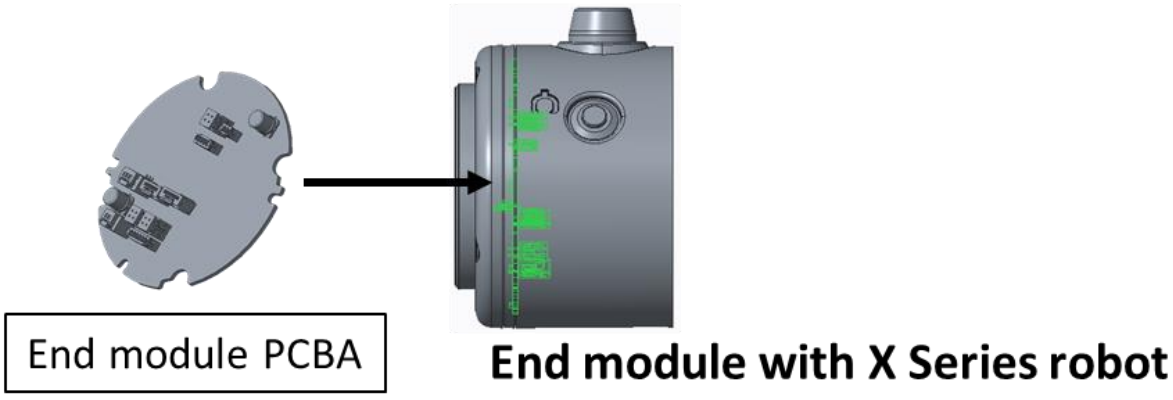


3.7 200 Series Joint

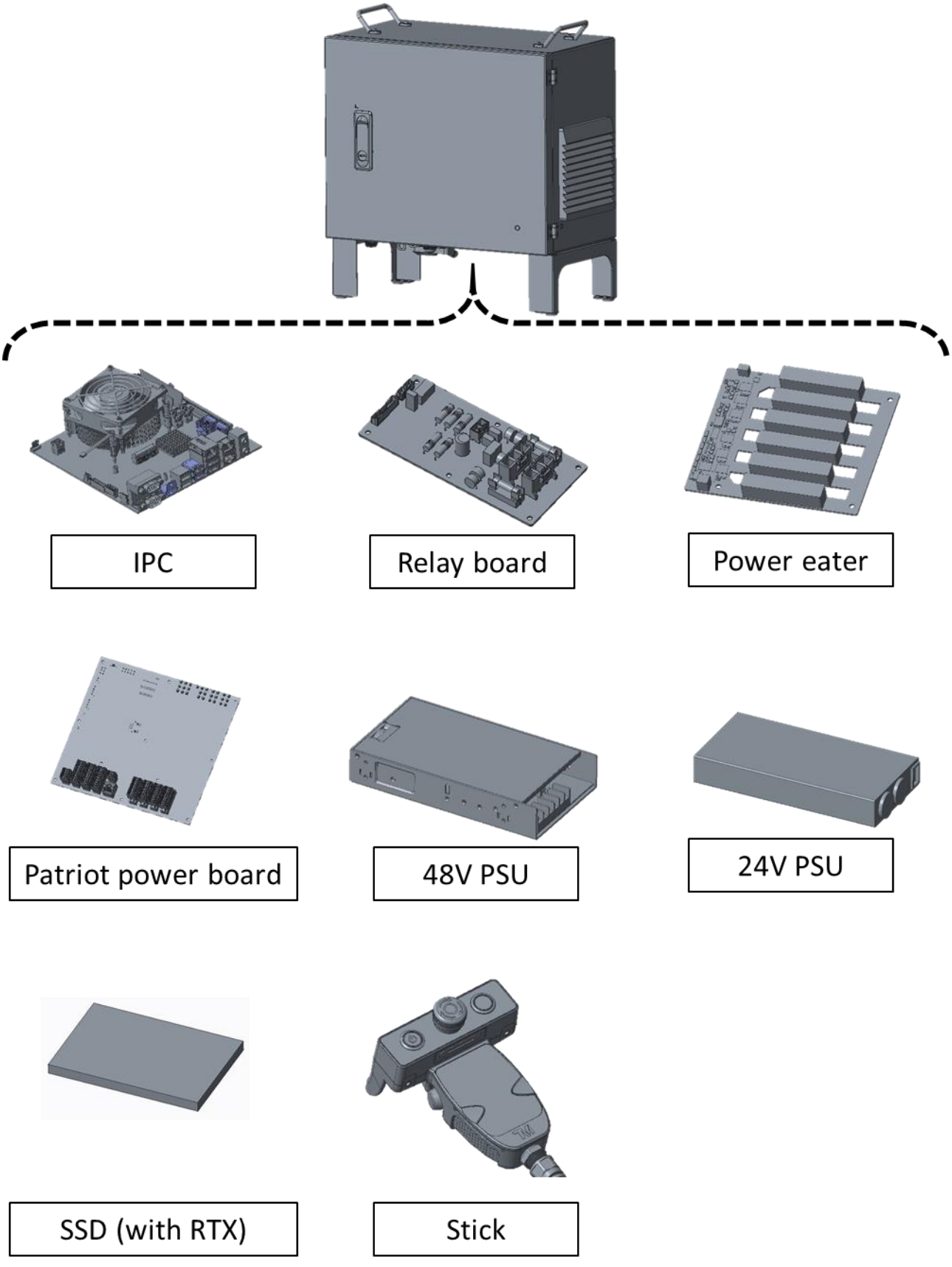


3.8 End module



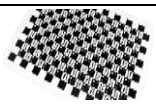
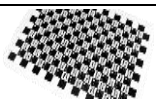


3.9 End module



4. Tool list

Name	Physical Reference	Specification	Model	Remarks
Open end wrench		5.5 mm		Used for200 Series Joint
Open end wrench		8 mm		Used for 500 Series Joint
Open end wrench		10mm		Used for 800 Series Joint
Hex socket screwdriver		5.5 mm		Used for200 Series Joint
Hex socket screwdriver		8 mm		Used for 500 Series Joint
Hex socket screwdriver		10mm		Used for 800 Series Joint
Torque wrench		5.5 mm 20 kgf·cm	TOHNICHI 50CL-MH	Used for 200 Series Joint
Torque wrench		8 mm 92 kgf·cm	TOHNICHI 150CL-MH	Used for 500 Series Joint
Torque wrench		10mm 250kgf-cm	TOHNICH 225CL-MH	Used for 800 Series Joint
Wrench head		SH8D × 5.5 5.5 mm	TOHNICHI SH8D*5.5	Used for 200 Series Joint
Wrench head		SH8D × 8 8 mm	TOHNICHI SH8D*8	Used for 500 Series Joint
Wrench head		SH10D × 10 mm	TOHNICHI SH10D*10	Used for 800 Series Joint
Torque screw driver		6 - 10 kgf·cm	TOHNICHI 12 RTD	
Torx bit		T10		Used for Joint cover
Hex bit		2.5mm		Used for outer cover of camera module
Hex wrenches		M1.5-M10		Used forBase & Control box components
Extension bit Holder		1/4 inch At least 150mm		Used for internal box's fixed screws, magnet type is recommended.

Name	Physical Reference	Specification	Model	Remarks
Hex socket bit		M10		Used for internal box's fixed screws, magnet type is recommended.
Phillips screw driver				Used for control box components
Tweezer				Used for removing cables
Adjestable spanner		8 inch		Used for robot cable
Diagonal cutting plier				Used for cutting cable ties
Long nose plier				Used for removing cables
Cable tie		120 × 2.5 mm^2		Used for securing wires
Cable tie		150 × 3.6 mm^2		Used for securing wires
Multimeter				Used for checking voltage and circuit
Precision screwdriver set		T06151		Used for screws
Electrical tape		Width: 18mm		Used for wrapping around camera cable connectors
USB flash drive				Used for Windows recovery
Dongle key			Techman Robot	Must contain authorization key of maintenance
2-cm Plate calibration		40 cm × 30 cm	Techman Robot	Used for camera calibration
1-cm Plate calibration		20 cm × 15 cm	Techman Robot	Used for camera calibration
TM Landmark			Techman Robot	Used for Kinematic calibration and Hand-eye calibration

5. Assembly and Disassembly Guide for Robot arm

5.1 Quick maintance Guide

5.1.1 To ensure the safe operation, at least two people should work together to disassembly it.

5.1.2 Before disassembly, ensure that the robot is powered off completely and that the external power cord and robot cable have been removed.

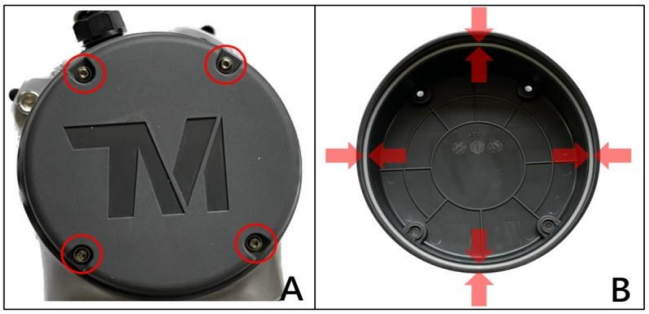
5.1.3 Before disassembly, remove the robot from the platform and place it horizontally on a non-hard surface (e.g., blanket or sponge pad).

5.1.4 Before disassembly, take photos to record the status and wiring method when not disassembled for reference during reassembly process.

5.1.5 Follow the right-hand rule when disassembling and installing screws.

5.2 Disassembly and assembly Joint cover and Joint rubber

5.2.1 Joint cover disassembly: To disassemble the joint cover, simply use a hex cap screwdriver to loosen the four hexagonal socket head cap screws (Fig. A).
Then, gently remove the cover by hand, being careful to keep the O-ring in the groove.

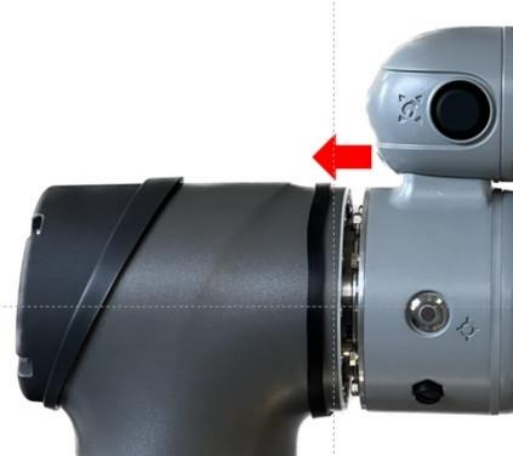


5.2.2 Joint cover assembly: To assembly the joint cover, ensure that the O-ring is in the groove (Fig. B) and tighten the four socket head cap screws using a torque screwdriver and a socket head torque screwdriver.

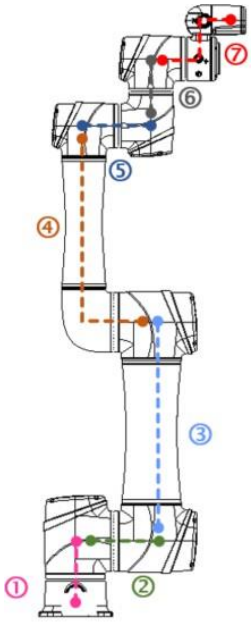
CAUTION:
Use the correct torque to tighten the screws according to the table below. Insufficient torque may result in inadequate sealing of the joint cover. Excessive tirque during screw tightening may cause damage to the joint cover.

Torque specifications for covers				
Joint Type	Screw Type	Torque Value (Kgf.cm)	Torque Value(Nm)	Total Screws
200 series	M3L6 Torx SOCKET HEAD CAP	6	0.6	4
500 series	M3L6 Torx SOCKET HEAD CAP	6	0.6	4
800 series	M3L6 Torx SOCKET HEAD CAP	6	0.6	4

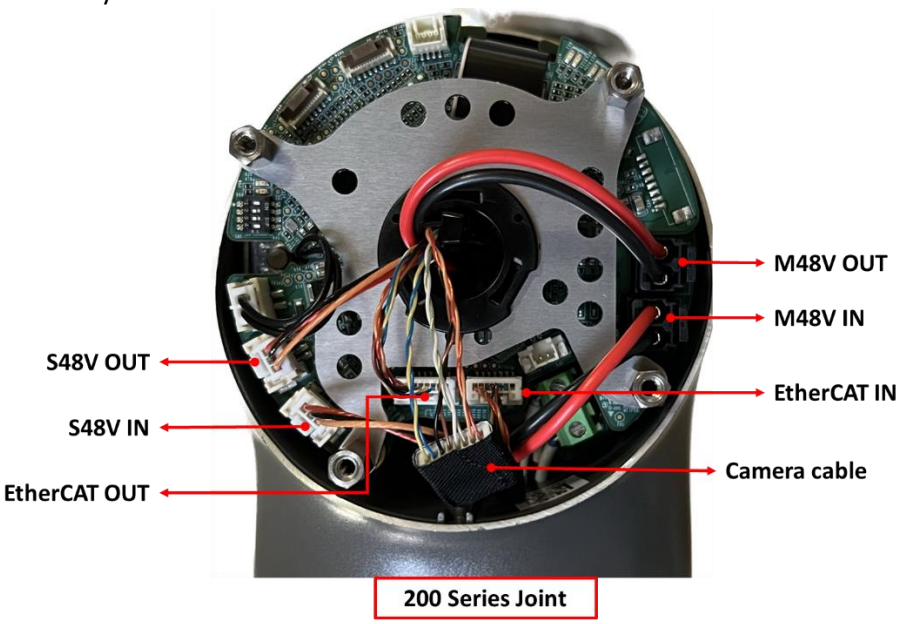
5.2.3 Remove Joint Rubber: Remove the Rubber with tweezers and open the white anti-dust cover to reveal the 200 Series / 500 Series / 800 Series Joint Screws.
Reverse the previous steps to install the dust cover and Rubber.



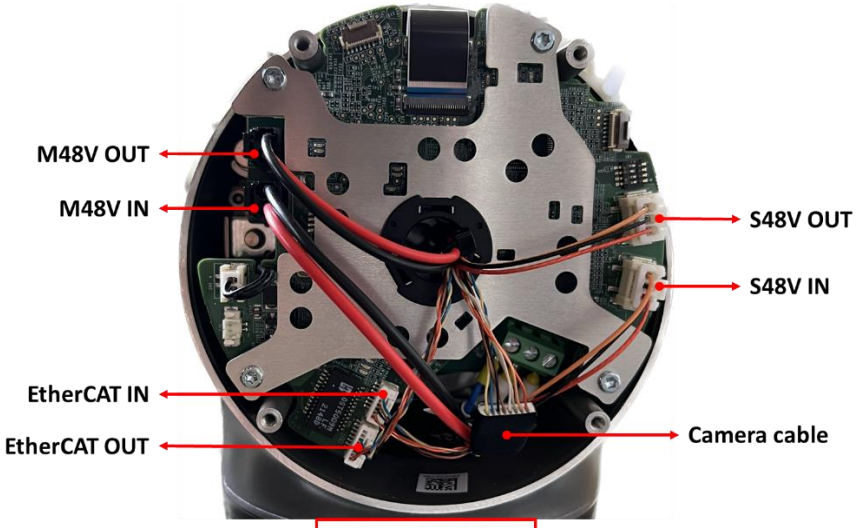
5.3 Camera cable postion



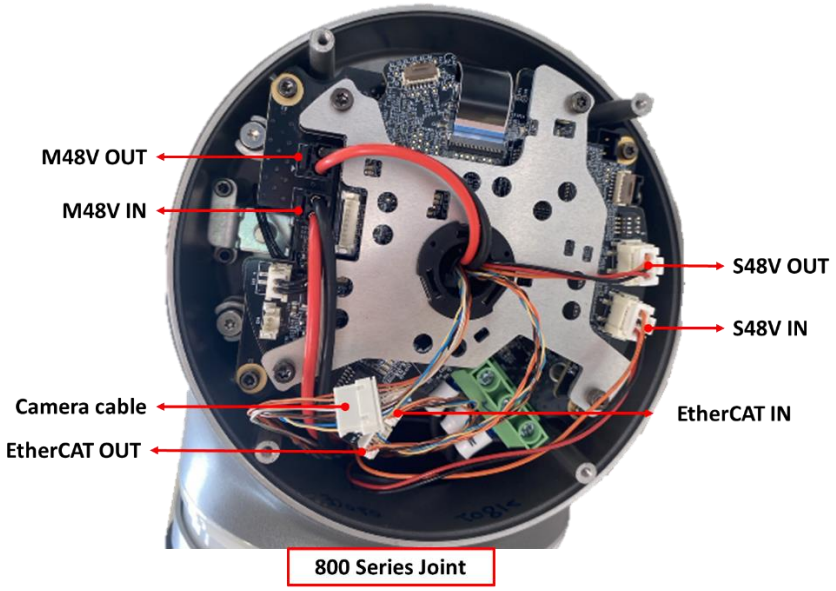
5.4 Disassembly and assembly Joint cable



200 Series Joint



500 Series Joint



800 Series Joint

5.5 Disassembly and Assembly Joint screw

CAUTION: Before remove Joint screws, ensure the Joint cable and connectors are disconnected; failure to disconnect the cable may result in damage to the Joint cable or components due to pulling or interference when removing the Joint.

5.5.1 Before remove Joint screws, remove Joint Cover and Joint Rubber.

5.5.2 Using open end wrench to loosen the screw for Joint connecting screws.

DANGER: Repeated use of disassembled screws is prohibited, as the screw adhesive on the screws will become ineffective, and the repeated use will increase unforeseen risks.

DANGER: Tighten the joint screws according to the specified torque value provided below.

Torque specifications for Joint screws				
Joint Type	Screw Type	Torque Value (Kgf.cm)	Torque Value(Nm)	Total Screws
200 series	M3L14 HEX HEAD CAP	20	2.0	8
500 series	M5L20 HEX HEAD CAP	92	9.0	8
800 series	M6L20 HEX HEAD CAP	150	15	10

5.5.3 When assembling the joint, to ensure the correct installation orientation, it is necessary to interlock the key and slot between the joints (refer to Figure 1) (see Figure 2). Operators can visually align the holes or insert a Ø1.9mm pin into the hole to verify proper installation (see Figure 3). If the hole of two joints are not in the same direction, or if misalignment prevents the insertion of the locating pin, do not proceed with further assembly.

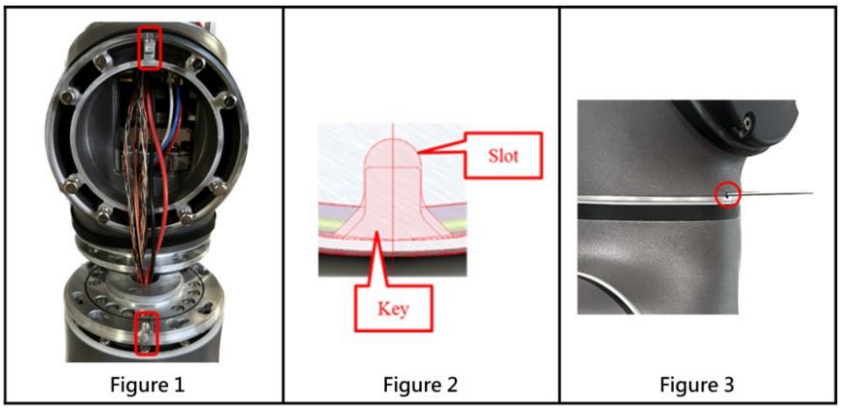
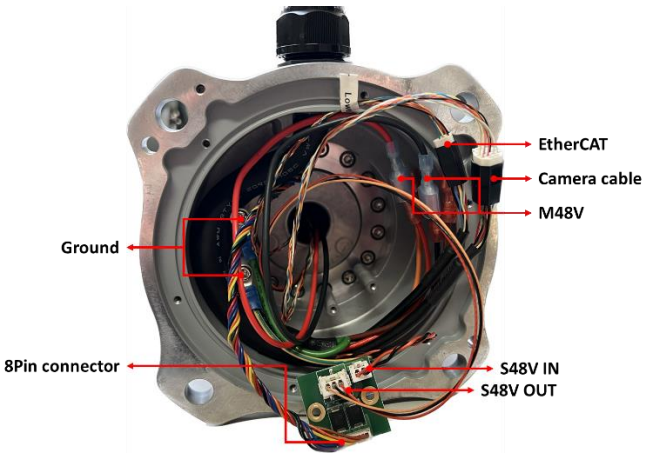


Figure 1 Figure 2 Figure 3

5.6 Disassembly and Assembly of Base and Robot Cable

5.6.1 Before removing the Base cover, loosen the corresponding screws and disconnect the wiring between the Robot cable and Joint 1.



5.6.2 Use wrench to loosen the bottom connector, then carefully pull out the Robot cable.

5.6.3 When assembling the Base and Robot cable, please follow the reverse steps of the previous procedure.

5.7 Disassembly and assembly 800 Series Joint

5.7.1 Remove the Joint cover and Joint rubber.

5.7.2 Remove the Joint cable from the Joint。

5.7.3 Remove the screws connecting the Joint to other Joints or the Arm, then detach the Joint.

5.7.4 During assembly, follow the reverse steps of the previously mentioned procedure.

5.8 Disassembly and assembly 500 Series Joint

5.8.1 Remove the Joint cover and Joint rubber.

5.8.2 Remove the Joint cable from the Joint。

5.8.3 Remove the screws connecting the Joint to other Joints or the Arm, then detach the Joint.

5.8.4 During assembly, follow the reverse steps of the previously mentioned procedure.

5.9 Disassembly and assembly 200 Series Joint

5.9.1 Remove the Joint cover and Joint rubber.

5.9.2 Remove the Joint cable from the Joint。

5.9.3 Remove the screws connecting the Joint to other Joints, the Arm, or the End module, then detach the Joint.

5.9.4 During assembly, follow the reverse steps of the previously mentioned procedure.

5.10 Disassembly and assembly Upper arm

5.10.1 Remove Joint cover and Joint rubber which in Joint 2 & Joint 3

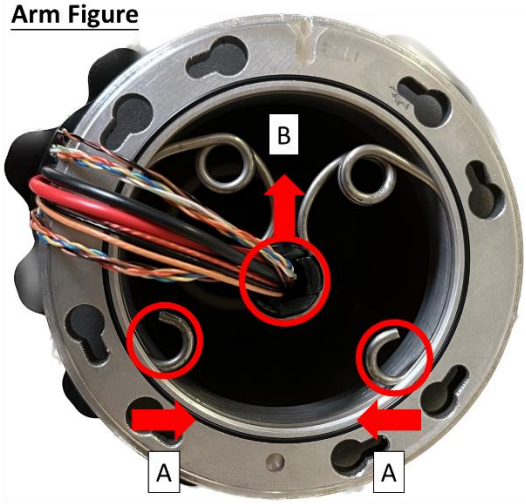
5.10.2 Remove Joint cable which in Joint 2 & Joint 3

5.10.3 Remove the screws connecting the Upper arm to Joint 2 and Joint 3, then detach the Upper arm.

5.10.4 During assembly, follow the reverse steps of the previously mentioned procedure.

5.10.5 (Please refer Arm figure below) After removing the Upper arm, use needle-nose pliers to compress the bracket at location A, then extract the bracket from the groove. Next, remove the wiring and plastic bushing at location B.

Arm Figure



5.11 Disassembly and assembly Lower arm

5.11.1 Remove Joint cover and Joint rubber which in Joint 3 & Joint 4

5.11.2 Remove Joint cable which in Joint 3 & Joint 4

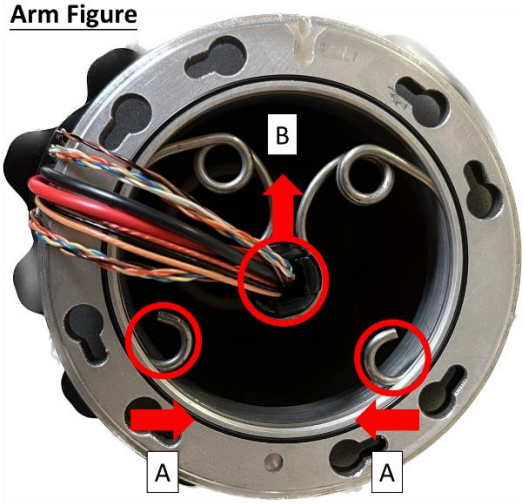
5.11.3 Remove the connecting screws between the Lower arm and Joint 4.

5.11.4 Remove the connecting screws between Joint L and Joint 3.

5.11.5 After removing the Lower arm, remove the screws connecting the Lower arm to Joint L, then remove the Lower arm.

5.11.6 (Please refer Arm figure below) After removing the Upper arm, use needle-nose pliers to compress the bracket at location A, then extract the bracket from the groove. Next, remove the wiring and plastic bushing at location B.

Arm Figure



5.12 Disassembly and assembly End module

5.12.1 Remove Joint cover and Joint rubber which in Joint 6

5.12.2 Remove Joint cable which in Joint 6.

5.12.3 Remove the connecting screws between Joint 6 and the End module, then detach the End module.

5.12.4 During assembly, follow the reverse steps of the previously mentioned procedure.

5.13 Disassembly and assembly Light module

5.13.1 Refer to the picture below to remove the four screws securing the camera light source module.

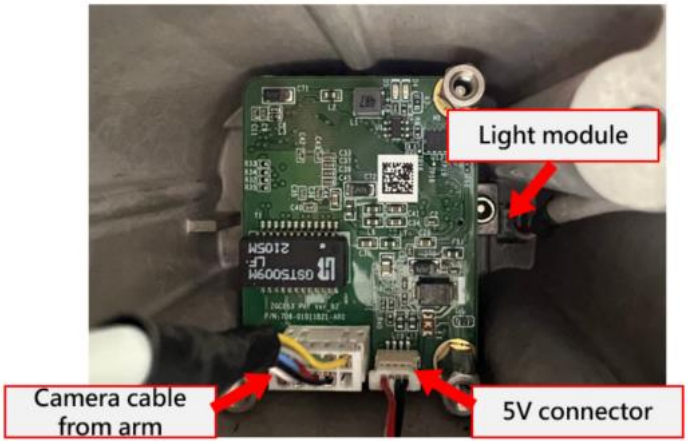
5.13.2 Unplug the power cable of the light source module and remove the light source module, being careful not to let the O-ring fall off.

5.13.3 During the assembly of the End module, please follow the reverse steps of the previously mentioned procedure.

5.14 Disassembly and assembly Camera module

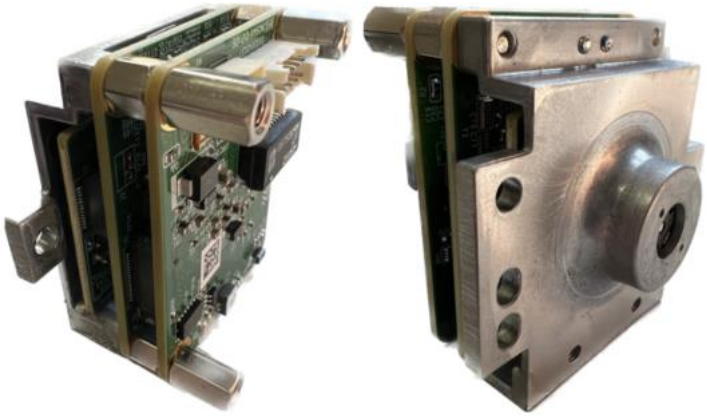
5.14.1 Loosen the three M3L10 screws on the camera module, separate the camera module casing from the End module. The torque during assembly is 10 kgf·cm.

5.14.2 Disconnect the cables as shown in the below.



5.14.3 After removing the camera module, take off the three M3L6 screws securing the TRI camera. The torque during assembly is 10 kgf·cm

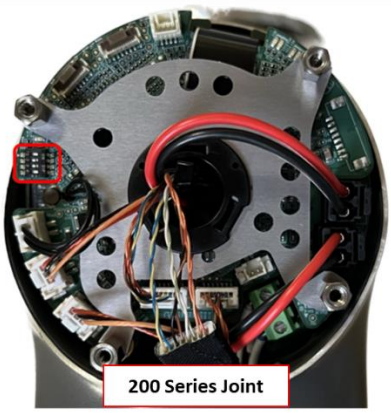
5.14.4 After removing the TRI camera unit (refer to the below picture), replace it directly with a new TRI camera. Do not perform any disassembly or modifications on the components of the unit.

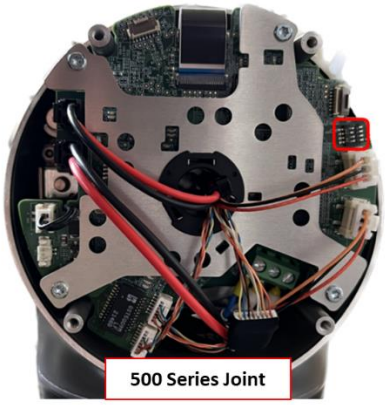


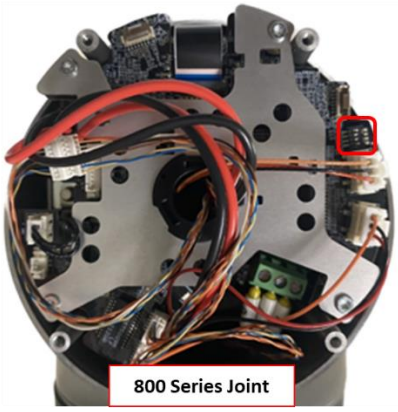
5.14.5 When assembling the camera, please follow the reverse steps of the previously mentioned procedure.

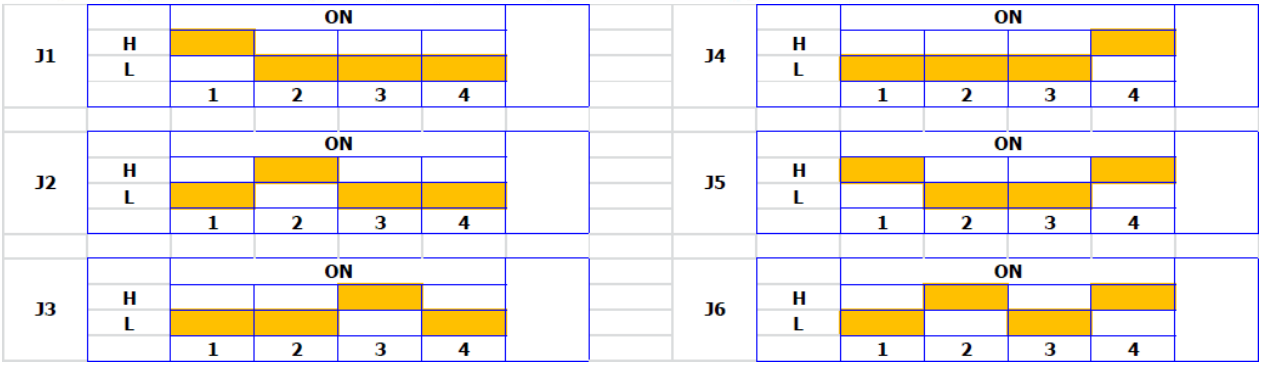
5.15 DIP Switch Setting

5.15.1 After replacing or rearranging Joints, use pliers to move the Joint DIP switch to the corresponding position according to the following specifications:









CAUTION: Failure to set the DIP switch on the Joint to the specified position may trigger Error Code 0x0000004E or other unexpected errors.

5.16 Software Update

5.16.1 Notes：

5.16.1.1 Follow the table below to update perform ReinstallrobotID, ESI and Firmware(FW) updates after replacing patriot power board, end module and joints：

	ReinstallrobotID	ESI	Firmware(FW)
Patriot power board	●	●	●
End module	●	●	●
Joints	○	●	●
●Required ○Not Required			

5.16.1.2 The Robot ID is stored in both patriot power board and end module PCBA. System may trigger error code 0x3C or others if it detects a discrepancy between the robot IDs of those two parts.

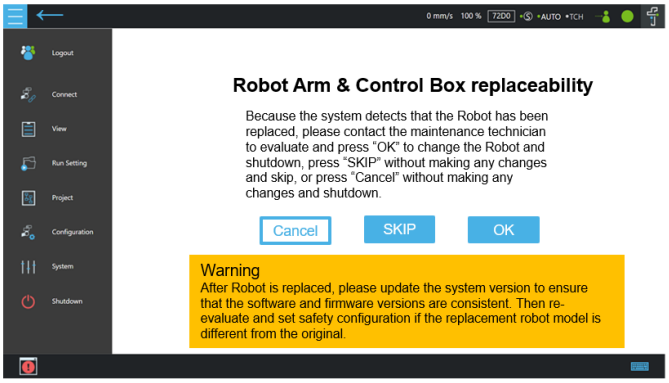
5.16.1.3 Replacing the above-mentioned components without updateing the ESI and firmware as required will not trigger errors immediately. However, to prevent potential unforeseen errors caused by inconsistencies in ESI and firmware versions between components or mismatches with the current TM Flow version, it is essential to perform updates after replacing components. This ensures that the ESI and firmware of all components align with the current TM Flow version.

5.16.1.4 Two update methods are provided below. Refer to the table for appropriate applications:

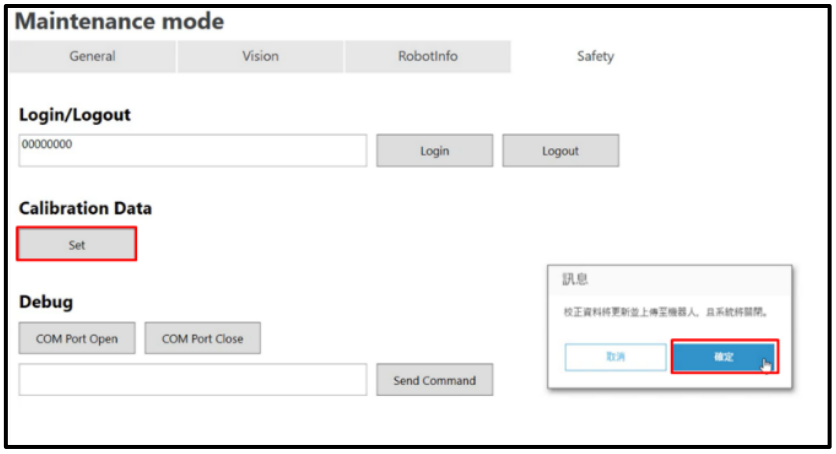
	TM Flow	Manually updating
Patrioit power board (new)	●	●
Patrioit power board (used)	○	●
End module (new)	●	●
End module (used)	○	●
Joint (new)	●	●
Joint (used)	●	●
●Applicable ○Not Applicable Both methods require a maintenance dongle.		

5.16.1.5 Restoring the calibration data:

(a.)Replacing patriot power board: User may see the following screen upon startup after replacing a new patrioit power board. Click ‘OK’ and enter the default password (ddefault 00000000), the control box will reboot and synchronize the calibration data to the patriot power board.



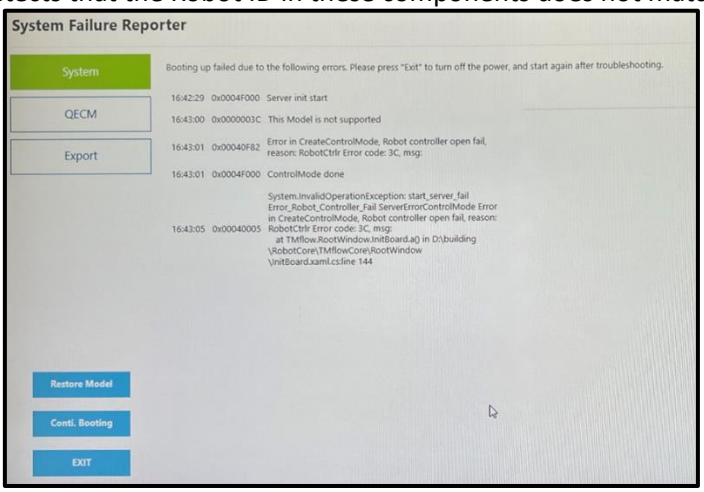
(b.)Replacing end module: After replacing and new end module, user must enter the maintenance mode (firstly click SKIP on the page ‘Robot Arm & Control Box replaceability’) and type in the password (default 00000000) and log in. Then, click calibration data ‘Set’ to upload the calibration data to the end module PCBA.



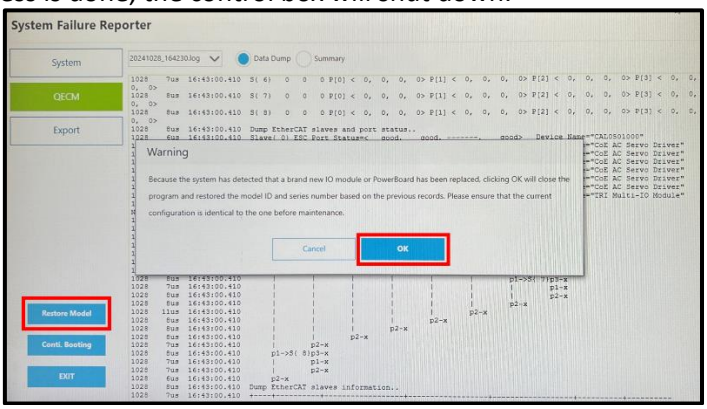
5.16.2 Updating Robot ID, ESI and Firmware via TM Flow:

5.16.2.1 When replacing robot joints, it is only necessary to perform TM Flow update after powering on. There is no need to update the Robot ID.

5.16.2.2 After replacing brand-new end module or patriot power board, since these components do not initially have a Robot ID written into them, the system will display the following error screen (Error code 0x3C) when it detects that the Robot ID in these components does not match the robot model.



5.16.2.3 Click Restore model. The system will write the corresponding Robot ID into the blank end module and patriot power board base on the robot model last time recorded by the control box. Once the written process is done, the control box will shut down.



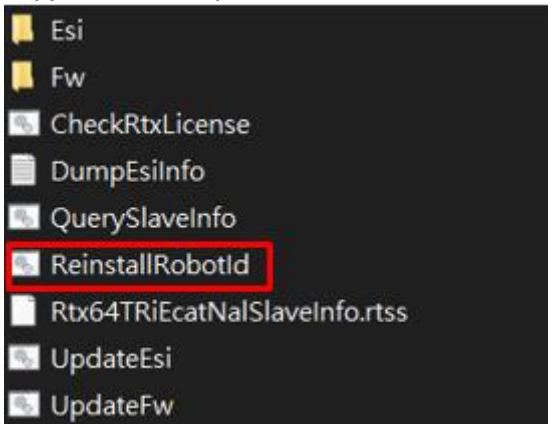
5.16.2.4 After restarting, follow the ‘System Update’section in the software manual to update the TM Flow to the same or newer version. During the system update process, ESI and firmware will be updated automatically.

5.16.3 Manually updating Robot ID, ESI and Firmware:

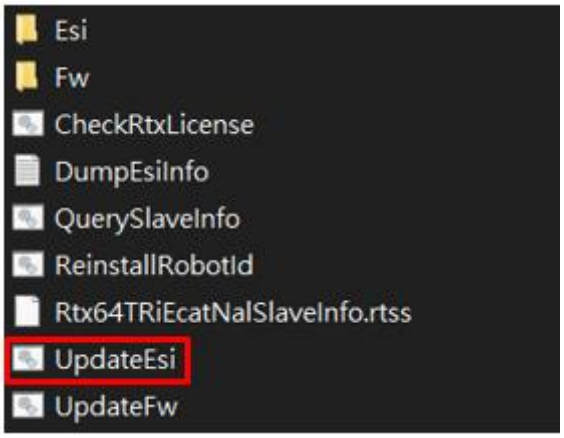
5.16.3.1 Enter Windows: While the control box is powered off, press the emergency stop button and insert the maintenance dongle to the control box. After powering on, TM Flow will display error codes due to the emergency stop cutting off the power between control box and the robot arm. Click ‘Exit’ at the bottom left of the screen to enter Windows.

Warning: After entering Windows, release the emergency stop button. Once released, check if the end module indicator light is blinking. If the light is not blinking, it indicates that the control box is not correctly connected to the robot arm. Do not proceed with the subsequent steps and priotirize troubleshooting the issue.

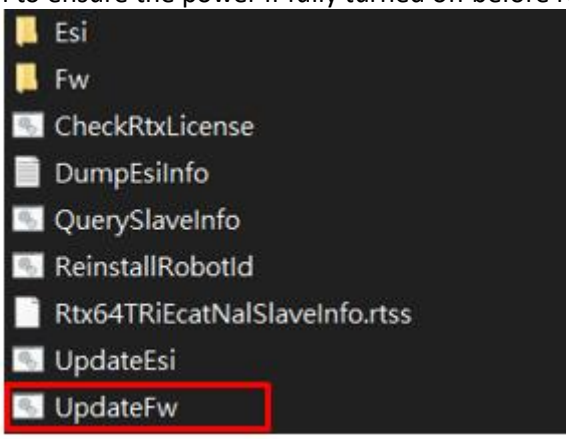
5.16.3.2 ReinstallrobotID: After replacing patriot power board or end module and entering Windows, run the file ‘ReinstaillRobotID’ located in the path: D:\Techman Robot\TM Flow\ModuleRelease. This step can be skipped if only joints were replaced.



5.16.3.3 UpdateEsi: After entering Windows, run the file ‘UpdateEsi’ located in the path: D:\Techman Robot\TM Flow\ModuleRelease.



5.16.3.4 UpdateFW: After entering Windows, run the file ‘UpdateFW’ located in the path: D:\Techman Robot\TM Flow\ModuleRelease. Once the firmware update is complete, completely power off the control box and robot arm. It is recommended to unplug the external power cable after shutting down and then plug it back in to ensure the power if fully turned off before restarting.



6. Disassembly /Assembly Control Box

6.1 Quick maintance guide

6.1.1 To ensure operational safety, at least two persons are required to collaborate in the disassembly process.

6.1.2 Before disassembly, place the control box on a soft surface (such as a blanket or sponge pad) for disassembly.

6.1.3 Before disassembly, take photos to record the status and wiring method when not disassembled.

6.1.4 Follow the right-hand rule when disassembling and installing screws.

6.1.5 When installing components, refer to the wiring photos or the wire photos taken before disassembly. Install the wires and ensure proper cable management.

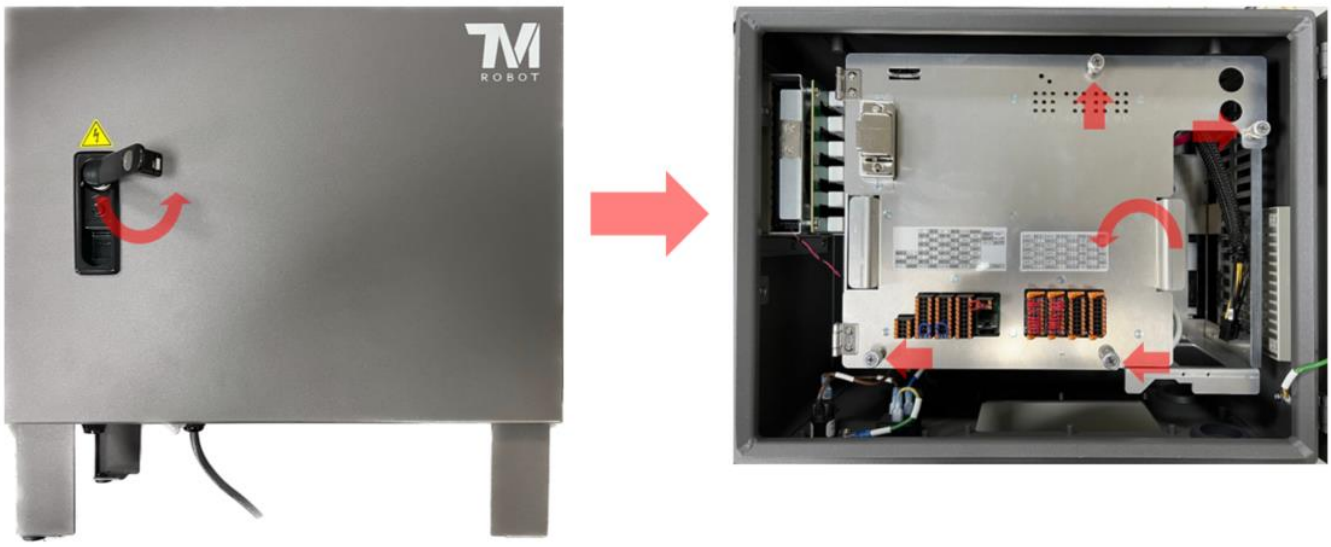
6.1.6 When installing components, use a torque wrench to tighten the parts according to the torque specifications table below:

Torque specifications for Control board		
Item	torque value(Kgf.cm)	torque value(Nm)
IPC	6	0.6
Patriot power board	6	0.6
Relay board	6	0.6
Power eater board	6	0.6
PSU cable	10	0.98
PSU Bracket	14	1.37
SSD Bracket	14	1.37

6.2 Open the Control Box Outer Casing

6.2.1 Before opening the outer casing of the control box, ensure that the control box is completely powered off, and disconnect the external power cord and robot cable.

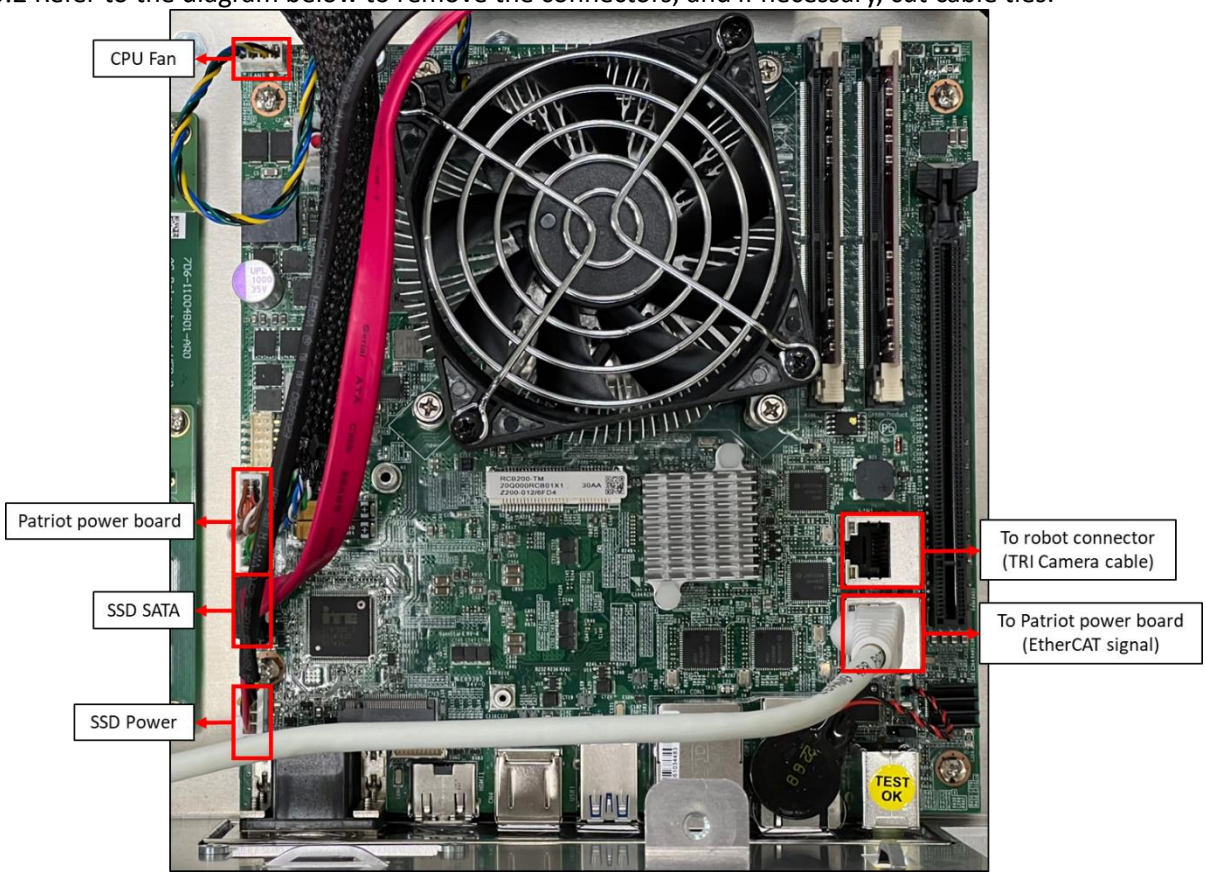
6.2.2 Open the outer casing cover of the control box, loosen the four inner casing screws, and open the inner casing cover.



6.3 Disassembly/Assembly of IPC

6.3.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover.

6.3.2 Refer to the diagram below to remove the connectors, and if necessary, cut cable ties.



6.3.3 Loosen the four screws securing the IPC.

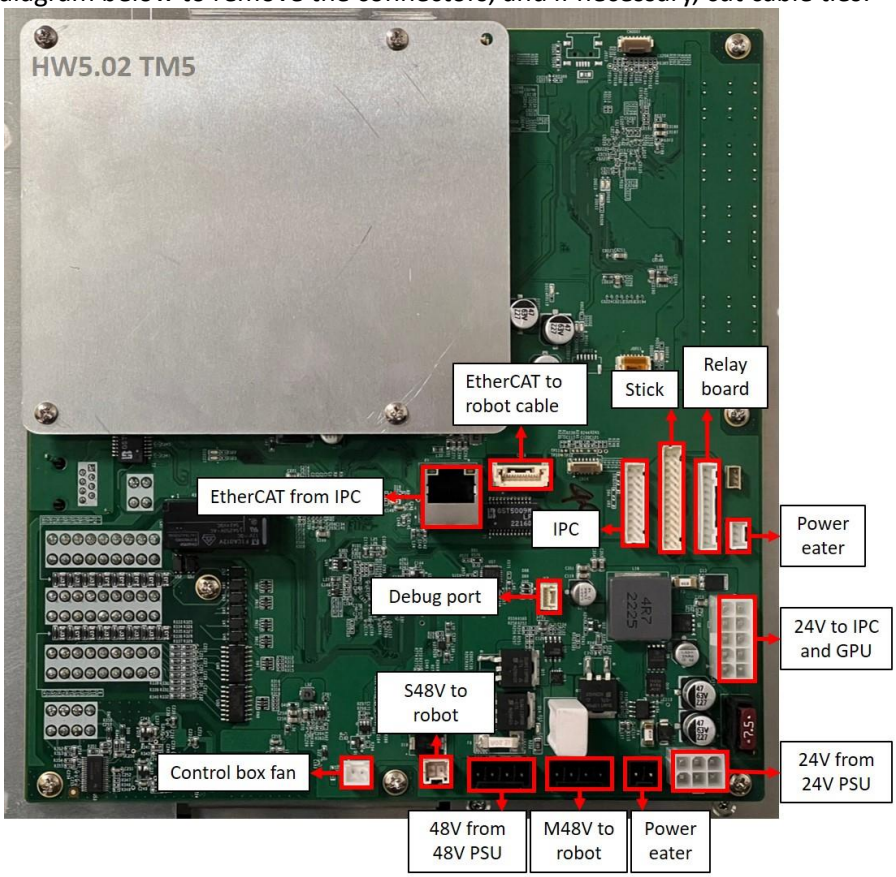
6.3.4 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner.

6.4 Disassembly/Assembly of the Patriot Power Board

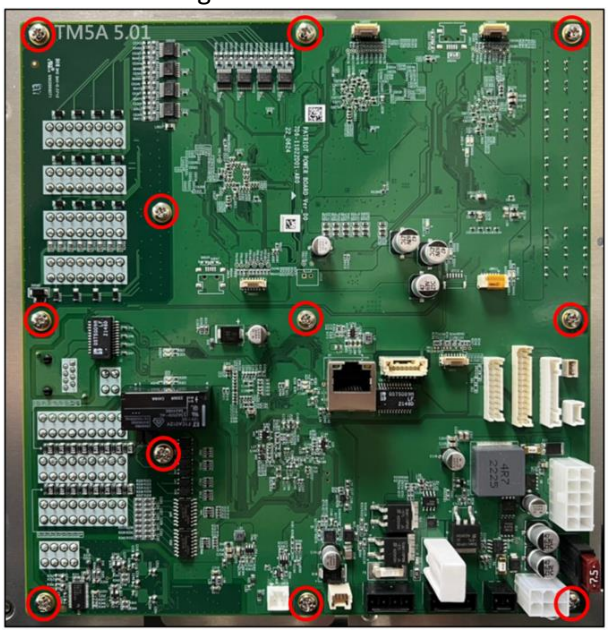
Caution: Replacing the Patriot power board will reset the Safety settings in the TM flow, please refer to the Safety settings section in the software manual for saving and recovery.

6.4.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover.

6.4.2 Refer to the diagram below to remove the connectors, and if necessary, cut cable ties:



6.4.3 Loosen the 11 screws securing the Patriot Power Board.

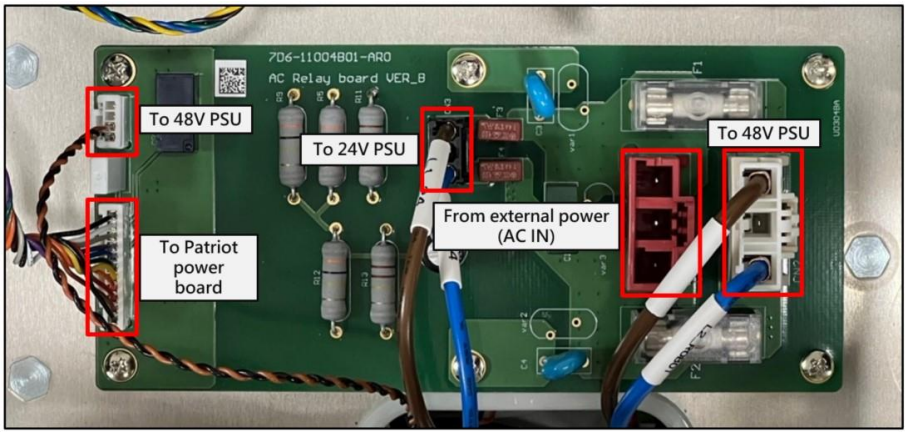


6.4.4 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

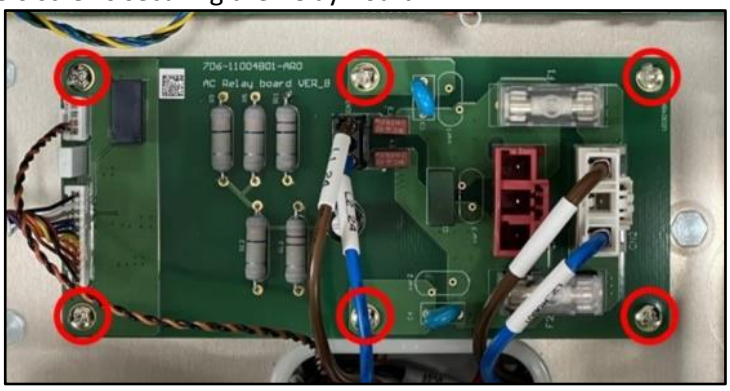
6.5 Disassembly/Assembly Relay board

6.5.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover.

6.5.2 Refer to the diagram below to remove the connectors, and if necessary, cut cable ties



6.5.3 Loosen the 6 screws securing the Relay Board.

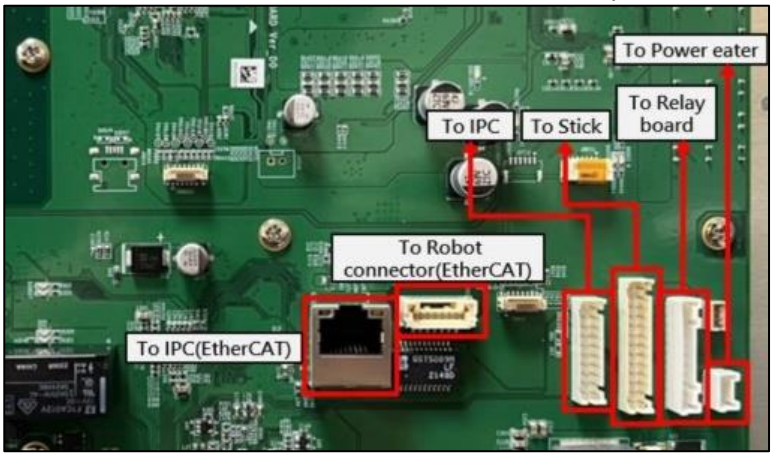


6.5.4 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

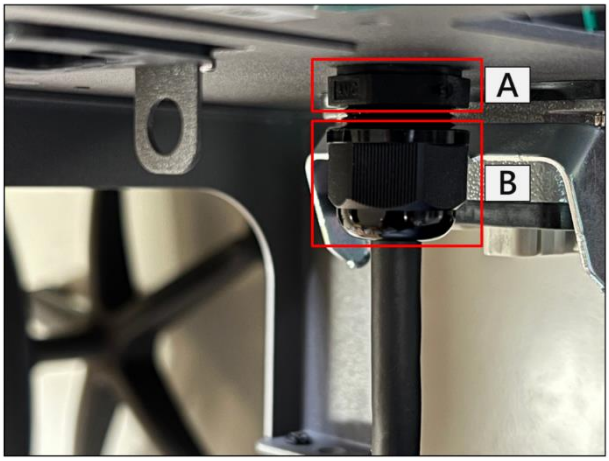
6.6 Disassembly/Assembly Stick

6.6.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover

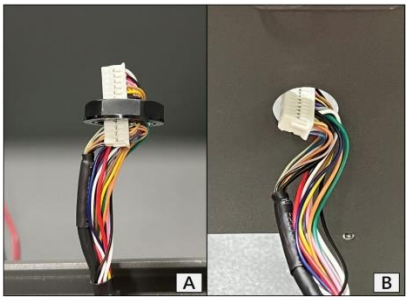
6.6.2 Refer to the diagram below to remove the Stick connector, and if necessary, cut cable ties:



6.6.3 Refer to the diagram to sequentially loosen Stick securing nut A and wire securing nut B:



6.6.4 Refer to the diagram to gently bend the Stick connector slightly, and sequentially thread it through the Stick securing nut (Figure A) and the control box (Figure B) to remove the Stick.



6.6.1 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

6.7 Disassembly/Assembly of Robot Connector and Internal Composite Cable

6.7.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover

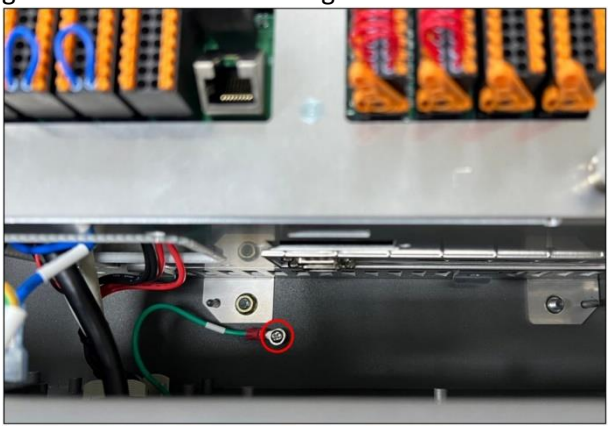
6.7.2 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Robot connector (Servo 48V)" connector.

6.7.3 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Robot connector (Motor 48V)" connector.

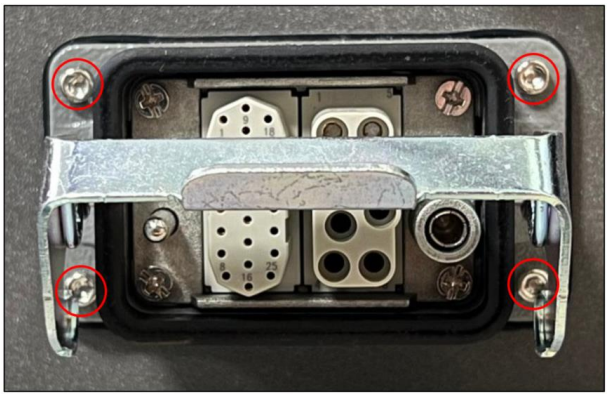
6.7.4 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Robot connector (EtherCAT)" connector.

6.7.5 Refer to "Disassembly/Assembly of IPC" to remove the "To Robot connector (Camera)" connector.

6.7.6 Remove the grounding cable as shown in the diagram.



6.7.7 Remove the four Robot connector screws shown in the diagram and take out the internal composite cable.



6.7.8 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

6.8 Disassembly/Assembly of Inner Casing

6.8.1 Refer to "Open the Control Box Outer Casing" to open the outer casing cover and inner casing cover

6.8.2 Refer to "Disassembly/Assembly of Robot Connector and Internal Composite Cable" to remove the Robot connector and internal composite cable.

6.8.3 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Power eater board A" connector.

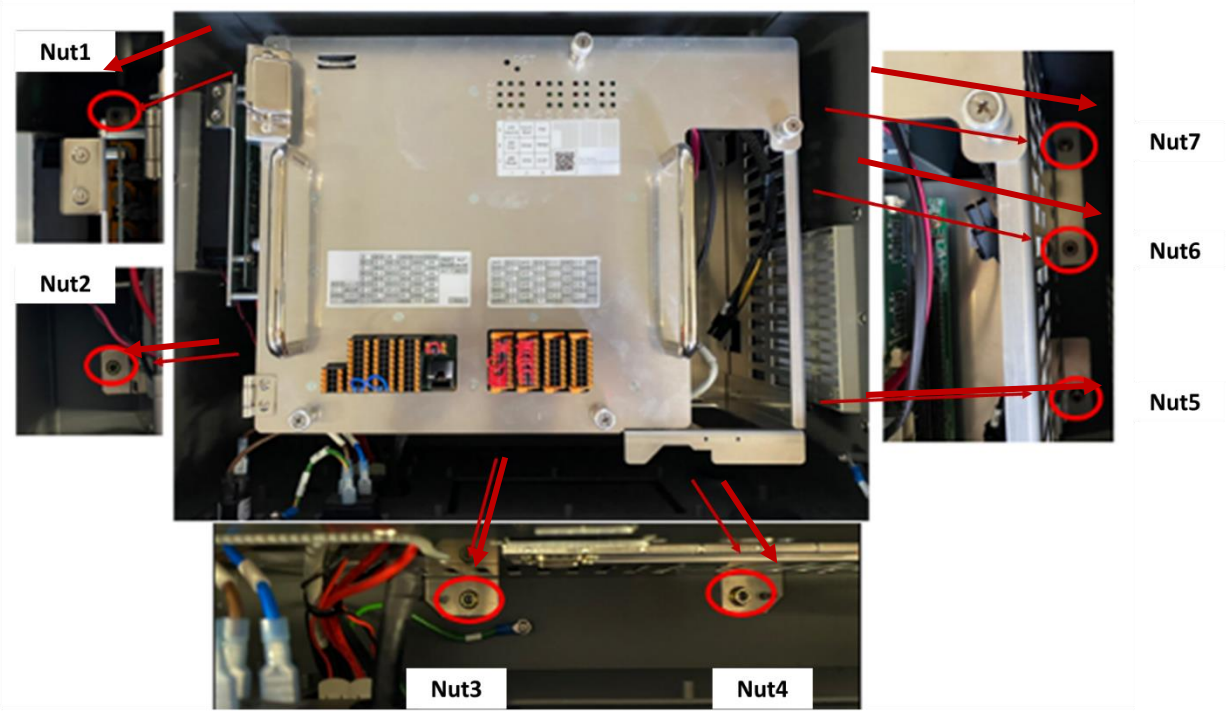
6.8.4 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Power eater board B" connector.

6.8.5 Refer to "Disassembly/Assembly of the Patriot Power Board" to remove the "To Control box fan" connector.

6.8.6 Refer to "Disassembly/Assembly of the Relay Board" to remove the "From external power (AC IN)" connector.

6.8.7 Refer to the diagram below to remove the 7 inner casing securing nuts and take out the inner casing.

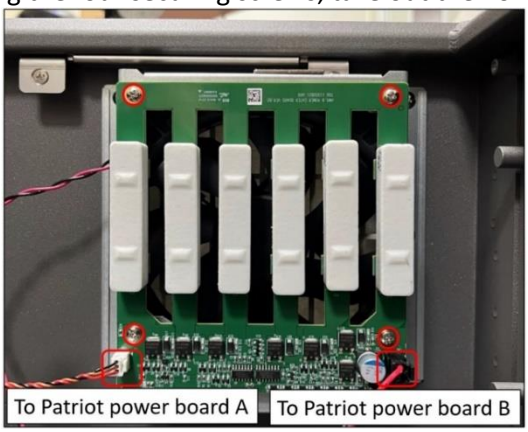
6.8.8 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner



6.9 Disassembly/Assembly of Power Eater Board

6.9.1 Refer to "Disassembly/Assembly of Inner Casing" to remove the inner casing.

6.9.2 Refer to the diagram below to remove the connectors "To Patriot power board A" and "To Patriot power board B". After removing the four securing screws, take out the Power Eater Board.

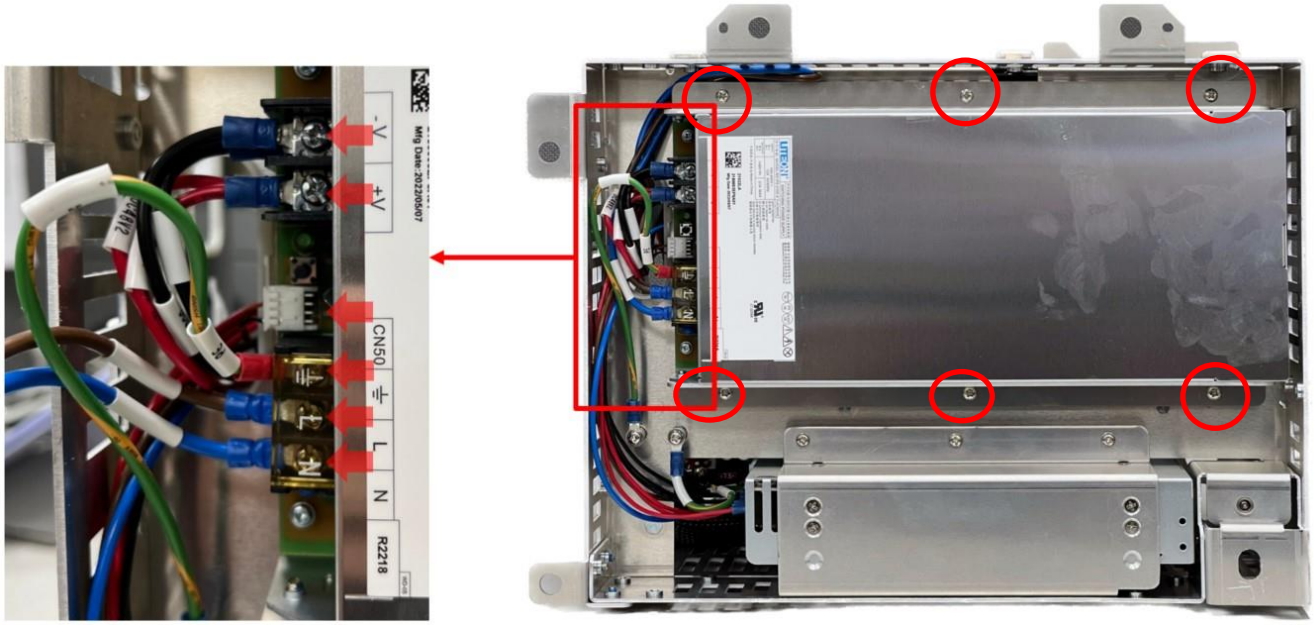


6.9.3 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner.

6.10 Disassembly/Assembly of 48V PSU

6.10.1 Refer to "Disassembly/Assembly of Inner Casing" to remove the inner casing.

6.10.2 Refer to the diagram below to disconnect the wiring.



6.10.3 Refer to the diagram below to remove the six securing screws and take out the 48V PSU with the bracket.

6.10.4 Refer to the diagram below to remove the six securing screws and take out the 48V PSU.

6.10.5 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

6.11 Disassembly/Assembly of 24V PSU

6.11.1 Refer to "Disassembly/Assembly of Inner Casing" to remove the inner casing.

6.11.2 Refer to the diagram below to remove the two securing screws.

6.11.3 Refer to the diagram below to remove the three securing screws and one grounding wire screw.

6.11.4 Refer to the diagram below to disconnect the wiring and take out the 24V PSU with the bracket.

6.11.5 Refer to the diagram below to remove the six bracket securing screws and take out the 24V PSU.

6.11.6 During installation, follow the reverse steps of the above procedure. If cable ties were cut, secure the wires again in the original manner

6.12 Disassembly/Assembly of Filter

6.12.1 Slide the tray upward along the tray slide to remove it

6.12.2 Remove the filter and replace it with a new one.

6.12.3 Reinstall the tray.

7. Light Indication

7.1 Power board Light Indication

LED Position

LED Position Corresponding Function

A	24V Source	Heart-beat	PW!
B	48V PSU	Error	Temp!
C	48V Mode	STO!	ECAT!
	1	**2**	**3**

LED Position	LED Name	LED Status Description
A1	24V Source	Off = External 24V
		On = Internal 24V
		100ms/100ms Rapid Blink = Internal 24V Error
		500ms/500ms Blink = Internal 24V Current Exceeded
B1	48V PSU	Off = PSU off
		On = (Reserved)
		500ms/500ms Blink = PSU on
C1	48V Mode	Off = 48V off
		On = Normal Mode
		500ms/500ms Blink = Limit Mode
A2	HeartBeart	Off = FW Stuck or Abnormal Protection Pause
		On = FW Stuck
		500ms/500ms Blink = Running
B2	Error	Off = Normal
		100ms/100ms Rapid Blink = ESC Not Ready
		500ms/500ms Blink = Abnormal Protection Pause
		Coding = Error code (Reserved)
C2	STO Alarm	Off = Normal
		On = STO (ESM<OP)
		100ms/100ms Rapid Blink = STO (Low Voltage)
		500ms/500ms Blink = STO (Patriot Act.)
A3	Power Alarm	Off = Normal
		On = 48V & 24V Warning
		100ms/100ms Rapid Blink = 48V Warning
		500ms/500ms Blink = 24V Warning
B3	Temperature Alarm	Off = Normal
		On = PCB & Eater Warning
		100ms/100ms Rapid Blink = PCB Warning
		500ms/500ms Blink = Eater Warning

LED Position	LED Name	LED Status Description
C3	EtherCAT Alarm	Off = Normal
		On = Packet Loss Warning
		100ms/100ms Rapid Blink = InvalidFrame or RxErr or PUErr counted
		500ms/500ms Blink = PDIErr counted
		1000ms/1000ms Slow Blink = Forwarded RxERR counted

7.2 End module Indication Light Ring

7.2.1 Special Light Indication

Initializing:	Alternating between Red and Light Off equally
Power On with STO status:	Failed to finish booting up and Light Off (Buzzer no beep)
Power On with SOS status:	Finished booting up and the light indicated as the tables below.
Robot in STO status:	Light Off (Buzzer no beep)
Robot in SOS status:	Light indicated as the tables below.
Updating:	Alternating between Red and Light Off equally (at doubled speed)
Fatal Error(Need to re-boot):	Solid Red Light (Buzzer emits a long beep)

NOTE:

- STO (Safe Torque Off)* status condition includes:

1. Category 0 Stop.
2. Category 1 Stop.
3. Emergency Stop function input LOW signal.

- SOS (Safe Operation Stop)* status condition includes:

1. Safeguard function Input LOW signal.
2. Enabling Switch function at OFF Status.
3. Under safety configuration status of either safety-related parameters parameterization, Robot Stick MODE Switch function or Enable/Disable of Robot Stick function.

Refer to *Safety Manual* for details.

*Both names come from IEC 61800-5-2.

NOTE:

The different Light Indication of HW3.2 here are:

AUTO Mode: Blue

Recovery Mode: (Not provided in HW3.2)

Maintenance Setting: White

7.2.2 Regular Light Indication

The regular Light Indication alternates between 2 categories of light indication: Operation Mode Light Indication and Auxiliary Light Indication. The blinking ratio of the light indications indicates the various status of the robot. In addition, the display color of Auxiliary Light Indication prioritizes by conditions.

Operation Mode	Running status	Space/Status	Operation Mode Light Indication	Auxiliary Light Indication
MANUAL MODE	Hold to Run or Step Run	Normal	Green (100%)	-
		Error	Green (50%)	Red (50%)
		In Recovery Mode	Green (50%)	Yellow (50%)

		Trigger Maintenance Settings	Green (90%)	Blue (10%)
		Trigger Human-Machine Safety Settings	Green (90%)	Purple (10%)
	Project is running	Normal	Green (50%)	Light Off (50%)
		Error	Green (50%)	Red (50%)
		In Recovery Mode	Green (50%)	Yellow (50%)
		Trigger Maintenance	Green (50%)	Blue (50%)
Operation Mode	**Running status**	**Space/Status**	**Operation Mode Light Indication**	**Auxiliary Light Indication**
		Settings		
		Trigger Human-Machine Safety Settings	Green (50%)	Purple (50%)
	System under SOS status	Normal	Green (10%)	Light Off (90%)
		Error	Green (50%)	Red (50%)
		In Recovery Mode	Green (50%)	Yellow (50%)
		Trigger Maintenance Settings	Green (10%)	Blue (90%)
		Trigger Human-Machine Safety Settings	Green (10%)	Purple (90%)
AUTO MODE	Project is not running	Normal	White (100%)	-
		Error	White (50%)	Red (50%)
		In Recovery Mode	White (50%)	Yellow (50%)
		Trigger Maintenance Settings	White (90%)	Blue (10%)
		Trigger Human-Machine Safety Settings	White (90%)	Purple (10%)
	Project is running	Normal	White (50%)	Light Off (50%)
		Error	White (50%)	Red (50%)
		In Recovery Mode	White (50%)	Yellow (50%)
		Trigger Maintenance Settings	White (50%)	Blue (50%)

		Trigger Human-Machine Safety Settings	White (50%)	Purple (50%)
	Paused in Project or system under SOS status	Normal	White (10%)	Light Off (90%)
		Error	White (50%)	Red (50%)
		In Recovery Mode	White (50%)	Yellow (50%)
		Trigger Maintenance Settings	White (10%)	Blue (90%)
		Trigger Human-Machine Safety Settings	White (10%)	Purple (90%)

7.3 Joint LED Indication

LED Indicator Locations on the Arm Mainboard Assembly

Status		Servo LED (Green)	Error LED (Red)
MCU power on		NA	NA
Error		Error Slow Blink	Flashes with Error code
FW integrity Fail	Bootstrap	Flashes: Off/On (0.042/0.042 sec)	Always On
	Failsafe	Flashes: Off/On (0.168/0.168 sec)	Always On
Without FW		Never On	Never On
Servo on		Fast Blink	Never On
Servo off		Slow Blink	Never On

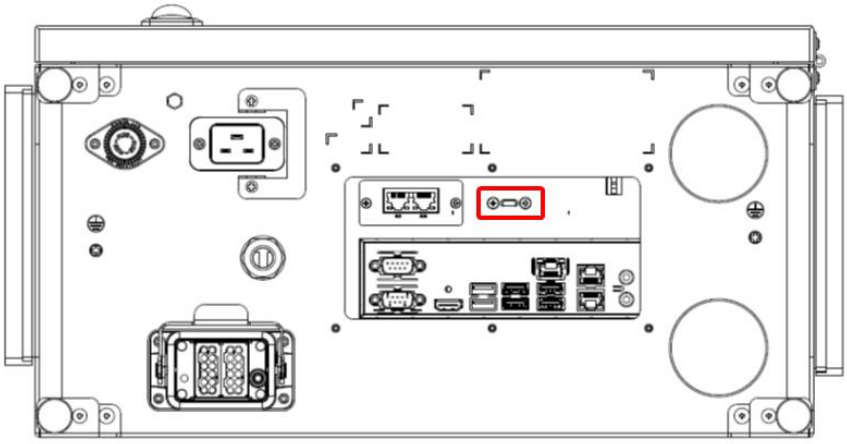
8. Other Software for support functions

8.1 Debug port

8.1.1 Tool list

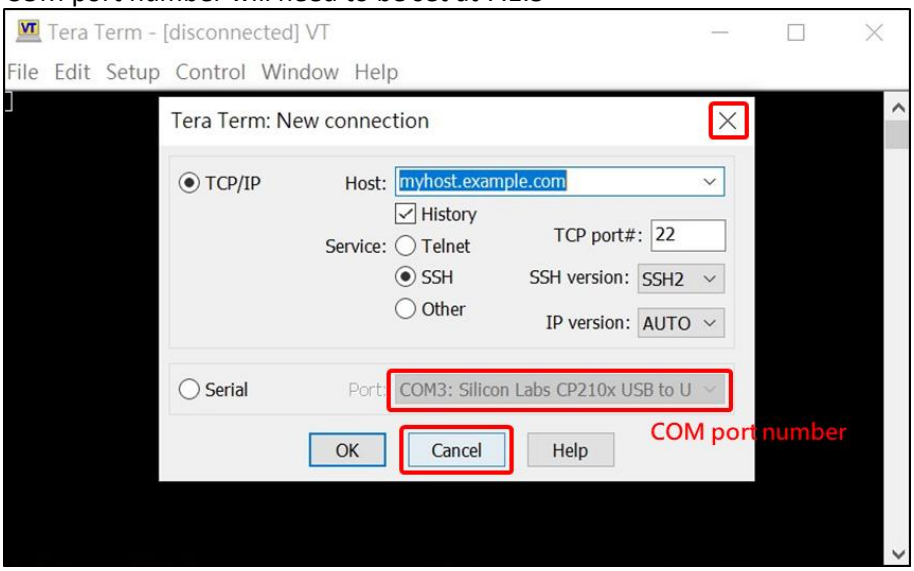
Item	Description
Laptop	Used for installing Tera term and CP2102 deriver
USB cable	Used for connecting control box and laptop. **Type C to Type A** is recommended ***Need data transfer function**
CP2102 *Software	To ensure that the laptop correctly detects the debug port Recommended download link: https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers?tab=downloads
Tera term *Software	Used for establishing the connection and displaying the information Recommended download link: https://ttssh2.osdn.jp/index.html.en

8.1.2 Power up the control box and connect it to the laptop by using a USB cable.

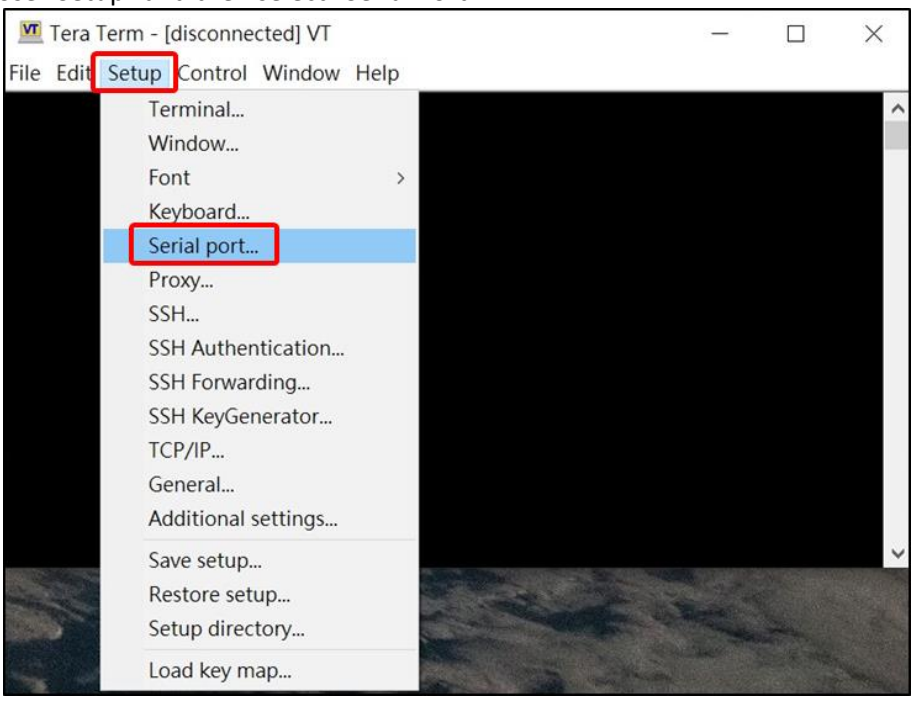


8.1.3 Activate Tera Term and then close the pop-up window by selecting "Cancel" or "Close"

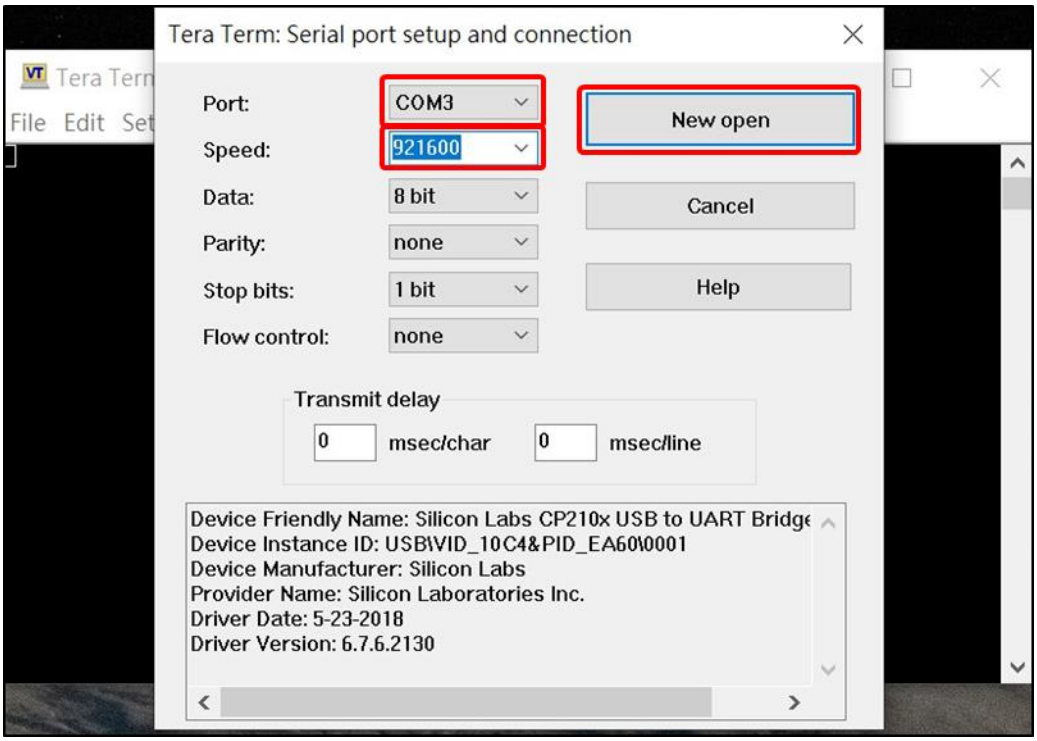
*The COM port number will need to be set at 7.1.5



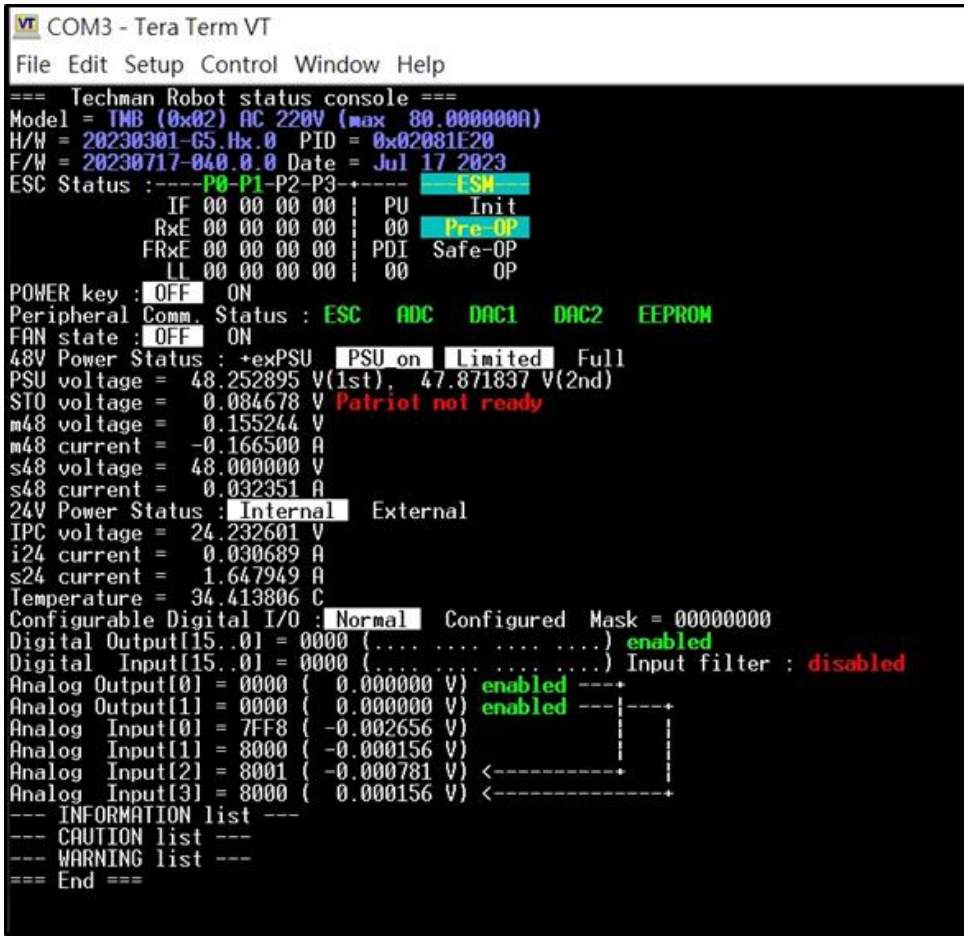
8.1.4 Choose "Setup" and then select "Serial Port"



8.1.5 Choose the port as indicated in step 2; set the speed to 926100, and then click on "New open"



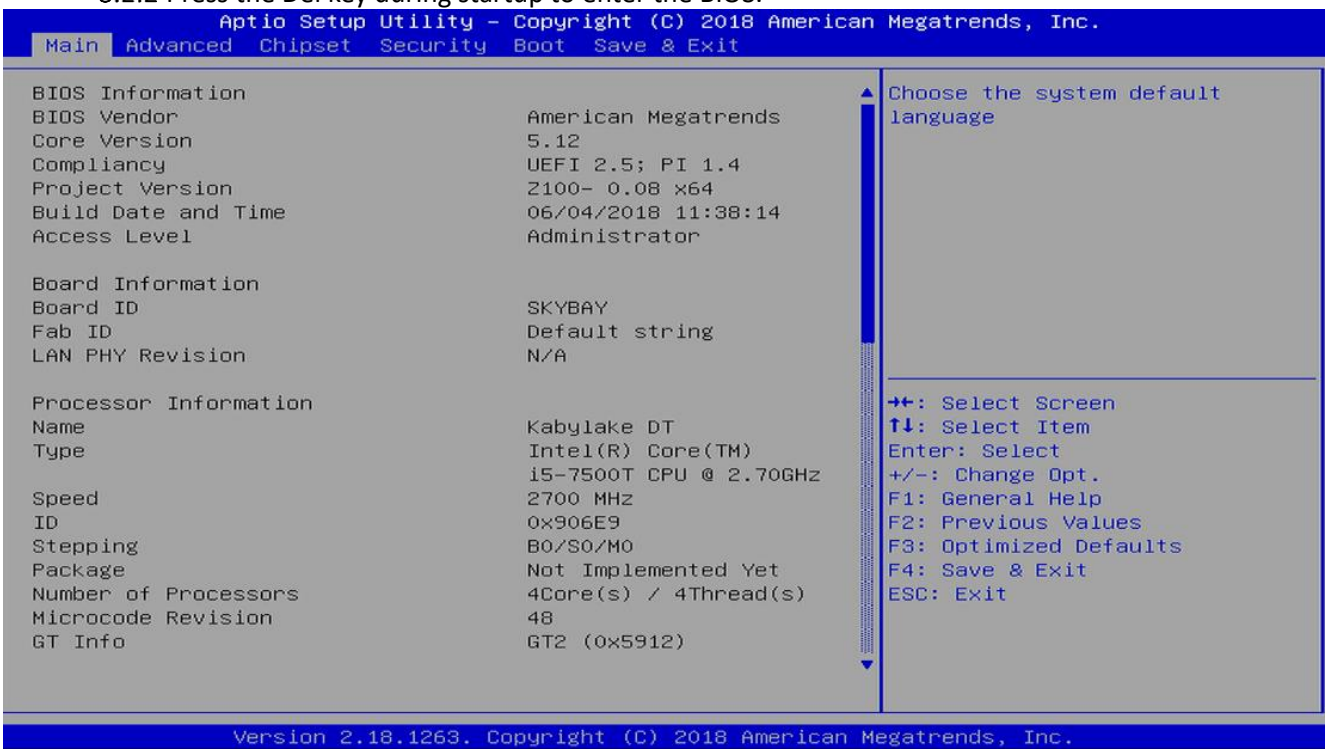
8.1.6 Following screen indicates a successful connection.


COM3 - Tera Term VT
File Edit Setup Control Window Help
=== Techman Robot status console ===
Model = TM8 (0x02) AC 220V (max 80.000000A)
H/W = 20230301-G5.Hx.0 PID = 0x02081E20
F/W = 20230717-040.0.0 Date = Jul 17 2023
ESC Status :----P0-P1-P2-P3-+---- ESM
IF 00 00 00 00 | PU Init
RxE 00 00 00 00 | 00 Pre-OP
FRxE 00 00 00 00 | PDI Safe-OP
LL 00 00 00 00 | 00 OP
POWER key : OFF ON
Peripheral Comm. Status : ESC ADC DAC1 DAC2 EEPROM
FAN state : OFF ON
48V Power Status : +exPSU PSU on Limited Full
PSU voltage = 48.252895 V(1st), 47.871837 V(2nd)
STO voltage = 0.084678 V Patriot not ready
m48 voltage = 0.155244 V
m48 current = -0.166500 A
s48 voltage = 48.000000 V
s48 current = 0.032351 A
24V Power Status : Internal External
IPC voltage = 24.232601 V
i24 current = 0.030689 A
s24 current = 1.647949 A
Temperature = 34.413806 C
Configurable Digital I/O : Normal Configured Mask = 00000000
Digital Output[15..0] = 0000 (.... ....) enabled
Digital Input[15..0] = 0000 (.... ....) Input filter : disabled
Analog Output[0] = 0000 (0.000000 V) enabled
Analog Output[1] = 0000 (0.000000 V) enabled
Analog Input[0] = 7FF8 (-0.002656 V)
Analog Input[1] = 8000 (-0.000156 V)
Analog Input[2] = 8001 (-0.000781 V)
Analog Input[3] = 8000 (0.000156 V)
--- INFORMATION list ---
--- CAUTION list ---
--- WARNING list ---
=== End ===

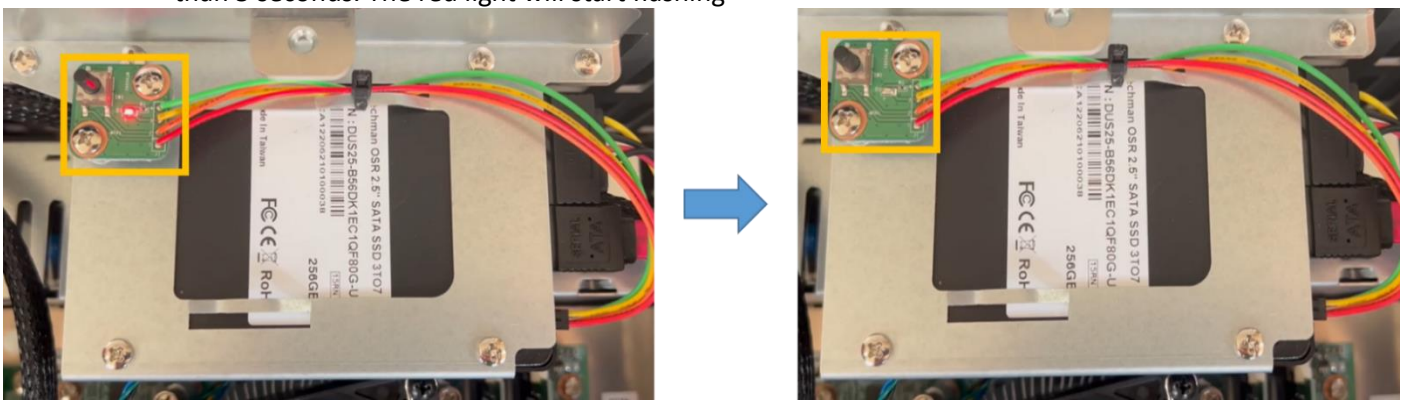
8.2 System recovery

8.2.1 This function is used to restore Disk C to the factory settings, while Disk D (e.g., projects, HMI configurations, etc.) will remain unchanged.

8.2.2 Press the Del key during startup to enter the BIOS.

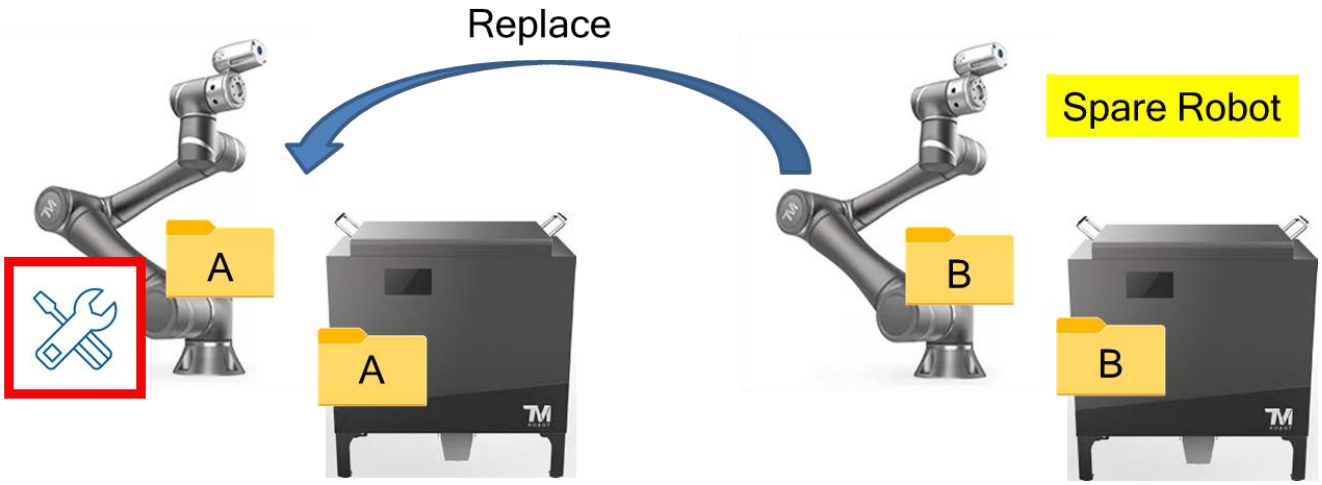


8.2.3 Open the outer casing of the control box, and press and hold the black button on the SSD for more than 5 seconds. The red light will start flashing



8.2.4 After waiting for 15 minutes, the system will complete the restoration, and the red light will become steady. Once the red light is steady, you can exit the BIOS, restart the system, and Disk C will be restored to its factory state.

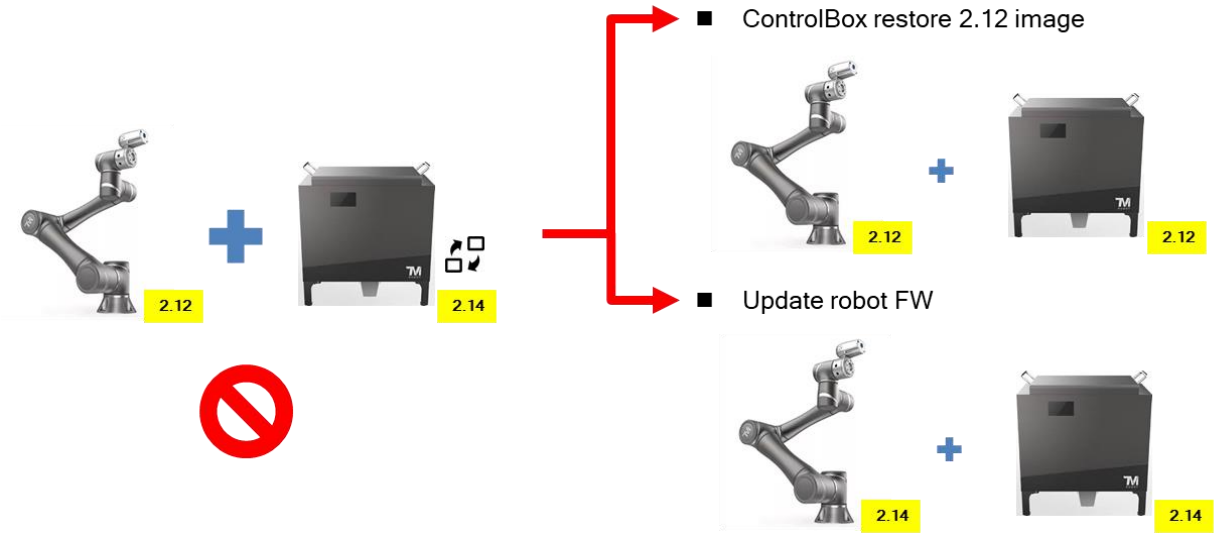
8.3 **Arm Exchange:** This function is designed for situations where either the arm or the control box experiences abnormalities. In cases of urgency, where the customer needs to quickly resume production on the assembly line, arm exchange can be performed to avoid production line downtime. As illustrated below, if Arm A is damaged, this feature facilitates the exchange of Arm A with the available Arm B in stock, enabling the production line to continue operations.



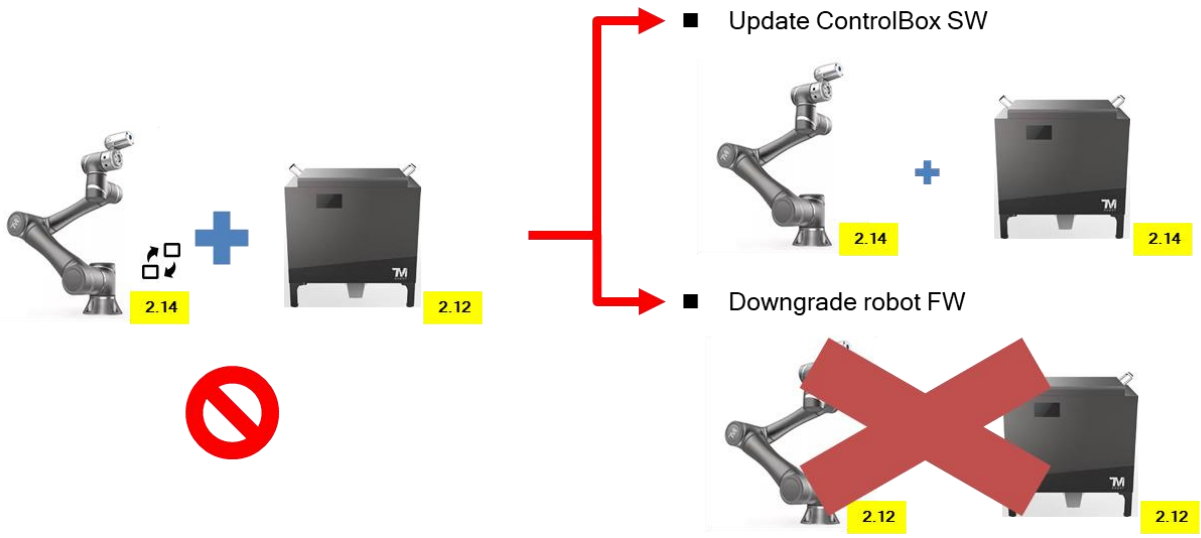
8.3.1 Remove the malfunctioning arm and directly connect the spare arm to the original control box. The calibration data stored in the arm's IO board will overwrite the data in the original control box, so it's crucial to back up the files in the original control box. The software will check whether the data between the arm and control box matches.

The following scenarios will explain the handling when the arm firmware (FW) does not match the control box HMI.

8.3.2 If the arm FW is version 2.12 but the spare control box's HMI version is 2.14, the user can choose to restore the control box's HMI image to version 2.12 or upgrade the arm FW to version 2.14.



8.3.3 When the arm FW is version 2.14, but the spare control box's HMI version is 2.12, the user can only upgrade the control box's HMI to match the FW. The main reason is that older versions of software or firmware may not recognize the new Joint type.



8.3.4 Not every arm and control box can support interchangeability. Exchange can only occur when Arm Model and Control Box Model are mutually compatible. The **Compatibility List** table below summarizes all compatible combinations. Only the Arm model and Control box model appearing simultaneously in the same column of the table can be interchanged.

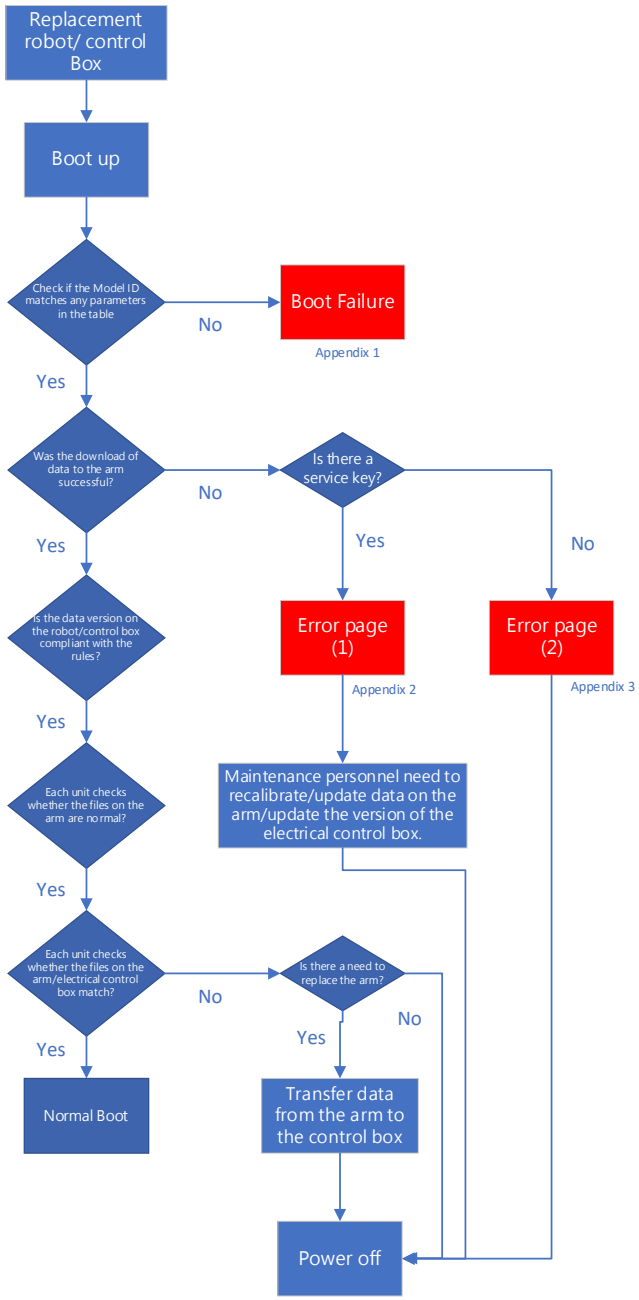
8.3.5 Example: TM5B-070050000 and CAL0500000 both appear in the same column, so this arm and this control box can be interchanged.

Compatibility List		
TM5B	**TMAB**	**TMVB & TMBB**
TM5B-070050000CAL0500000	TMAB-130050000CAM0500000	TMVB-000000000CXX0000000
TM5B-070050010CAL0500100	TMAB-130050010CAM0500100	TMBB-170500000CAH5000000
TM5B-070050000CM-0500000	TMAB-130050000CM-0500000	TMBB-170500010CAH5000100
TM5B-070050010CM-0500100	TMAB-130050010CM-0500100	TMBBX170500000CAH5000000
TM5B-070050000CM-0500010	TMAB-130050000CM-0500010	TMBBX170500010CAH5000100
TM5B-070050010CM-0500110	TMAB-130050010CM-0500110	TMBB-180050000CAH0500000
TM5B-090050000CAL0500000	TMAB-130050100CAM0501000	TMBB-180500010CAH5000100
TM5B-090050010CAL0500100	TMAB-130050110CAM0501100	TMBB-180050000CMH0500000
TM5B-090050000CM-0500000	TMAB-130050100CAM0501010	TMBB-190050000CAH0500000
TM5B-090050010CM-0500100	TMAB-130050110CAM0501110	TMBB-190050010CAH0500100
TM5B-090050000CM-0500010	TMAB-130050100CM-0501000	TMBB-190050000CAH0500010
TM5B-090050010CM-0500110	TMAB-130050110CM-0501100	TMBB-190050010CAH0500110
TM5B-090050100CAL0501000	TMAB-130050100CM-0501010	TMBB-190050000CMH0500000
TM5B-090050110CAL0501100	TMAB-130050110CM-0501110	TMBB-190050010CMH0500100
TM5B-090050100CAL0501010	TMABX130050100CAM0501000	TMBB-190050000CMH0500010
TM5B-090050110CAL0501110	TMABX130050110CAM0501100	TMBB-190050010CMH0500110
TM5B-090050100CM-0501000	TMABX130050100CAM0501010	TMBBX190050000CAH0500000
TM5B-090050110CM-0501100	TMABX130050110CAM0501110	TMBBX190050010CAH0500100
TM5B-090050100CM-0501010	TMABX130050100CM-0501000	TMBBX190050000CAH0500010
TM5B-090050110CM-0501110	TMABX130050110CM-0501100	TMBBX190050010CAH0500110
TM5BX090050100CAL0501000	TMABX130050100CM-0501010	TMBBX190050000CMH0500000
TM5BX090050110CAL0501100	TMABX130050110CM-0501110	TMBBX190050010CMH0500100
TM5BX090050100CAL0501010	TMAB-110050100CAM0501000	TMBBX190050000CMH0500010
TM5BX090050110CAL0501110	TMAB-110050110CAM0501100	TMBBX190050010CMH0500110
TM5BX090050100CM-0501000	TMAB-110050100CAM0501010	TMBB-191050000CAH0500000

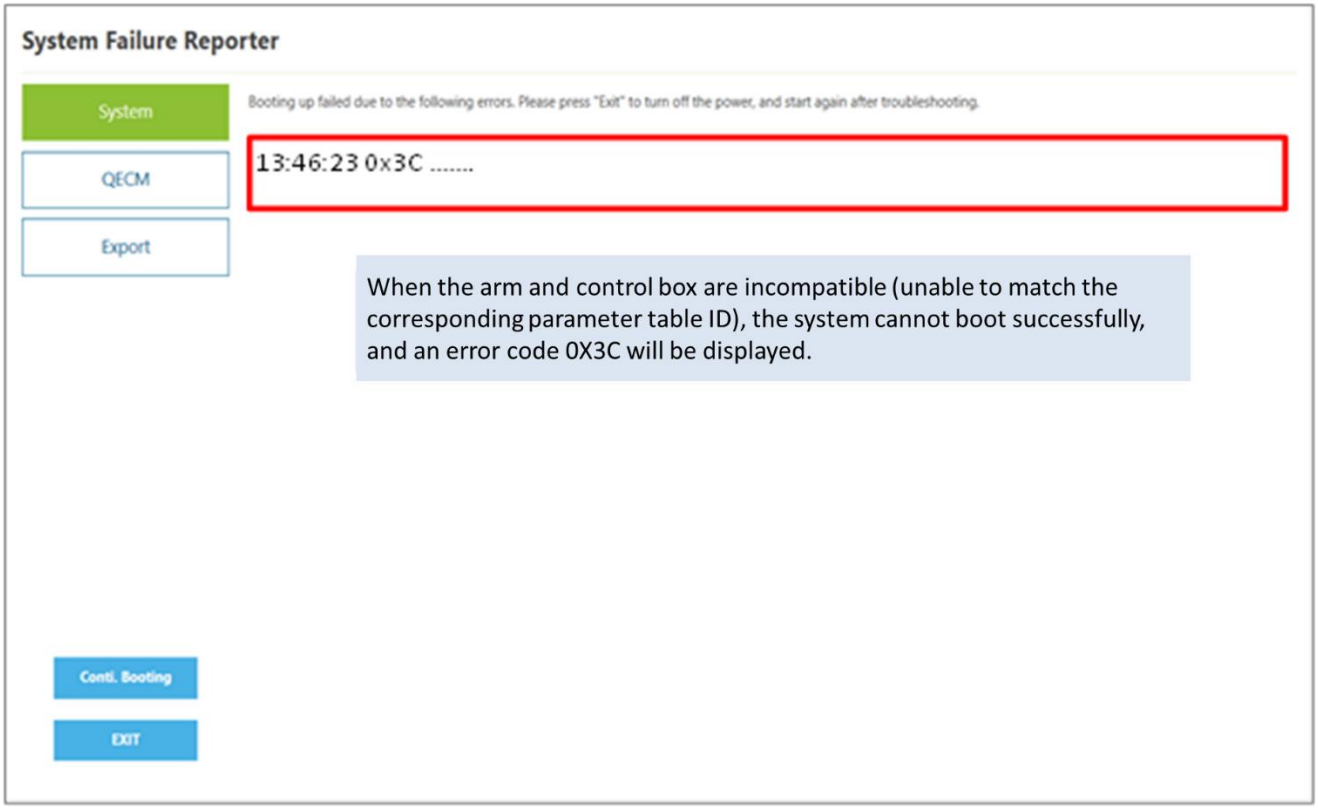
Compatibility List		
TM5B	TMAB	TMVB & TMBB
TM5BX090050110CM-0501100	TMAB-110050110CAM0501110	TMBB-191050010CAH0500100
TM5BX090050100CM-0501010	TMAB-110050100CM-0501000	TMBB-191050000CAH0500010
TM5BX090050110CM-0501110	TMAB-110050110CM-0501100	TMBB-191050010CAH0500110
TM5B-070050100CAL0501000	TMAB-110050100CM-0501010	TMBB-191050000CMH0500000
TM5B-070050110CAL0501100	TMAB-110050110CM-0501110	TMBB-191050010CMH0500100
TM5B-070050100CAL0501010	TMABX110050100CAM0501000	TMBB-191050000CMH0500010
TM5B-070050110CAL0501110	TMABX110050110CAM0501100	TMBB-191050010CMH0500110
TM5B-070050100CM-0501000	TMABX110050100CAM0501010	TMBBX191050000CAH0500000
TM5B-070050110CM-0501100	TMABX110050110CAM0501110	TMBBX191050010CAH0500100
TM5B-070050100CM-0501010	TMABX110050100CM-0501000	TMBBX191050000CAH0500010
TM5B-070050110CM-0501110	TMABX110050110CM-0501100	TMBBX191050010CAH0500110
TM5BX070050100CAL0501000	TMABX110050100CM-0501010	TMBBX191050000CMH0500000
TM5BX070050110CAL0501100	TMABX110050110CM-0501110	TMBBX191050010CMH0500100
TM5BX070050100CAL0501010	TMAB-090050100CAM0501000	TMBBX191050000CMH0500010
TM5BX070050110CAL0501110	TMAB-090050110CAM0501100	TMBBX191050010CMH0500110
TM5BX070050100CM-0501000	TMAB-090050100CAM0501010	TMBB-150500000CAH5000000
TM5BX070050110CM-0501100	TMAB-090050110CAM0501110	TMBB-150500010CAH5000100
TM5BX070050100CM-0501010	TMAB-090050100CM-0501000	TMBBX150500000CAH5000000
TM5BX070050110CM-0501110	TMAB-090050110CM-0501100	TMBBX150500010CAH5000100
	TMAB-090050100CM-0501010	TMBB-171050000CAH0500000
	TMAB-090050110CM-0501110	TMBB-171050010CAH0500100
	TMABX090050100CAM0501000	TMBB-171050000CAH0500010
	TMABX090050110CAM0501100	TMBB-171050010CAH0500110
	TMABX090050100CAM0501010	TMBB-171050000CMH0500000
	TMABX090050110CAM0501110	TMBB-171050010CMH0500100
	TMABX090050100CM-0501000	TMBB-171050000CMH0500010
	TMABX090050110CM-0501100	TMBB-171050010CMH0500110
	TMABX090050100CM-0501010	TMBBX171050000CAH0500000
	TMABX090050110CM-0501110	TMBBX171050010CAH0500100
		TMBBX171050000CAH0500010
		TMBBX171050010CAH0500110
		TMBBX171050000CMH0500000
		TMBBX171050010CMH0500100
		TMBBX171050000CMH0500010
		TMBBX171050010CMH0500110
		TMBB-172050000CAH0500000
		TMBB-172050010CAH0500100
		TMBB-172050000CAH0500010
		TMBB-172050010CAH0500110
		TMBB-172050000CMH0500000
		TMBB-172050010CMH0500100
		TMBB-172050000CMH0500010
		TMBB-172050010CMH0500110

Compatibility List		
TM5B	TMAB	TMVB & TMBB
		TMBBX172050000CAH0500000
		TMBBX172050010CAH0500100
		TMBBX172050000CAH0500010
		TMBBX172050010CAH0500110
		TMBBX172050000CMH0500000
		TMBBX172050010CMH0500100
		TMBBX172050000CMH0500010
		TMBBX172050010CMH0500110

8.3.6 The flowchart below showing the process that the system will follow in the background after swapping the arm with the control box. If there are no errors or anomalies during the process, it is considered a successful interchange. For troubleshooting in case of abnormal situations, please refer to the Appendix.

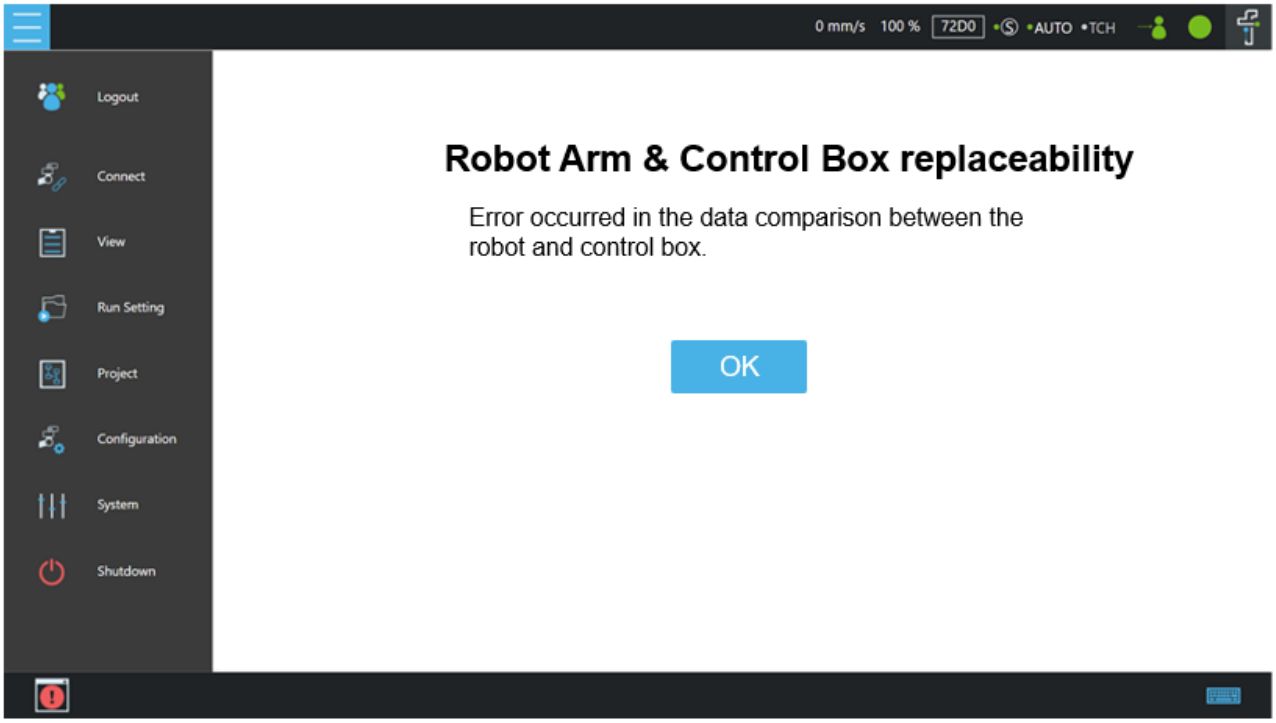

Replacement robot/ control Box
Boot up
Check if the Model ID matches any parameters in the table
No
Boot Failure
Appendix 1
Yes
Was the download of data to the arm successful?
No
Is there a service key?
Yes
No
Yes
Is the data version on the robot/control box compliant with the rules?
Error page (1)
Appendix 2
Error page (2)
Appendix 3
Yes
Each unit checks whether the files on the arm are normal?
Maintenance personnel need to recalibrate/update data on the arm/update the version of the electrical control box.
Yes
Each unit checks whether the files on the arm/electrical control box match?
No
Is there a need to replace the arm?
No
Yes
Yes
Normal Boot
Transfer data from the arm to the control box
Power off

Appendix 1



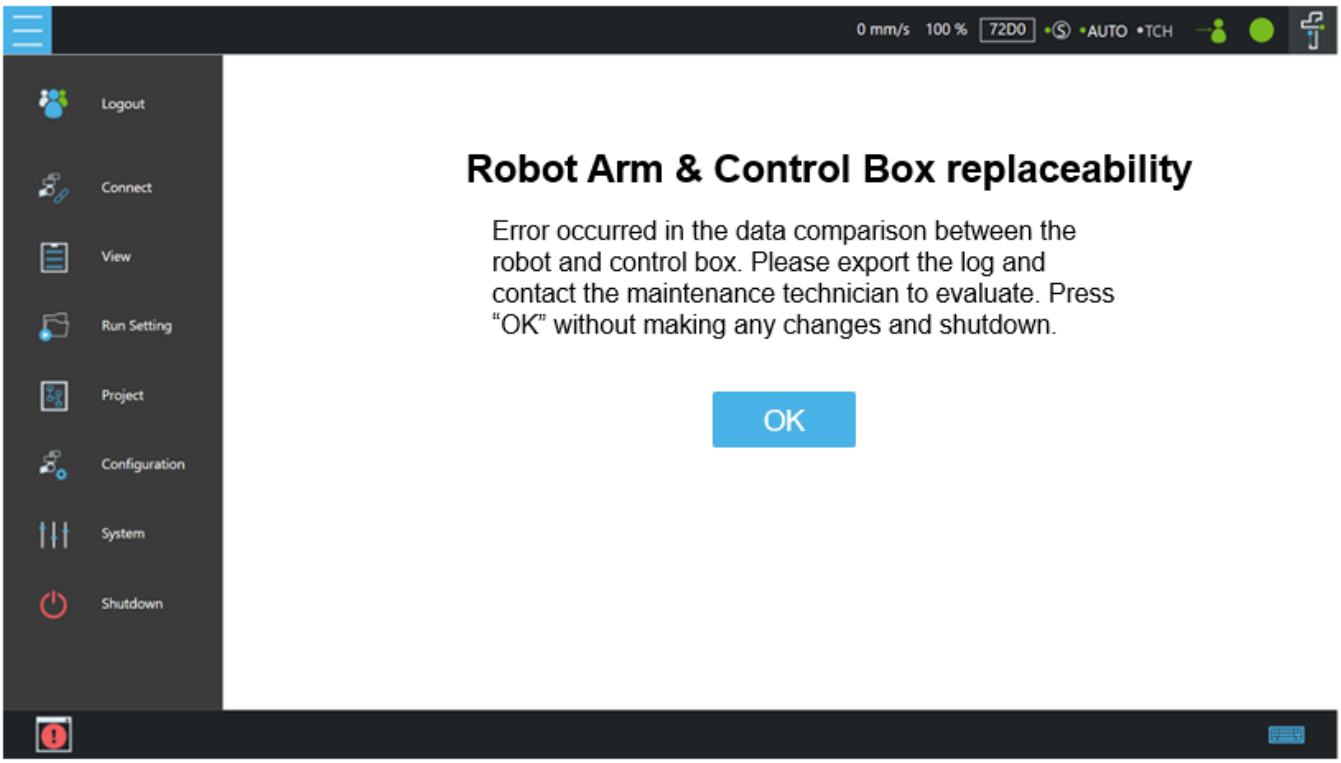
- This issue indicates that the arm and control box combination may not support interchangeability. Please double-check the compatibility list to ensure that the combination is valid. If it is a valid combination and you still encounter this problem, it is recommended to contact the headquarters' engineers for further assistance.

Appendix 2



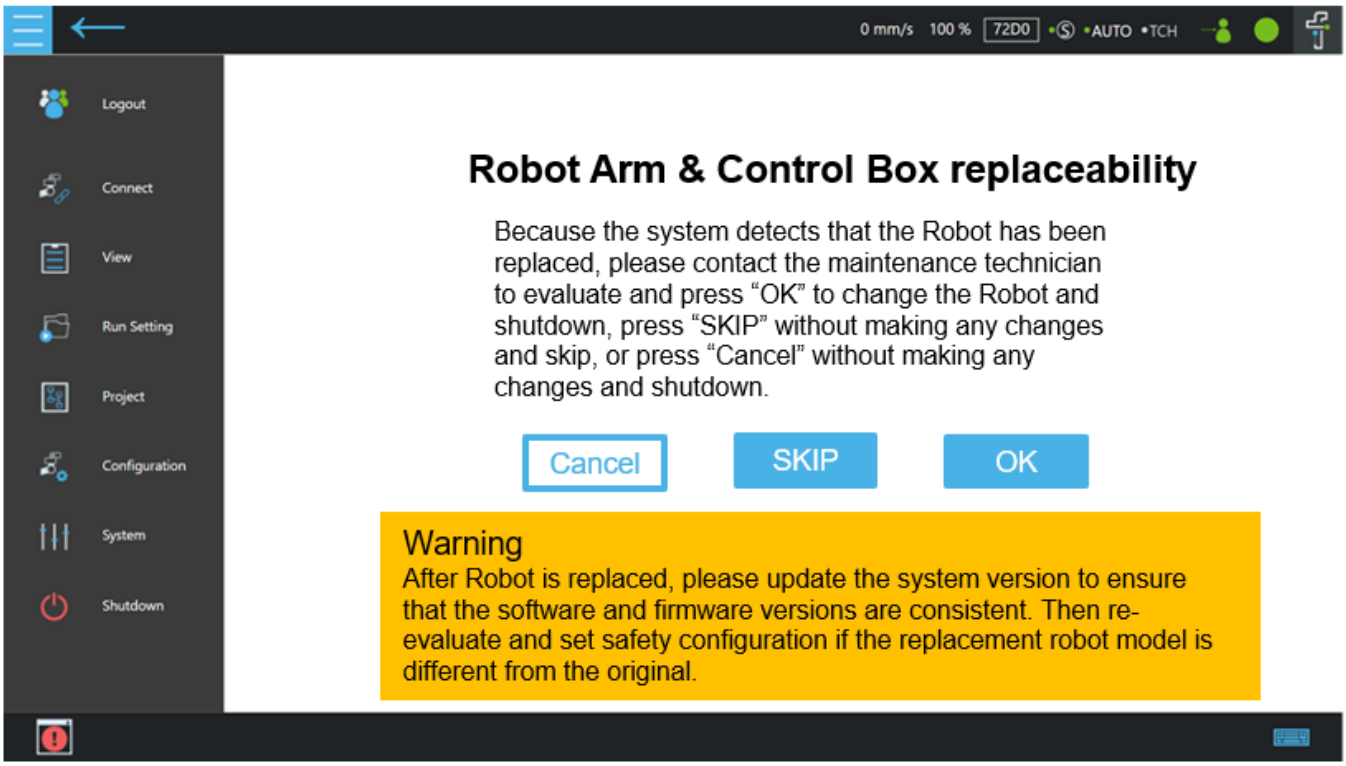
- This error indicates a data comparison issue, and it may trigger a special page with log entries such as 0x00045240 (download failed or data error) or 0xF0000180 (version comparison failed).
- The maintenance personnel need to recalibrate/update arm-end data/update control box version.

Appendix 3



- The error message "Data comparison error prompts a special page and logs 0x00045240 (download failed or data error) or 0xF0000180 (version comparison failed). Please export the logs and contact the headquarters maintenance personnel for assistance

Appendix 4



If all the above criteria are met, but the data on the arm side differs from the data on the control box side, switch to this special page after turning on the machine.

Cancel : Do not make any changes. Click to initiate the shutdown procedure.

SKIP：No changes needed. Click to exit this special page. If there is no service key, the button will be greyed out and cannot be clicked.

OK : Overwrite the data of the arm side to the control box side, and switch off the machine, if there is no Service key, the button will be greyed out and cannot be clicked.

Note: The visual connection camera check takes approximately 60 seconds. During Normal power on, the page may jump to this special page after a period of time. The check will first go to the Normal condition, and then jump to this special page when any unit is checked to a different condition.

Please click 'OK' and enter the Safety Password to confirm the arm change. This password is the same as the Safety Configuration Tool Password.

After replacing the arm, update the system version to ensure the firmware version remains the same. If the arm model has been changed, conduct a new safety assessment and modify the safety function settings

9. Calibration guide

Reference the order of images in the following sections for calibration.

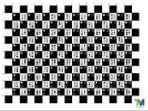
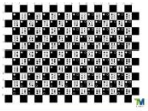
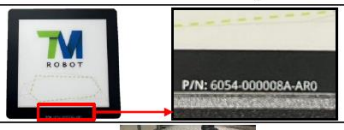
Contents

Important notes:

1. To avoid collisions, the gripper, external cables, and external equipment must be removed before performing calibration.
2. For the X-version robot without a camera, only **Dynamic Calibration** and **Hand-Guide Calibration** need to be performed.
3. **Camera Calibration** is required only when replacing the End Module or camera. If a Joint is replaced, perform **Kinematic Calibration**, **Hand-Eye Calibration**, **Verification**, and **Barcode Setting**.
4. Before calibration, ensure the robot is securely mounted to the platform, and that the platform remains stable without any shaking during arm movement.
5. Move the robot to the **Home Pose** while powered on and confirm there is no backlash or misalignment in any joint.
6. During calibration, use standard indoor lighting as the primary light source. Additional lighting is unnecessary unless in special environments with insufficient or unstable lighting.
7. To maintain stability in the relative position between the robot and the calibration plate, both must be mounted on the same platform.

9.1 Tools and space

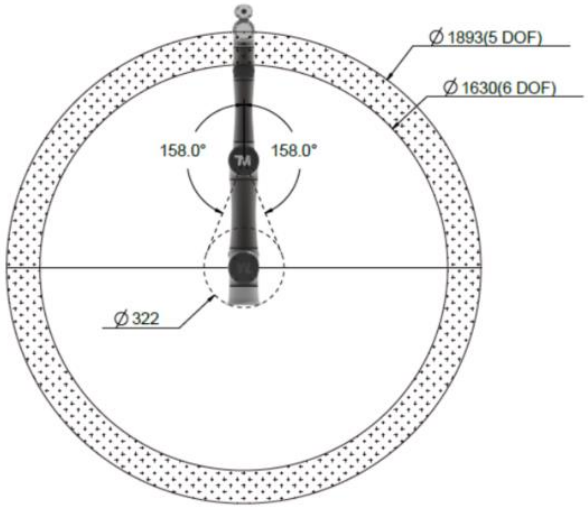
Tools and space

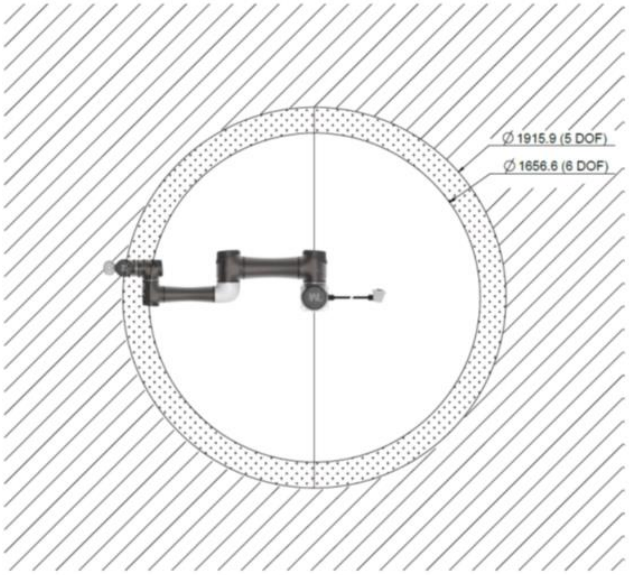
1	Maintenance dongle	
2	Small dice board *Only the new calibration plate can be used (the new version has a smooth touch, whereas the old version has noticeable printed texture when touched).	
3	Big dice board *Only the new calibration plate can be used (the new version has a smooth touch, whereas the old version has noticeable printed texture when touched).	
4	Landmark *Only the new aluminum anti-reflective version of the Landmark (with part number 6054-000008A-AR0 at the base) can be used, and ensure the protective film on top has been removed.	
5	Calibration plateform	

Tools and space

Ensure that there is enough space to perform the calibration.

TM5S / TM5S-M / TM5S-X

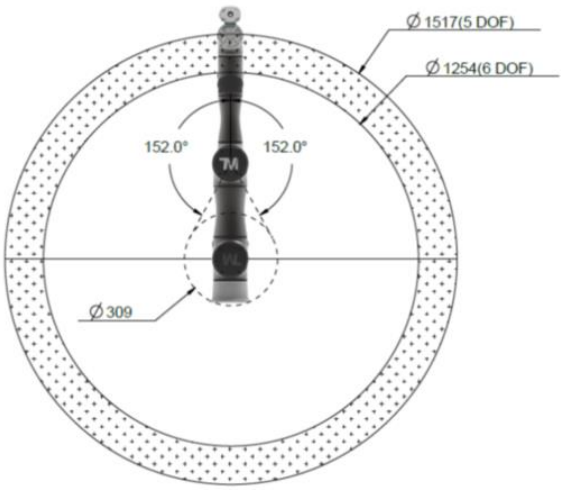


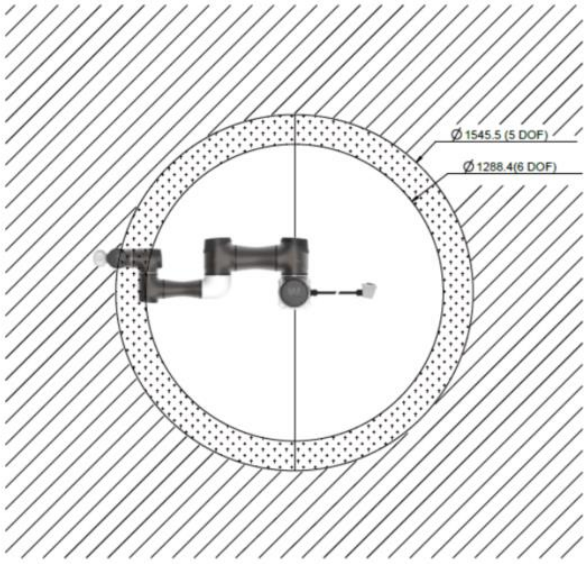


Tools and space

Ensure that there is enough space to perform the calibration.

TM7S / TM7S-M / TM7S-X

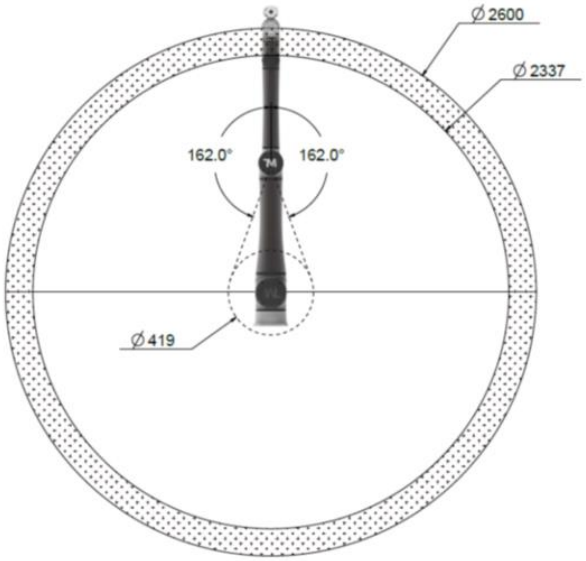


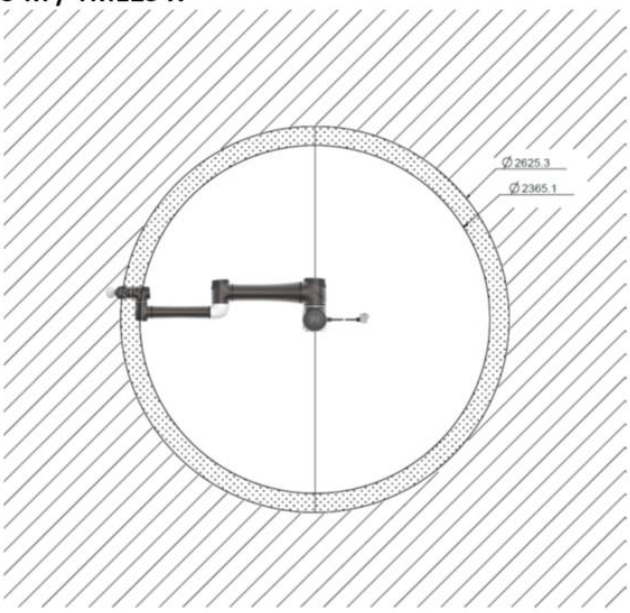


Tools and space

Ensure that there is enough space to perform the calibration.

TM12S / TM12S-M / TM12S-X

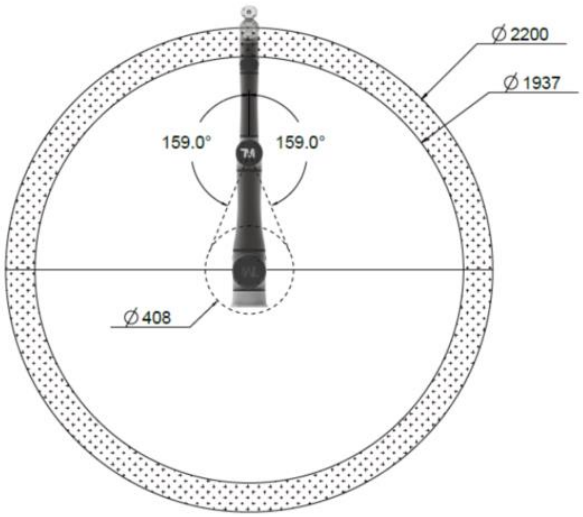


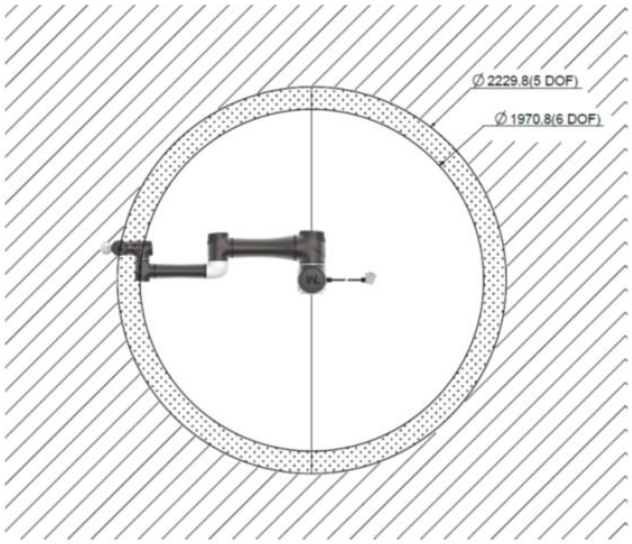


Tools and space

Ensure that there is enough space to perform the calibration.

TM14S / TM14S-M / TM14S-X

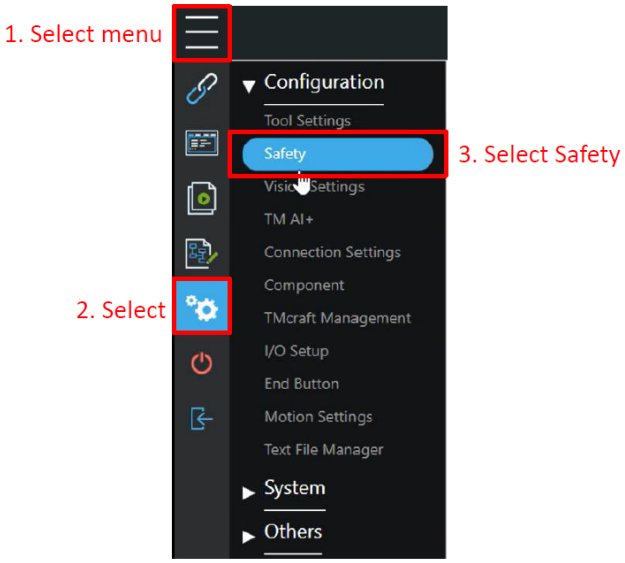




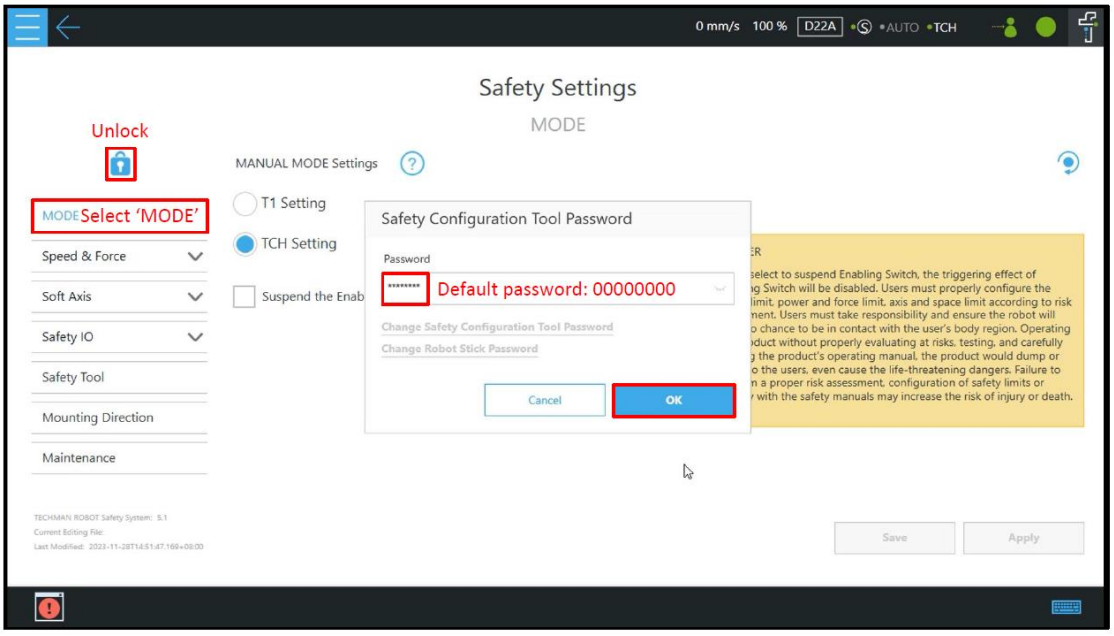
9.2 Settings for calibration

Settings for calibration

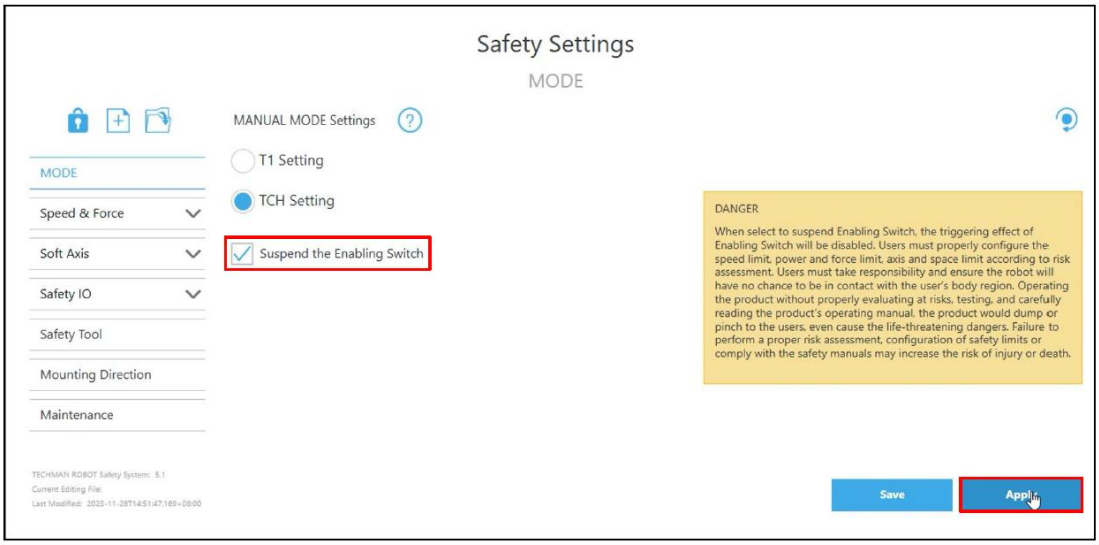
*Please restore the following settings after the calibration process is completed.
*Insert the maintenance dongle before perform following steps and calibration.



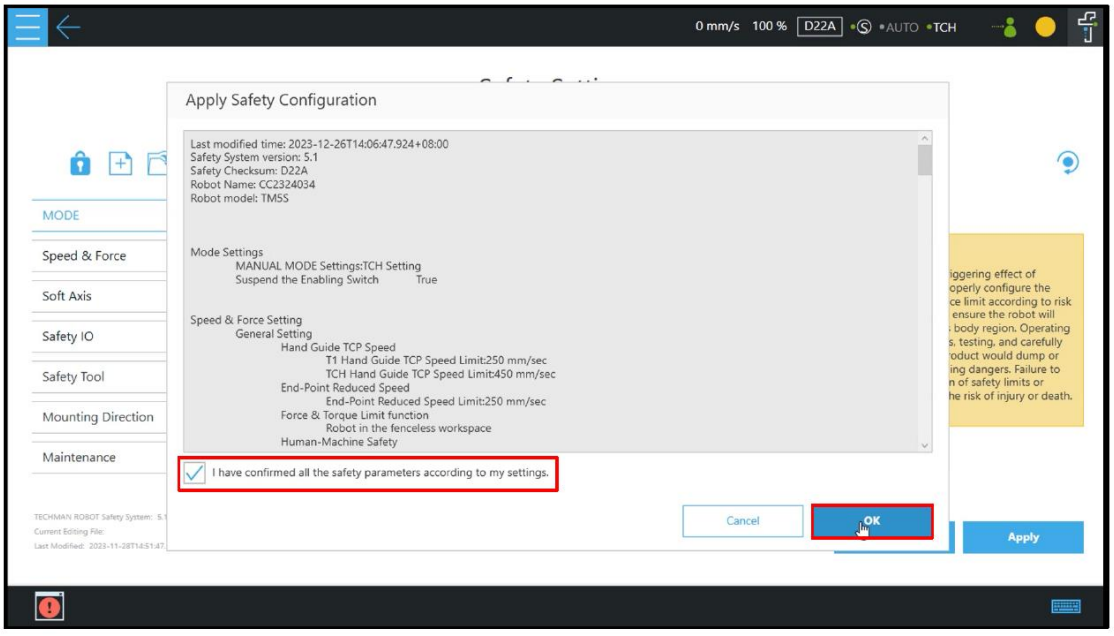
Settings for calibration



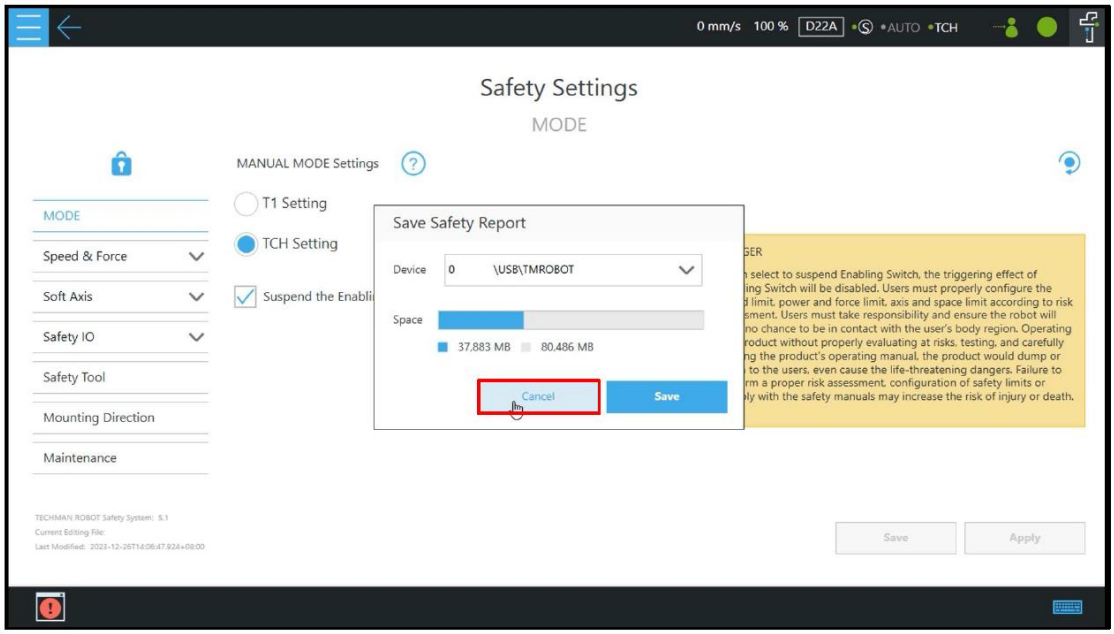
Settings for calibration



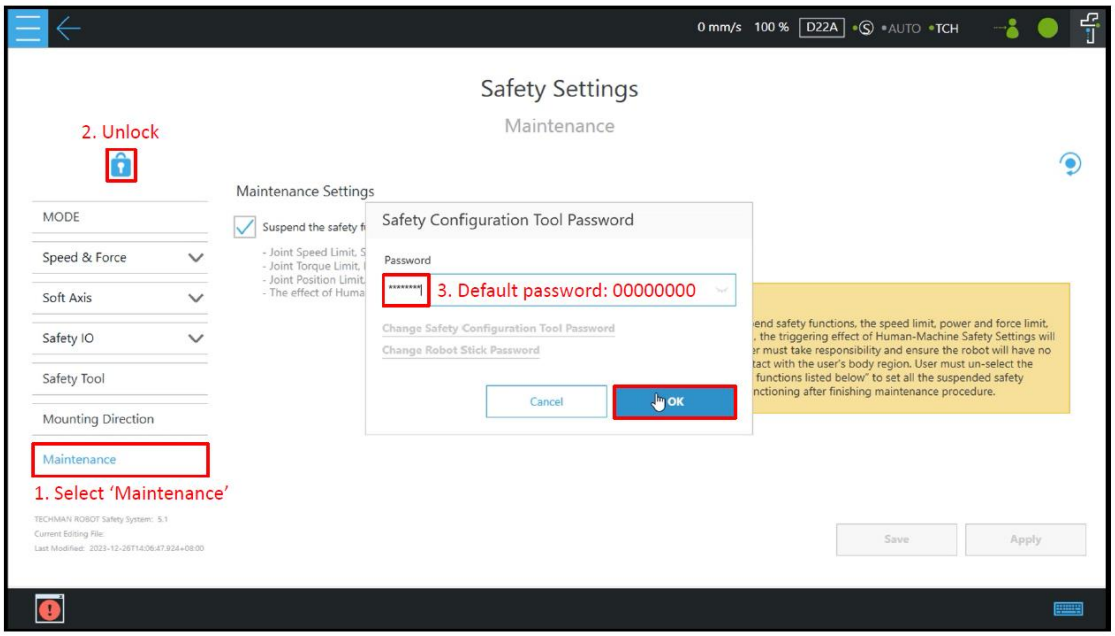
Settings for calibration



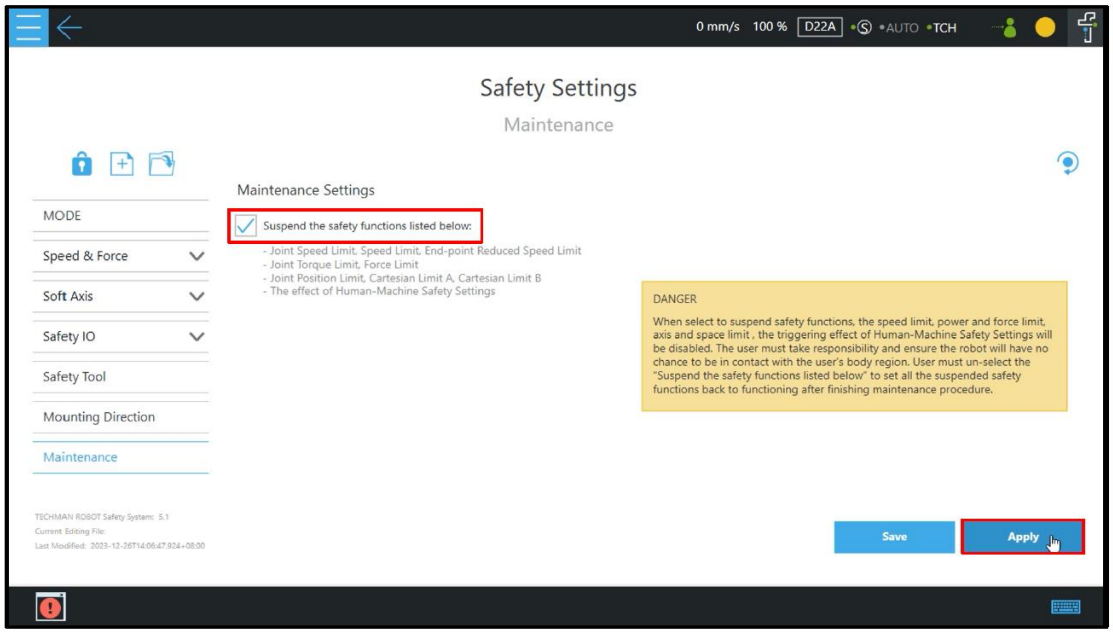
Settings for calibration



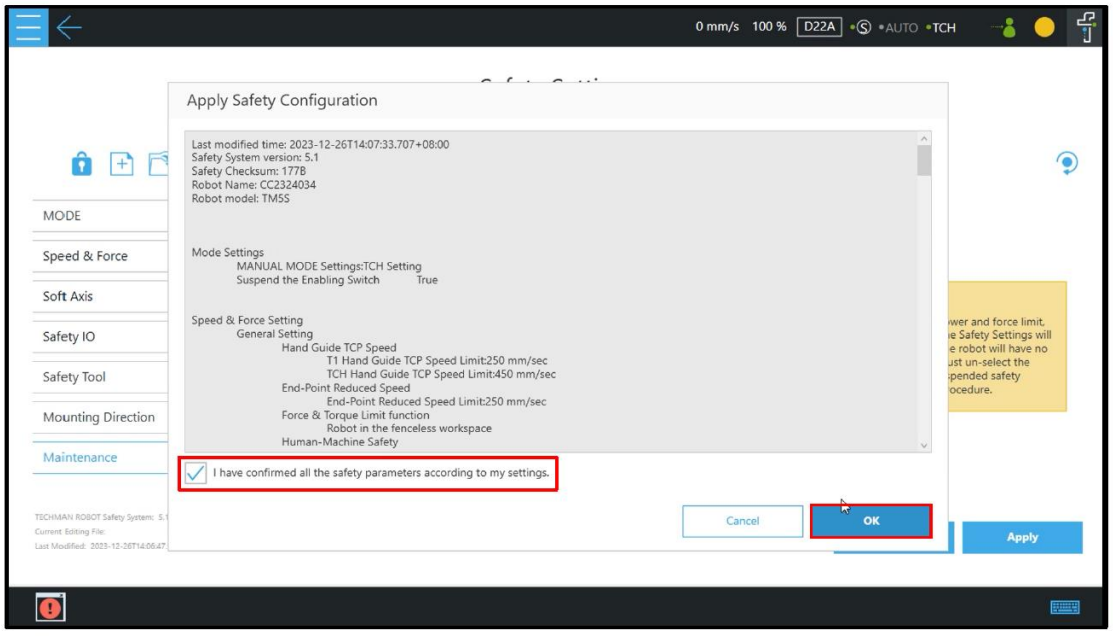
Settings for calibration



Settings for calibration



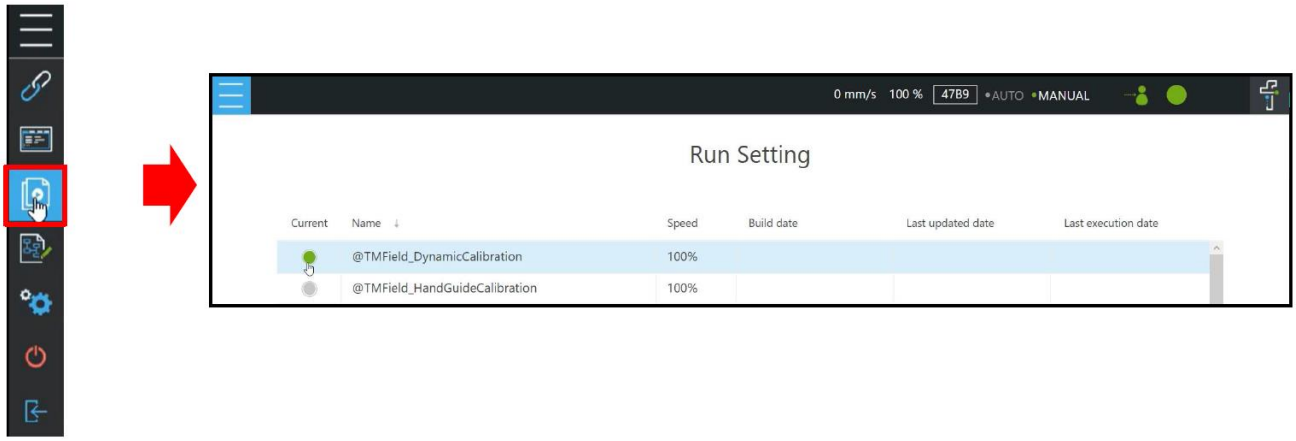
Settings for calibration



9.3 Dynamic calibrationand Hand-guide calibration

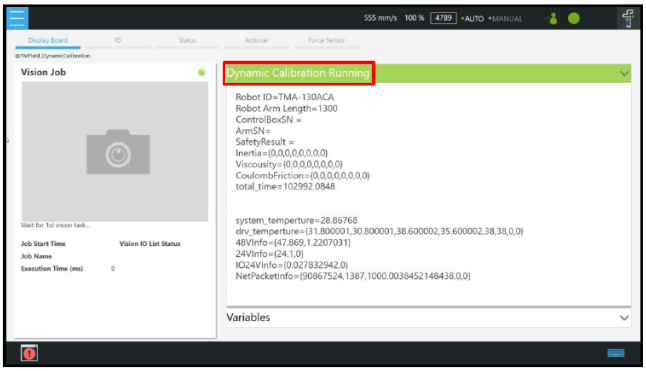
Dynamic calibration and Hand-guide calibration – Dynamic calibration

1. Select the @TMField_DynamicCalibration
2. Switch the robot into auto mode and run the project.

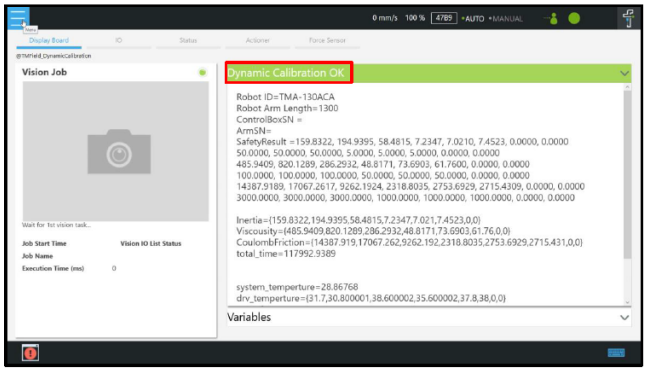


Dynamic calibration and Hand-guide calibration – Dynamic calibration

Dynamic calibration is running

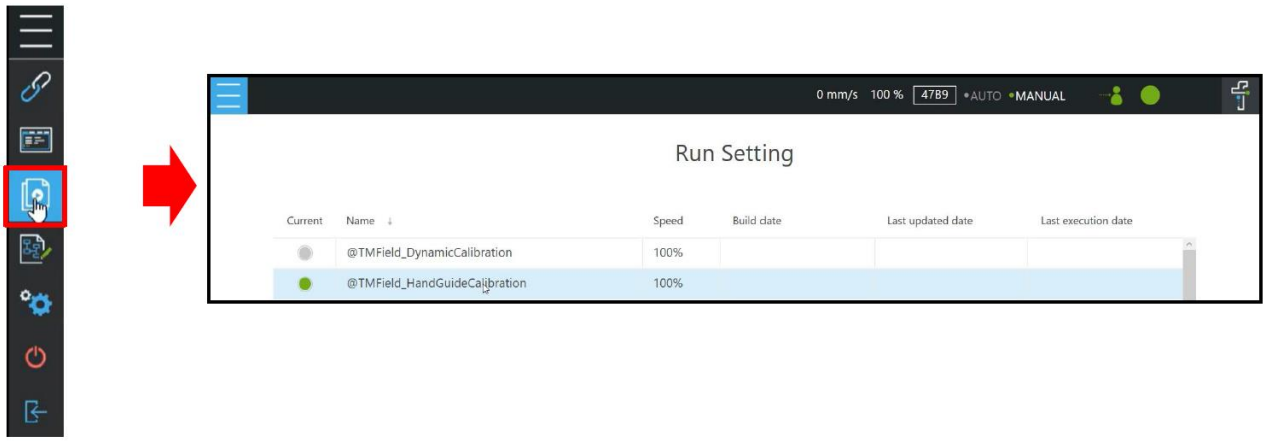


Dynamic calibration completed



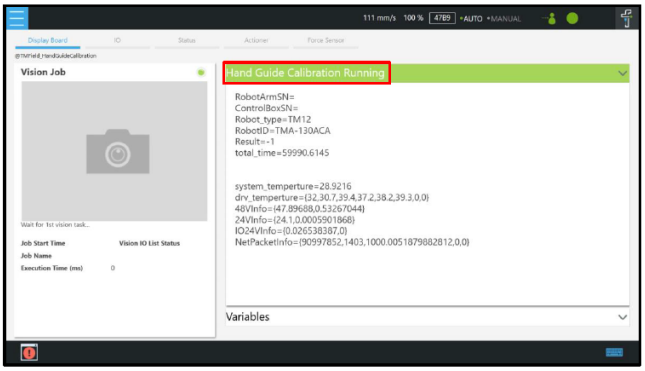
Dynamic calibration and Hand-guide calibration – Hand-guide calibration

1. Select the @TMField_HandGuideCalibration
2. Switch the robot into auto mode and run the project.

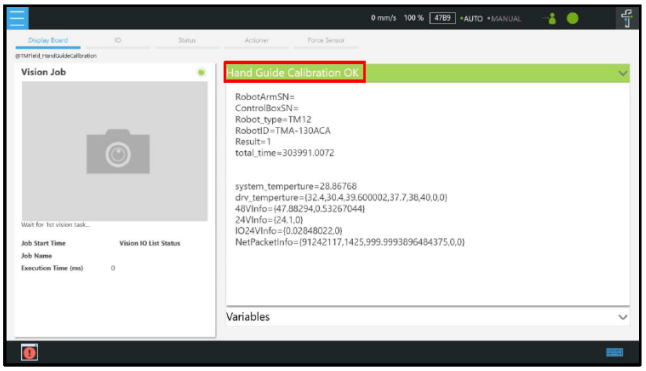


Dynamic calibration and Hand-guide calibration – Hand-guide calibration

Hand-guide calibration is running

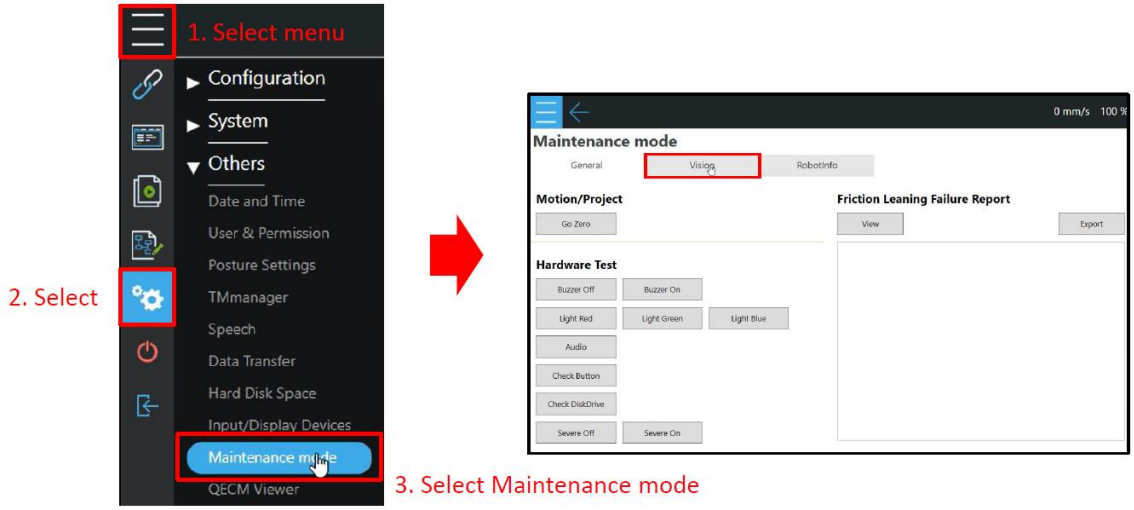


Hand-guide calibration completed

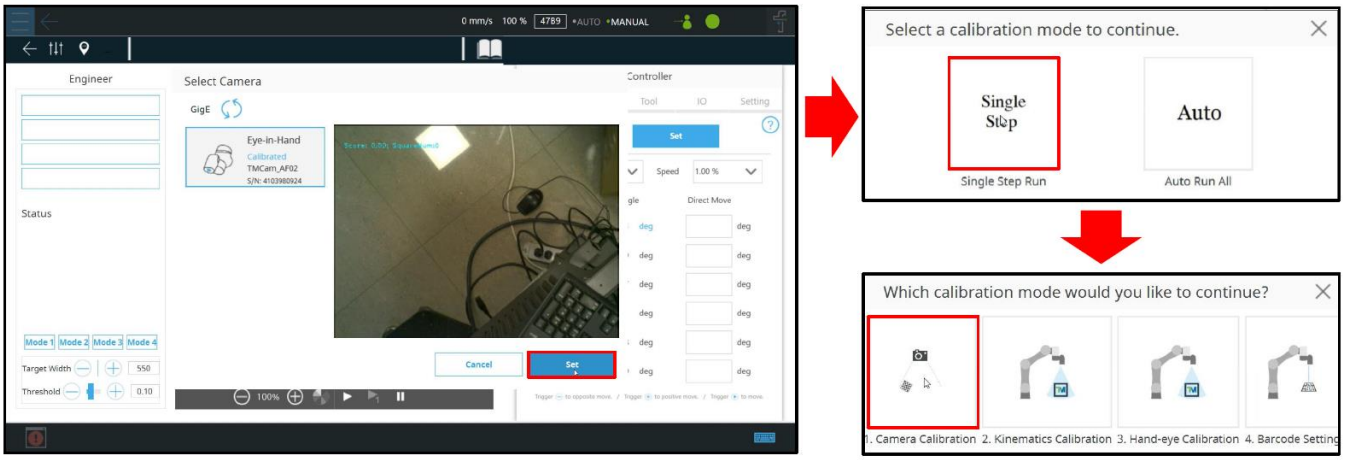


9.4 Camera calibration

Camera calibration

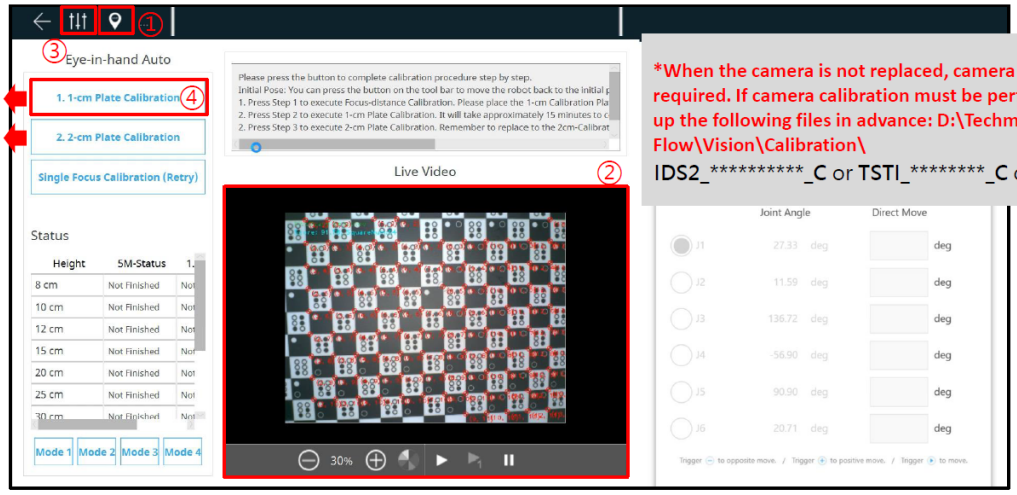


Camera calibration



Camera calibration

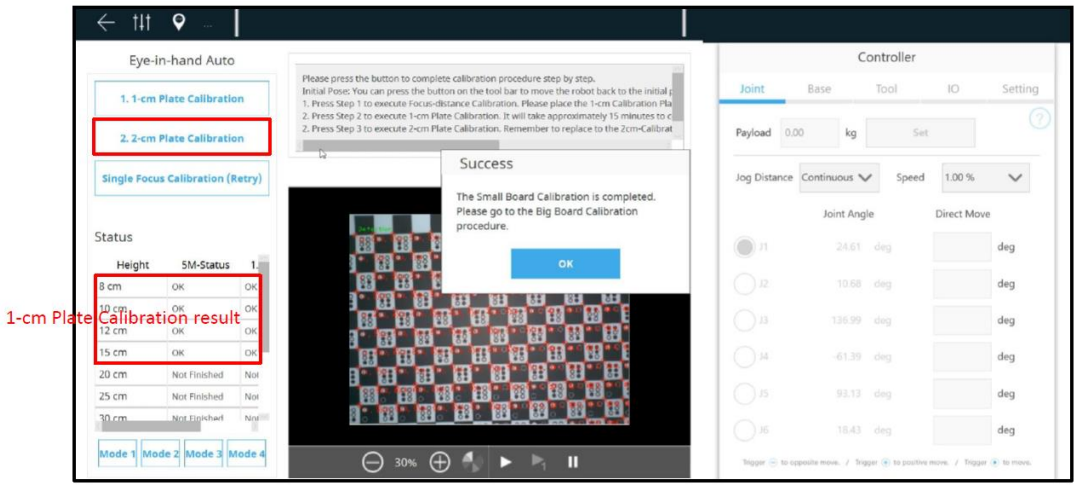
1. Use ① to move the robot to the designated position, then place the **small dice board** and make sure the camera can see the entire dice board as shown in ②
2. Use ③ to adjust the parameters (Activate the built-in light and set the values as 255; for other settings, click Auto once)
3. After setting up, click ④1-cm Plate Calibration to start the calibration



*When the camera is not replaced, camera calibration is not required. If camera calibration must be performed, please back up the following files in advance: D:\Techman Robot\TM Flow\Vision\Calibration\
IDS2_**********_C or TSTI_********_C or TRI_********_C

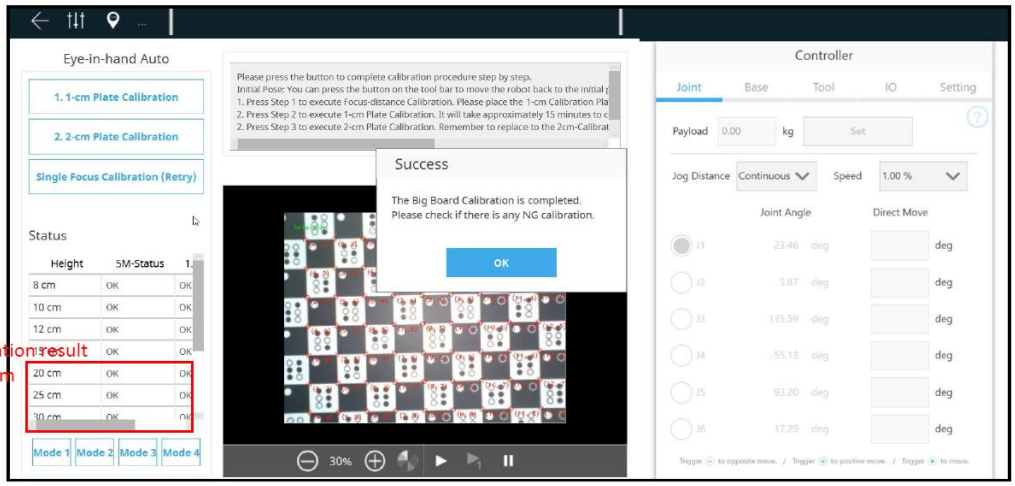
Camera calibration

1. Setting up the **big dice board** properly after 1-cm Plate Calibration(small dice board) is completed.
2. Run 2-cm Plate Calibration.



Camera calibration

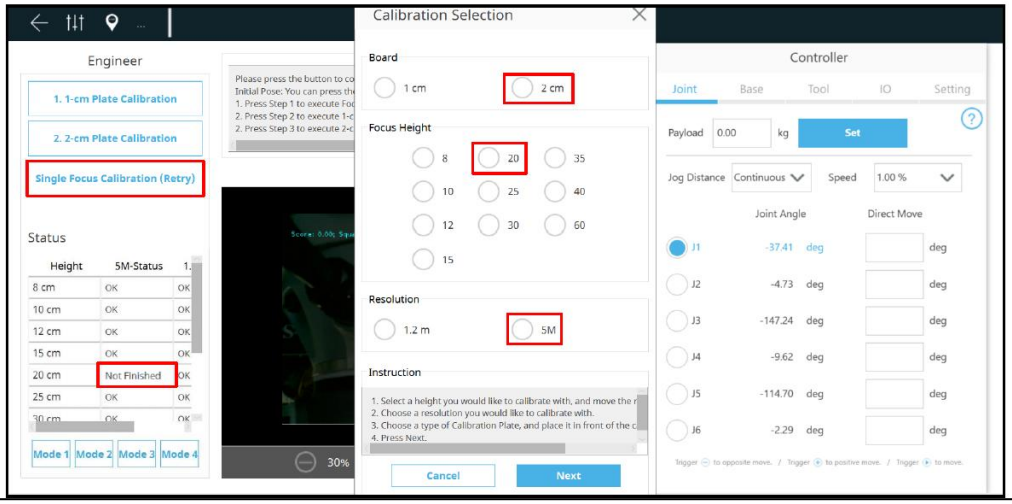
2-cm Plate Calibration completed.



2-cm Plate Calibration result from 20cm to 60cm

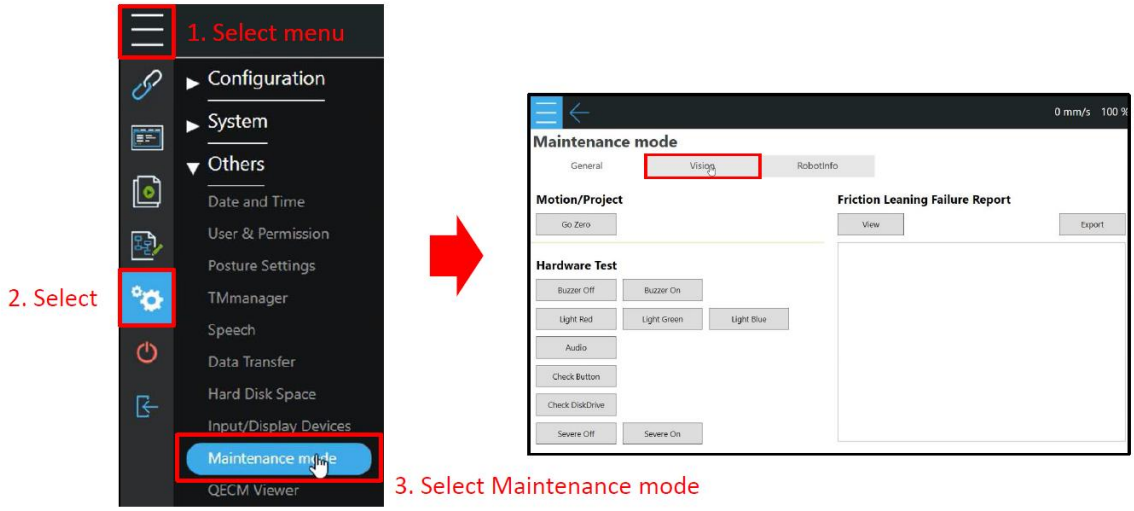
Camera calibration

1. If there is any status showing 'not finished' after completing the 2-cm Plate Calibration, use 'Single Focus Calibration' for re-calibrating.
2. E.g. 20cm 5M-Status failed. So the 'Board' setting would be 2cm, 'Focus height' would be 20, 'Resolution' would be 5M. Put the big dice board on the camera FOV and click Next.

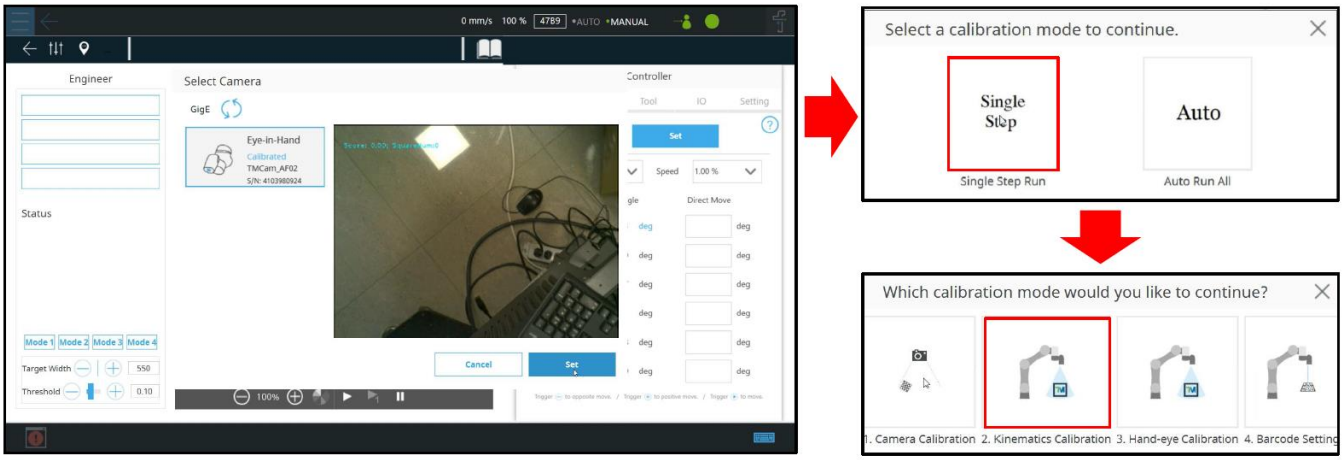


9.5 Kinematic calibration

Kinematic calibration

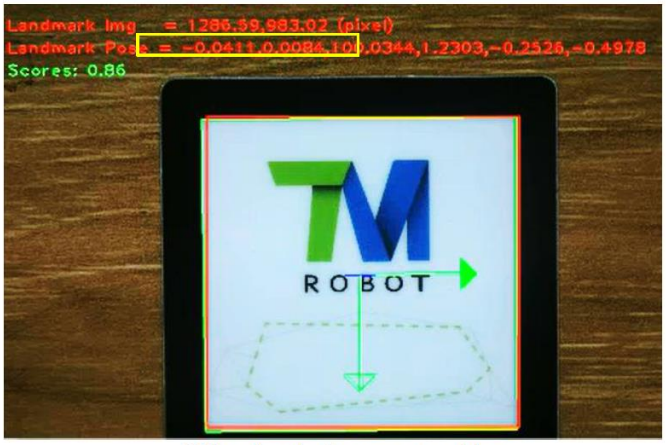


Kinematic calibration

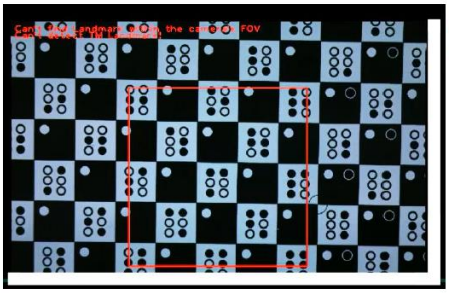


Kinematic calibration

1. Click "Move to Initial Position" to move the robot to its initial position.
2. First, place the Landmark at position (0, 0, 100) relative to the camera (Figure A). Then, remove the Landmark and replace it with the 1 cm calibration plate, ensuring the entire camera view is covered by the calibration plate (Figure B).
3. Set the camera parameters sequentially (Figure C) and save the settings.
4. After completing the parameter setup, remove the 1 cm calibration plate and place the Landmark back at position (0, 0, 100) relative to the camera (Figure A, or align the red and green frames in the camera view). Click "Kinematic Calibration" to start the calibration process.



(A)Landmark placement position



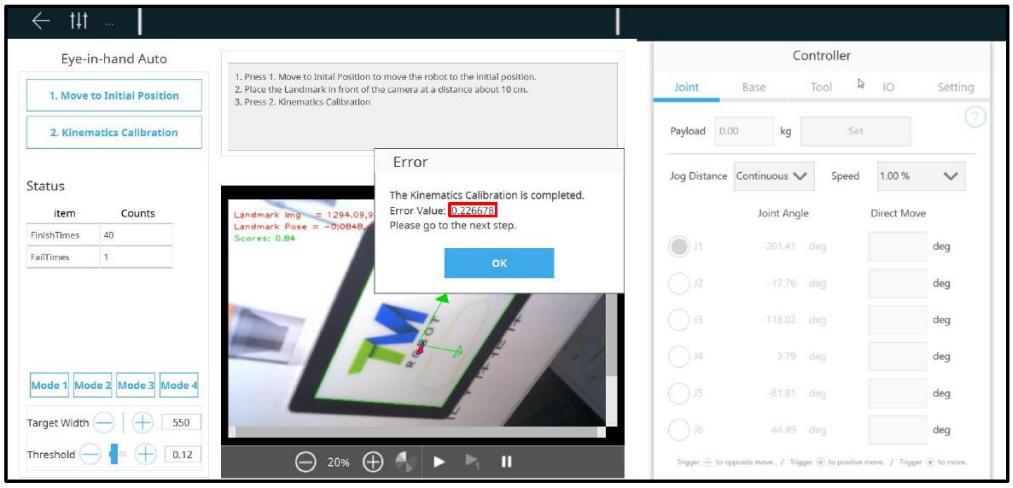
(B)Place 1 cm calibration plate

1. Built-in lighting: Enable and set the value to 255
2. Shutter Time: Set to 5000. Increase the value only if the light source is unstable or insufficient.
3. Gain: Set to 0
4. White balance: Press "Auto once
5. Focus: Set to 3

(C)Set camera parameter

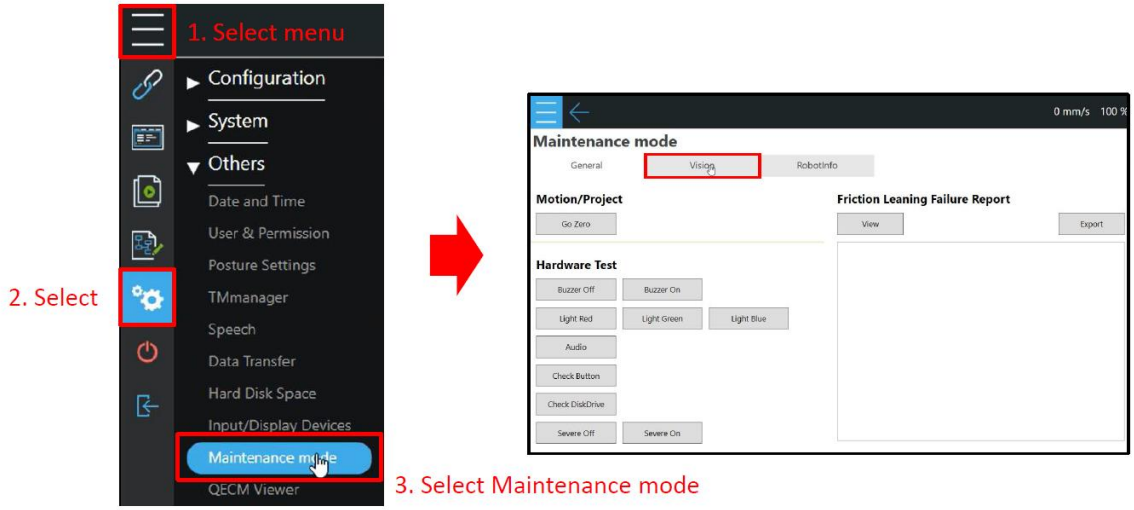
Kinematic calibration

1. Calibration will terminate after completing 40 successful calibrations (FinishTimes) or 15 failed calibrations (FailTimes).
2. After calibration, if the error value is below 0.3, the calibration is considered successful. If the error value exceeds 0.3 or the calibration fails, provide the following to Techman: **Camera view images, photos of the environment, video of the calibration process, Logs from the same day.**

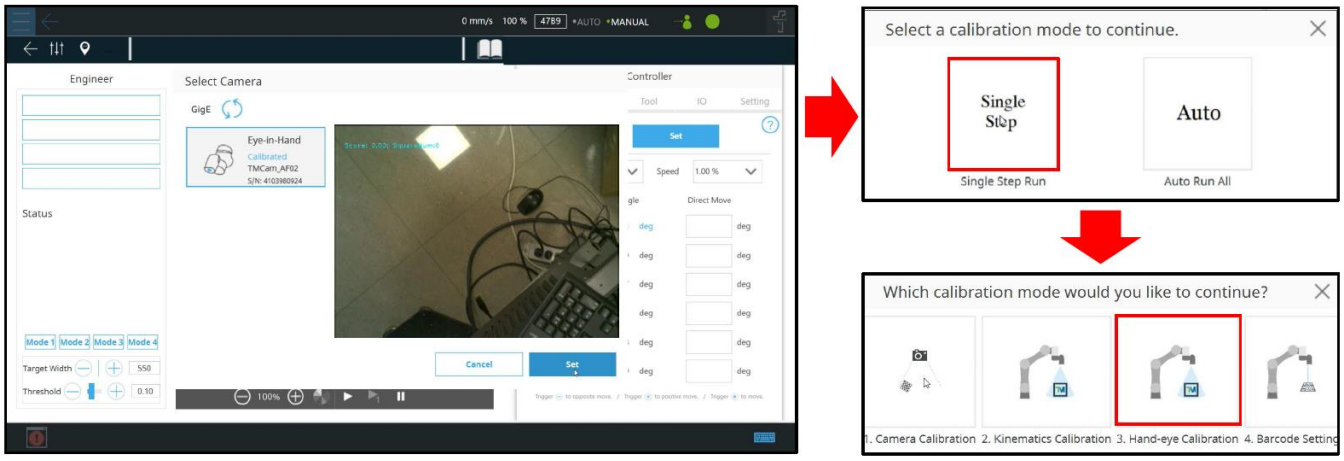


9.6 Hand-eye calibration and verification

Hand-eye calibration & Verification

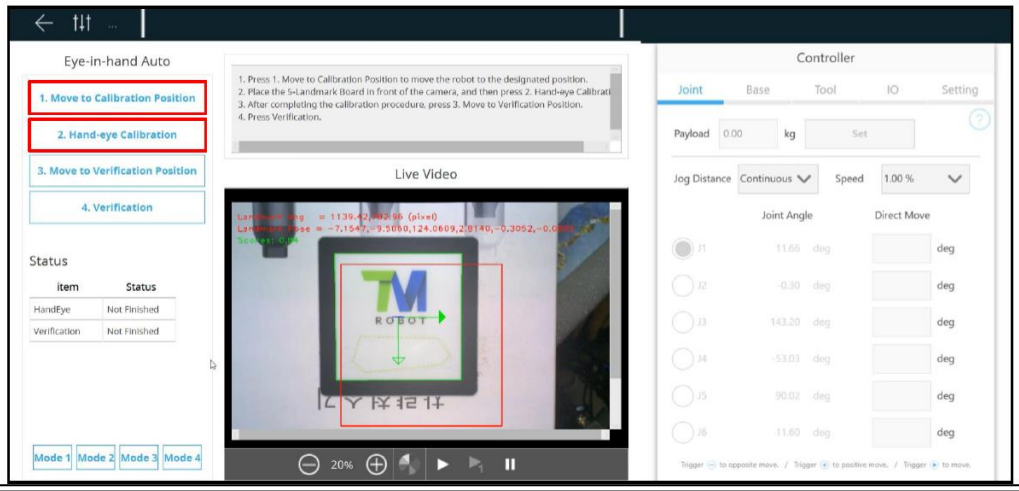


Hand-eye calibration & Verification



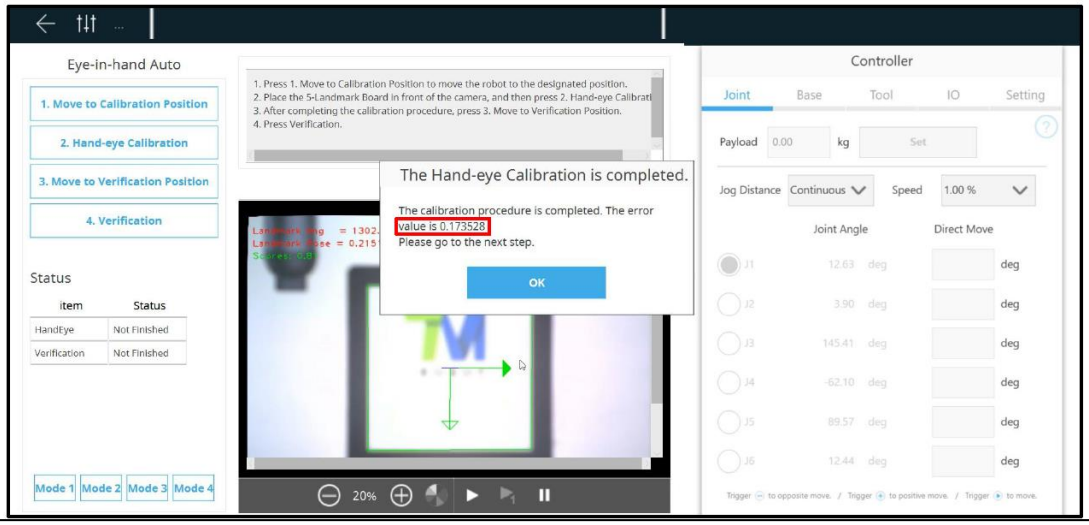
Hand-eye calibration & Verification

1. Press ‘Move to Calibration Position’ to move the robot to the designated position.
2. Continue using the calibration position and camera parameters from the Kinematic Calibration.
3. Press ‘Hand-eye Calibration’.



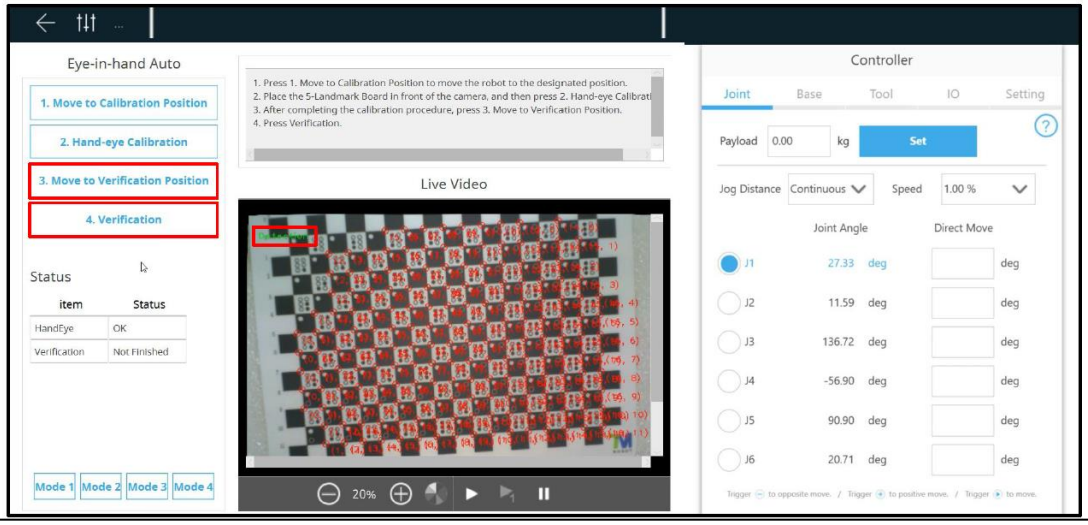
Hand-eye calibration & Verification

1. After completing the calibration, if the error value is below 0.3, the calibration is considered successful.
2. If the error value exceeds 0.3 or the calibration fails, send the following to Techman: **Camera view images, photos of the environment, video of the calibration process, Logs from the same day**



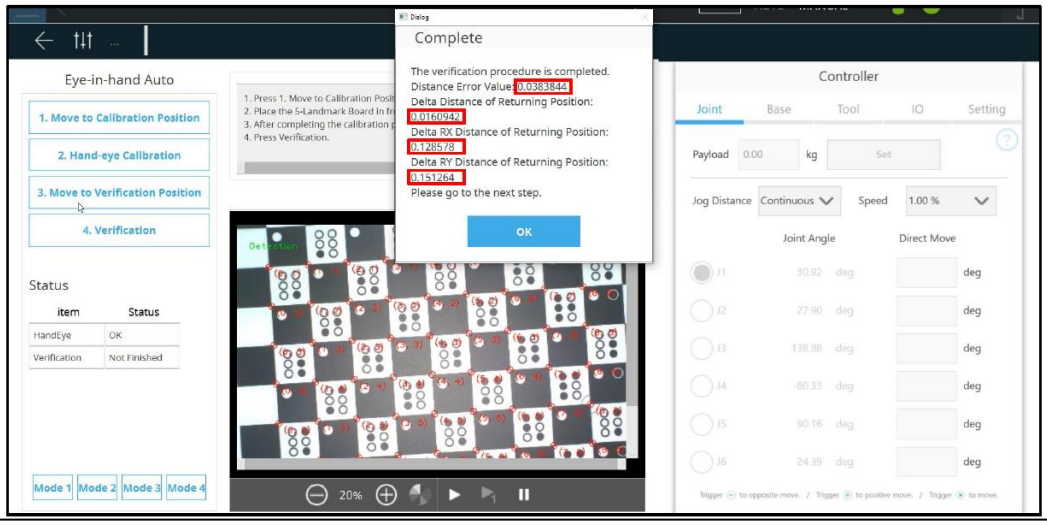
Hand-eye calibration & Verification

1. Press 'Move to Verification Position' to move the robot to the designated position after completing the hand-eye calibration.
2. Place the **small dice board**, turn on the camera light, and adjust camera parameters to ensure the small dice board can be detected. Then press 'Verification'.



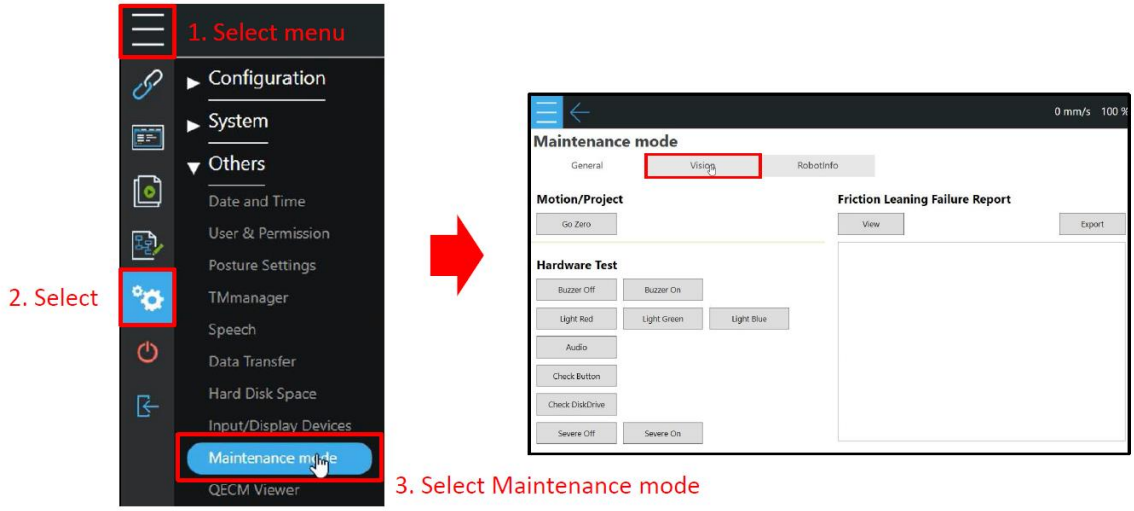
Hand-eye calibration & Verification

1. After calibration is complete, please ensure that the first and second values are below 0.5, and the third and fourth values are below 1.
2. If any of the values exceed the specified limits, please redo the Hand-eye calibration and Verification.
3. If the error value exceeds 0.3 or the calibration fails, send the following to Techman: **Camera view images, photos of the environment, video of the calibration process, Logs from the same day**

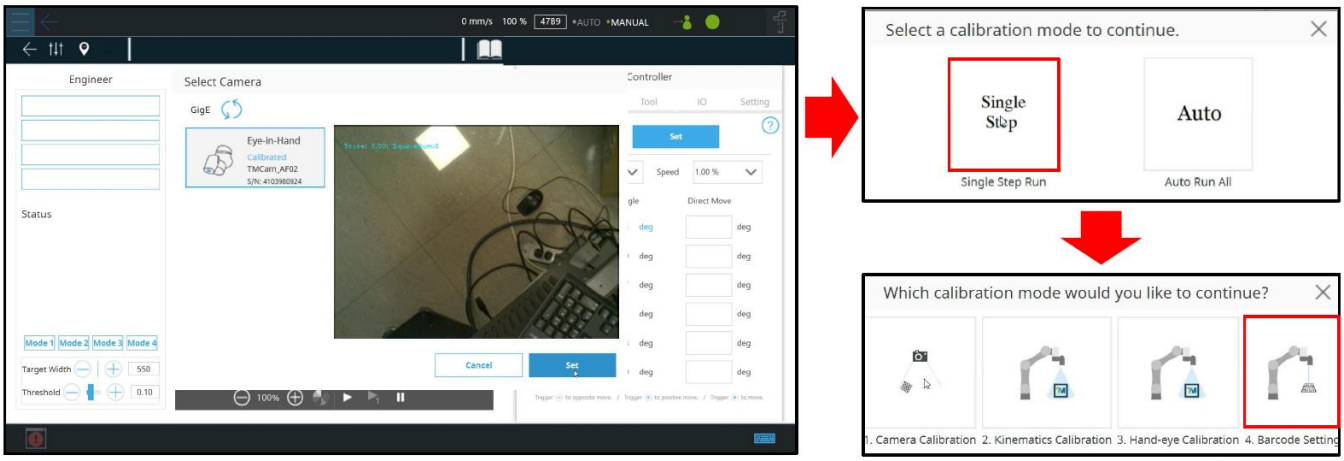


9.7 Barcode setting

Barcode setting

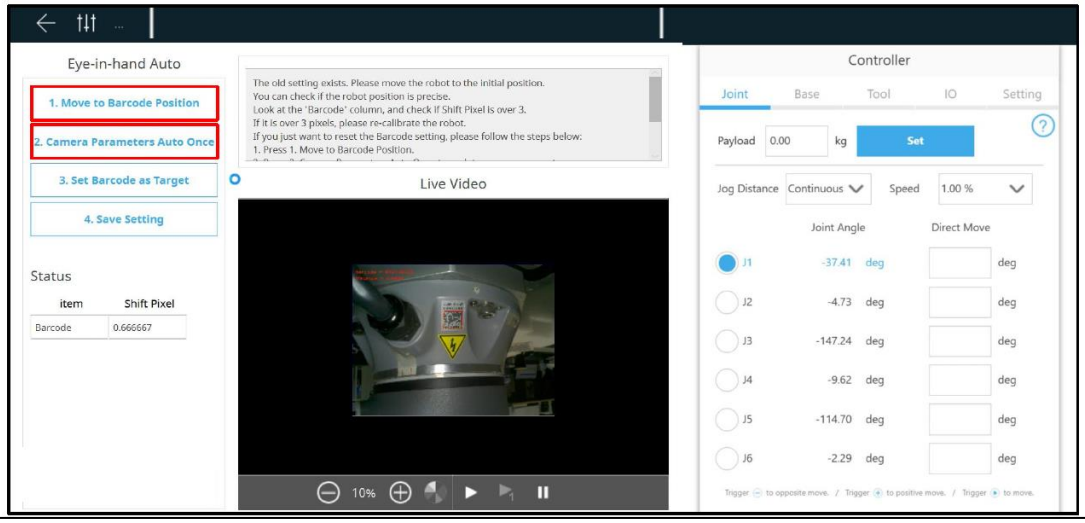


Barcode setting



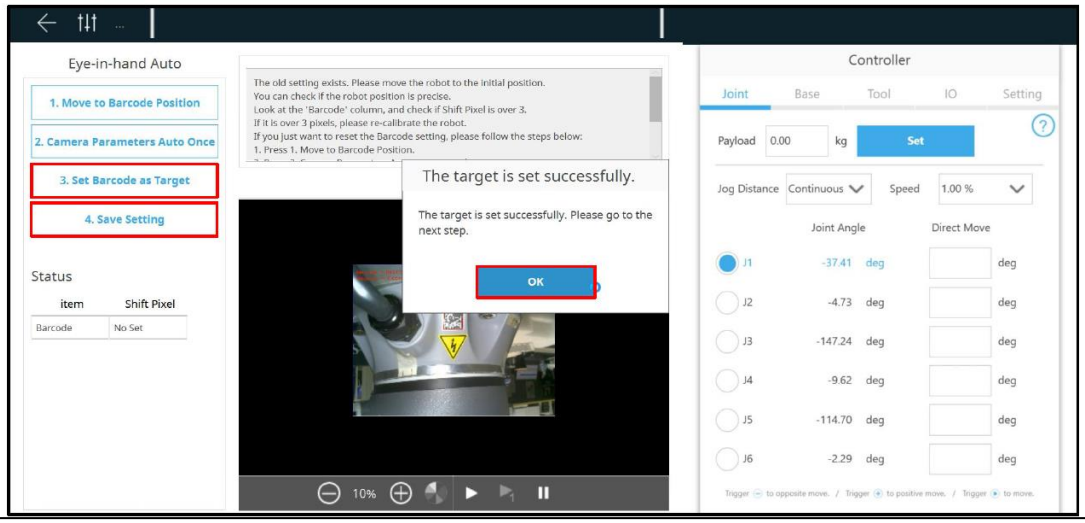
Barcode setting

1. Press ‘Move to Barcode Position’ to move the robot to the initial position.
2. Press ‘Camera Parameter Auto Once’ to set the camera parameter automatically.



Barcode setting

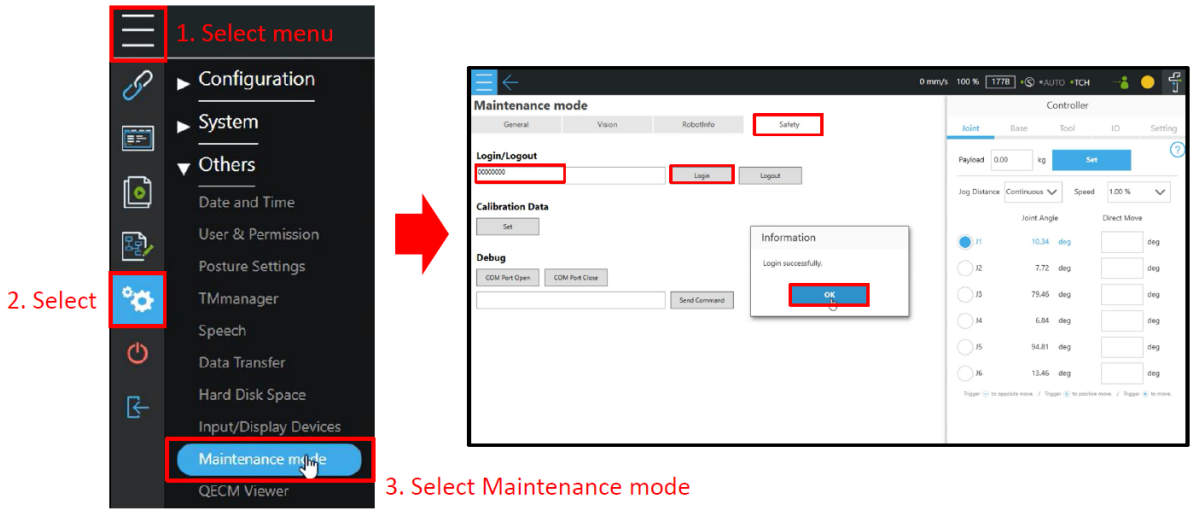
1. Press ‘Set Barcode as Target’ to save the present barcode location.
2. Press ‘Save setting’ and finish the calibration.



9.8 Save the calibration data

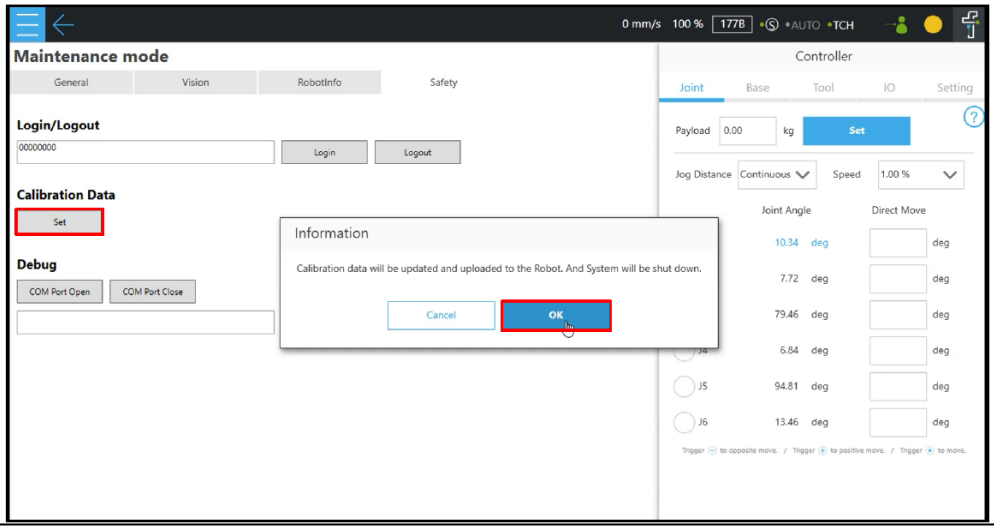
Save the calibration data

1. Go to 'Maintenance mode', select 'Safety'
2. Enter 00000000 and select Login, and then press 'OK'



Save the calibration data

1. Press 'Set' to upload the calibration data from control box to arm
2. Press 'OK' and the TMflow will shut down automatically



9.9 Snake dance

Snake dance_TM5A, TM5S, TM12, TM12S, TM14, TM14S, TM16, TM20

1. Create 2 nodes, each with following joint angles:

	Node 1	Node 2
J1	260	-260
J2	90	-90
J3	-150	150
J4	90	-90
J5	170	-170
J6	110	-110

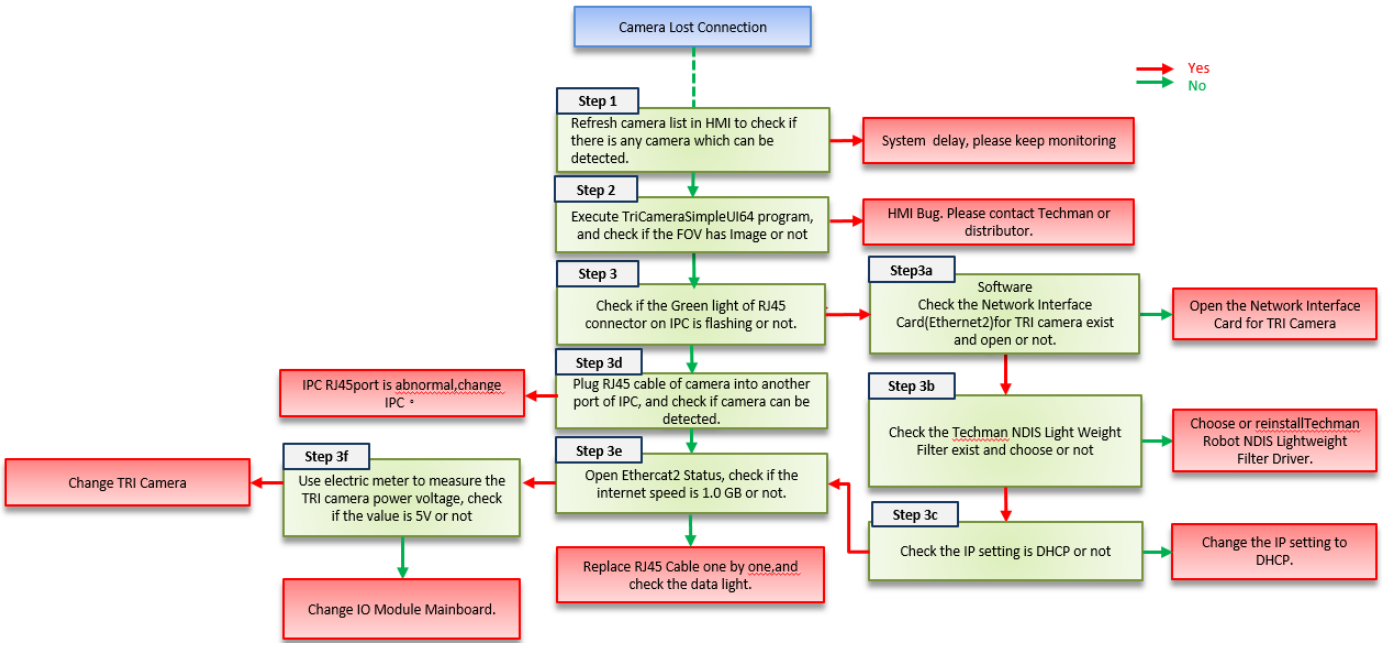
2. Make the 2 nodes run in a loop, run at 60% speed for 30 minutes.
3. If there is no abnormality after the test, the robot is ready for use.

10. Trouble shooting

10.1 Camera disconnection

Symptom description	EIH camera disconnected while using / EIH camera can not be detected
Possible causes	This issue may be caused by following reasons/components: 1. IPC 2. Internal complex cables 3. Robot cable 4. Camera cables inside the robot arm 5. TRI camera 6. System or driver
Symptom photos **Or Error codes**	0x00020000 0x00020003

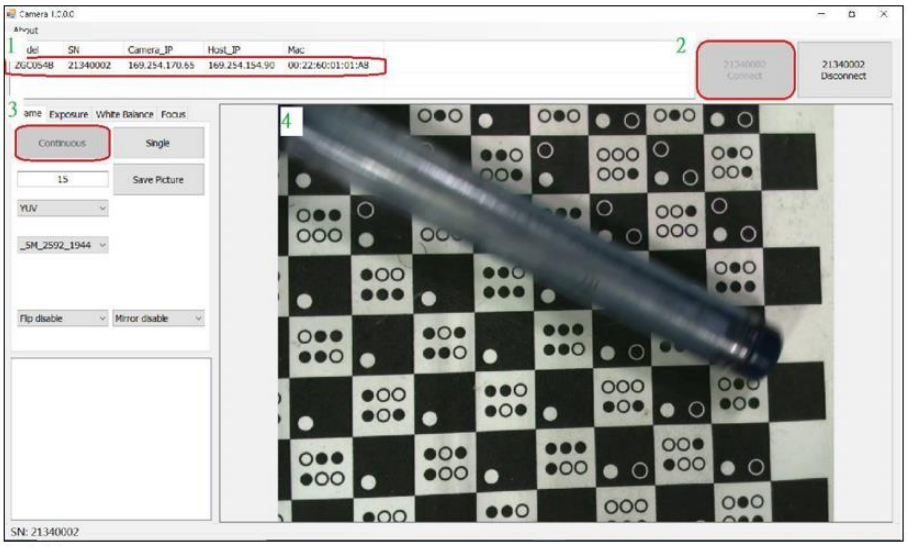
Notices



TriCameraSimpleUI64

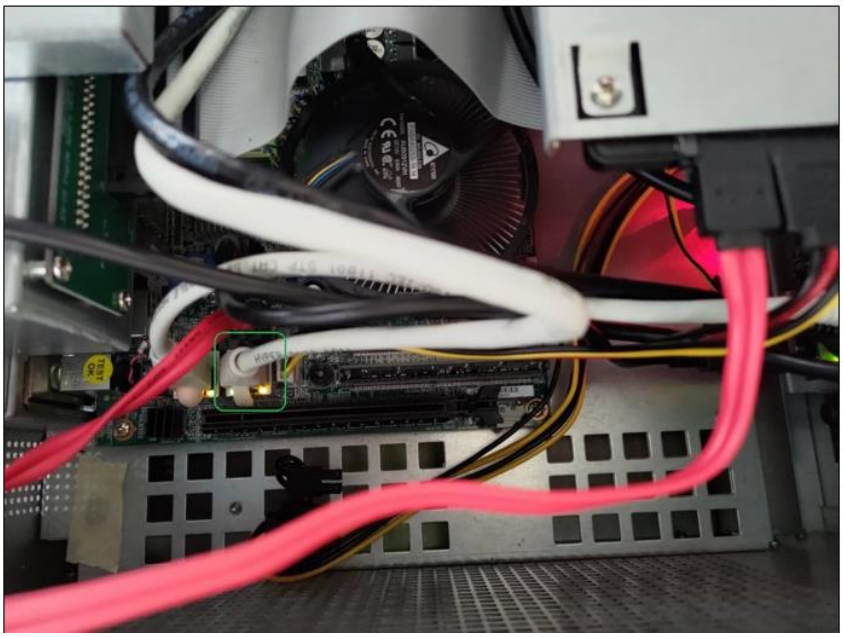
The TriCameraSimpleUI64 executable file is on the Control Box above HMI Vesion2.0.
Execute the following path file
D:\TRI_Camera\TriCameraSimpleUI64.exe

Step
1. Showing the camera
2. Connect (click)
3. Continuous(click)
4. Check if there is image on FOV



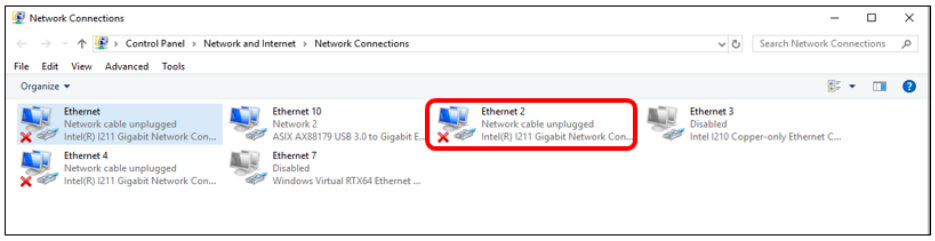
Check camera port on IPC

Check if the RJ45 Cable port on IPC flashes or not

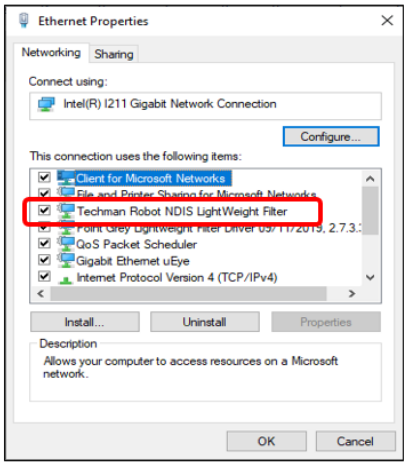


Check Network setting_1

1. Go to Control Pane -> Network and Internet -> Network and Sharing Center -> Change adapter settings
2. Check whether the Network Interface Card(Ethernet2)for TRI camera exists or not, and it should be activated.

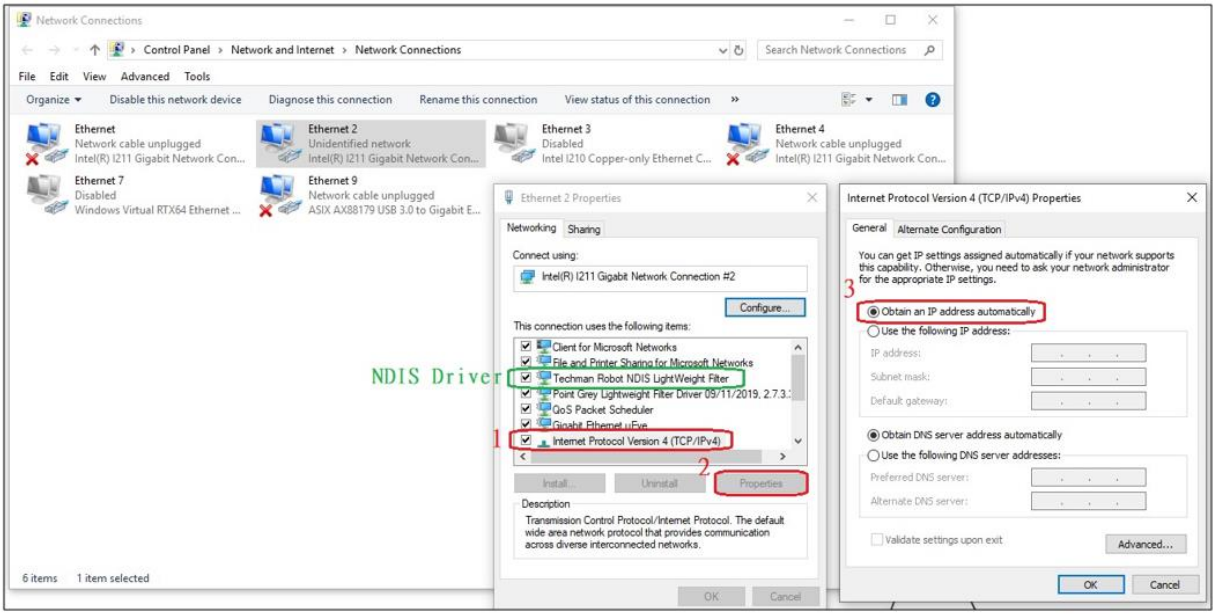


3. Right click the Ethernet2 and choose properties, check whether the Techman NDIS Light Weight Filter exists or not.



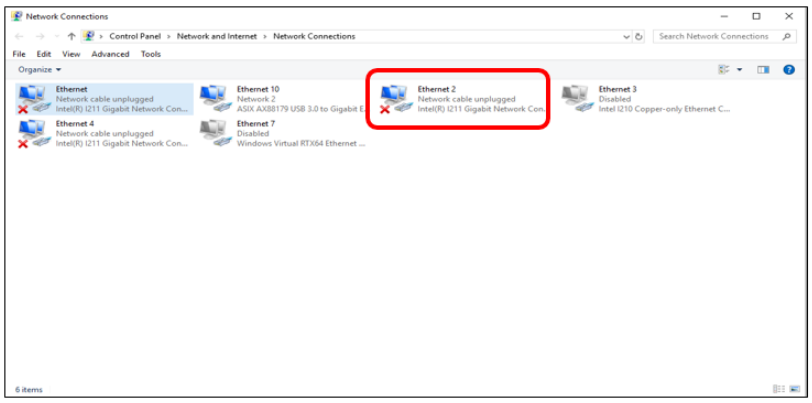
Check Network setting_2

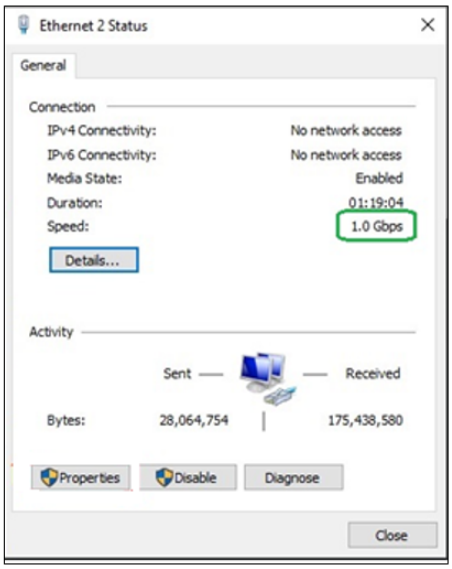
1. Choose Internet Protocol version4 and then choose properties. Check whether the IP setting is DHCP, set it as DHCP.



Check Network setting_3

1. Choose Ethernet2, and check whether the Ethernet Speed is 1.0 Gbps or not; if not, it means the problem could be caused by hard ware components.



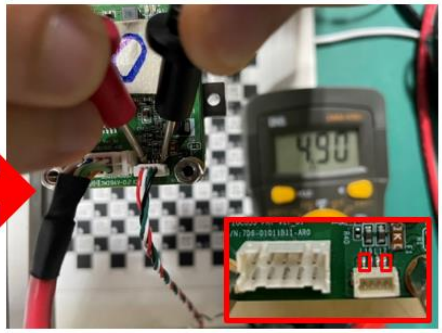


Check TRI camera

1. Follow Picture 1 to remove the Camera housing.
2. Use multi-meter to measure the TRI camera power voltage, check if the value is 5V or not as picture 2 & 3

Picture 1 - Remove camera housing screw

Picture 2 - Measure TRI camera Power



Picture 3 - Measure pins

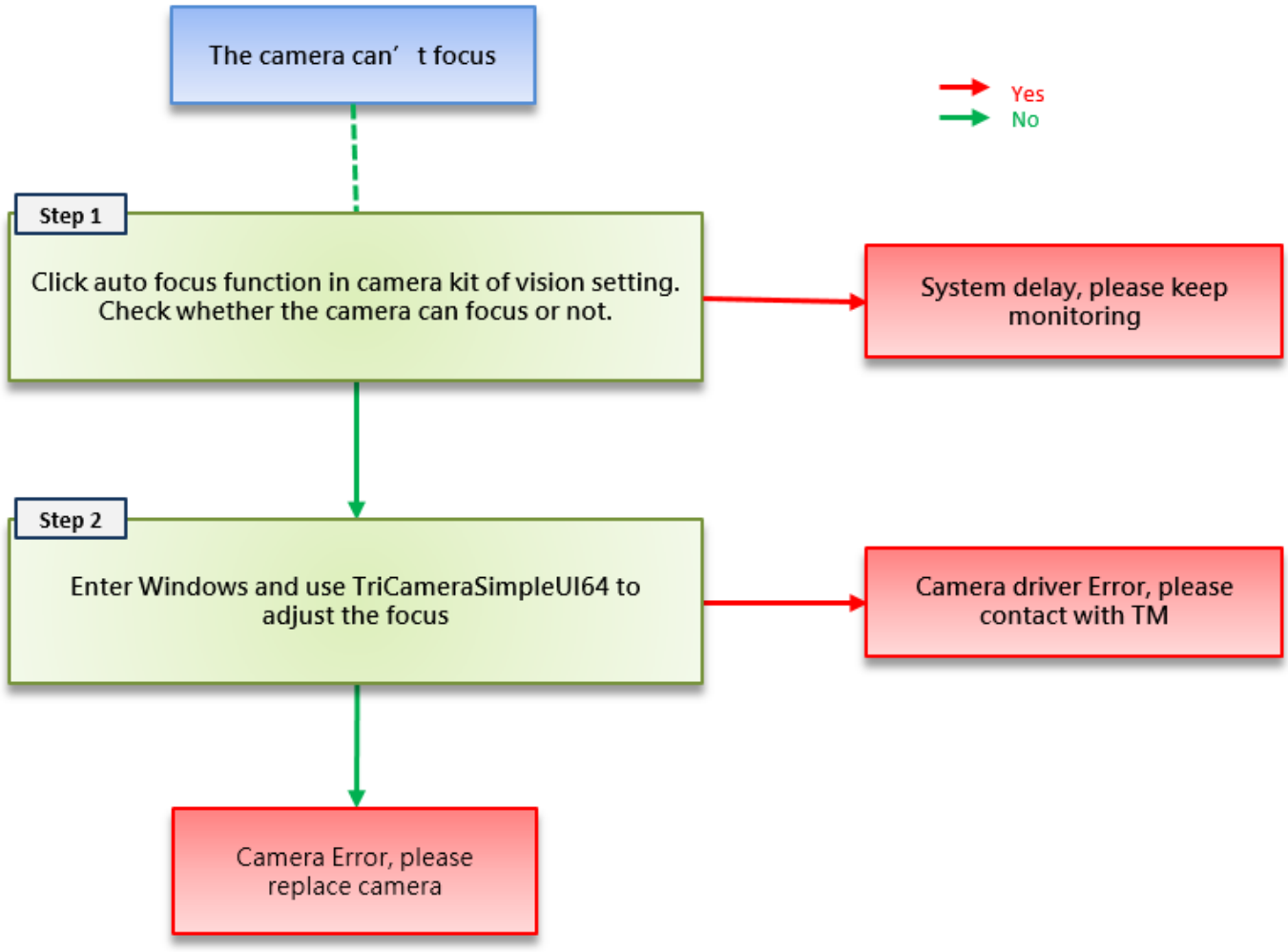
Check TRI Camera_LED indicators

1. The orange light on the left indicates link status, signifying that the RJ45 signals on both sides(IPC and TRI camera) are connected.
2. The yellow light on the right represents data, and it illuminates when data is being transmitted.
3. When capturing a picture, the blinking frequency will be faster. In principle, please use the data light to verify whether the TRI camera Ethernet is active or not.

10.2 Camera won’t focus

Symptom description	EIH camera can not focus by HMI adjustment
Possible causes	This issue may be caused by following reasons/components: 1. HMI 2. Camera
Symptom photos Or Error codes	N/A

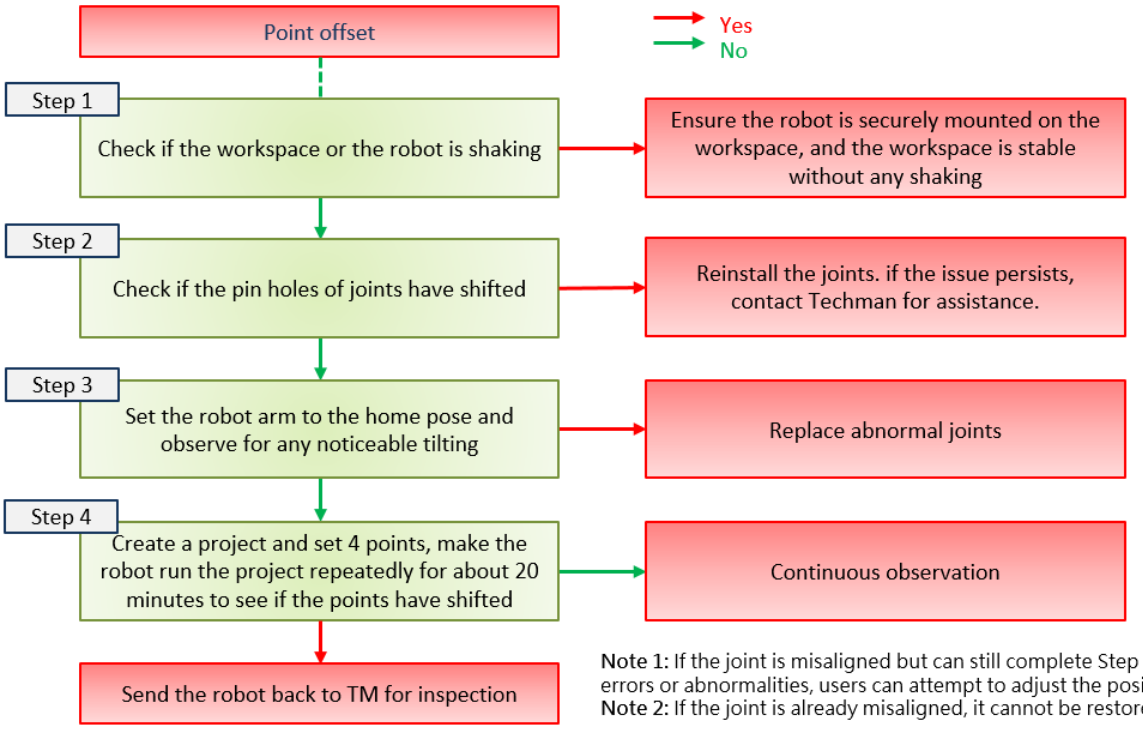
Notices



10.3 Point offset

Symptom description	The robot cannot reach the previous position after a collision or for an unknown reason. This issue typically arises following a collision or relocation.
Possible causes	This issue may be caused by following reasons/components: 1. Joint 2. End module 3. Surrounding equipment
Symptom photos Or Error codes	N/A

Notices

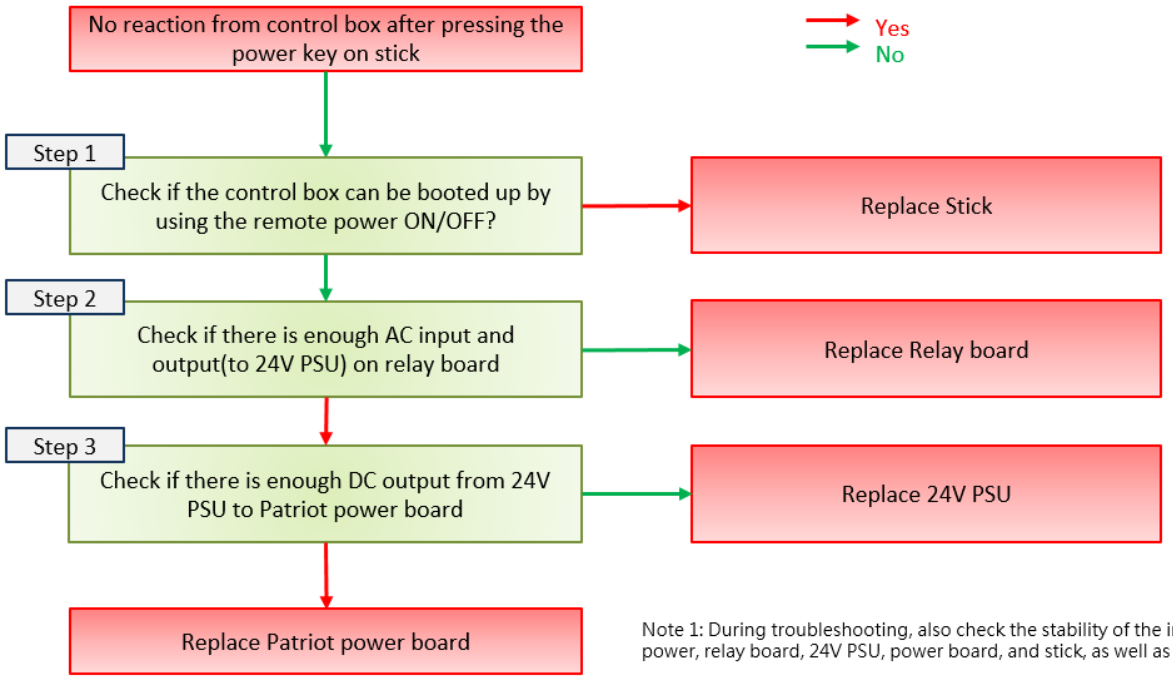


Note 1: If the joint is misaligned but can still complete Step 4 without triggering other errors or abnormalities, users can attempt to adjust the position and continue using it.
Note 2: If the joint is already misaligned, it cannot be restored by any calibration steps.

10.4 Control box fails to boot up

Symptom description	Control box fails to boot up after pressing the power key on the stick
Possible causes	This issue may be caused by following reasons/components: 1. Stick 2. Relay board 3. 24V PSU 4. Patriot power board
Symptom photos Or Error codes	N/A

Notices



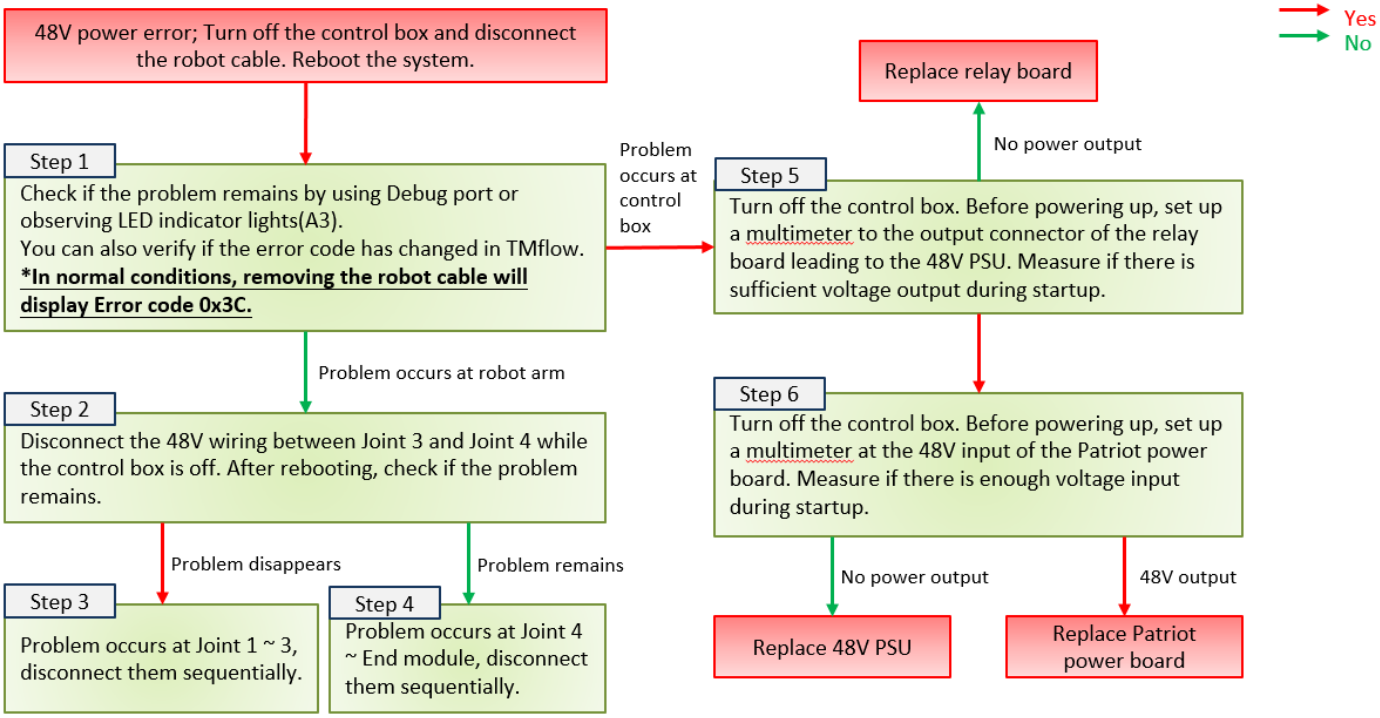
Note 1: During troubleshooting, also check the stability of the installation of external AC power, relay board, 24V PSU, power board, and stick, as well as other hardware cables.

10.5 Encoder error

Symptom description	TMflow shows messages relating to encoder error or encoder compensation error
Possible causes	This issue may be caused by following reasons/components: 1. Joint
Symptom photos Or Error codes	0xFFCE / 0xFFED / 0xFFE4
Notices	When encountering Encoder-related anomalies, determine which joint is causing the issue based on the Error code displayed in TMFlow, and request replacement for the affected joint.

10.6 Robot arm does not activate

Symptom description	There is no power supply from the control box to the robot arm, and the indicator light ring on the end module does not illuminate even after the control box has been booted up.
Possible causes	This issue may be caused by following reasons/components: 1. Power relay board 2. 48V PSU(Power supply) 3. Patriot power board 4. Power eater 5. Joints 6. End module
Symptom photos Or Error codes	0x3E / 0x53 …
Notices	When addressing this 48V circuit issue, we recommend starting by disconnecting the robot and control box. This step will help you identify and narrow down the range of components that need to be checked.



10.7 TM Safe error

Symptom description Can not access TMflow normally, showing error codes below.

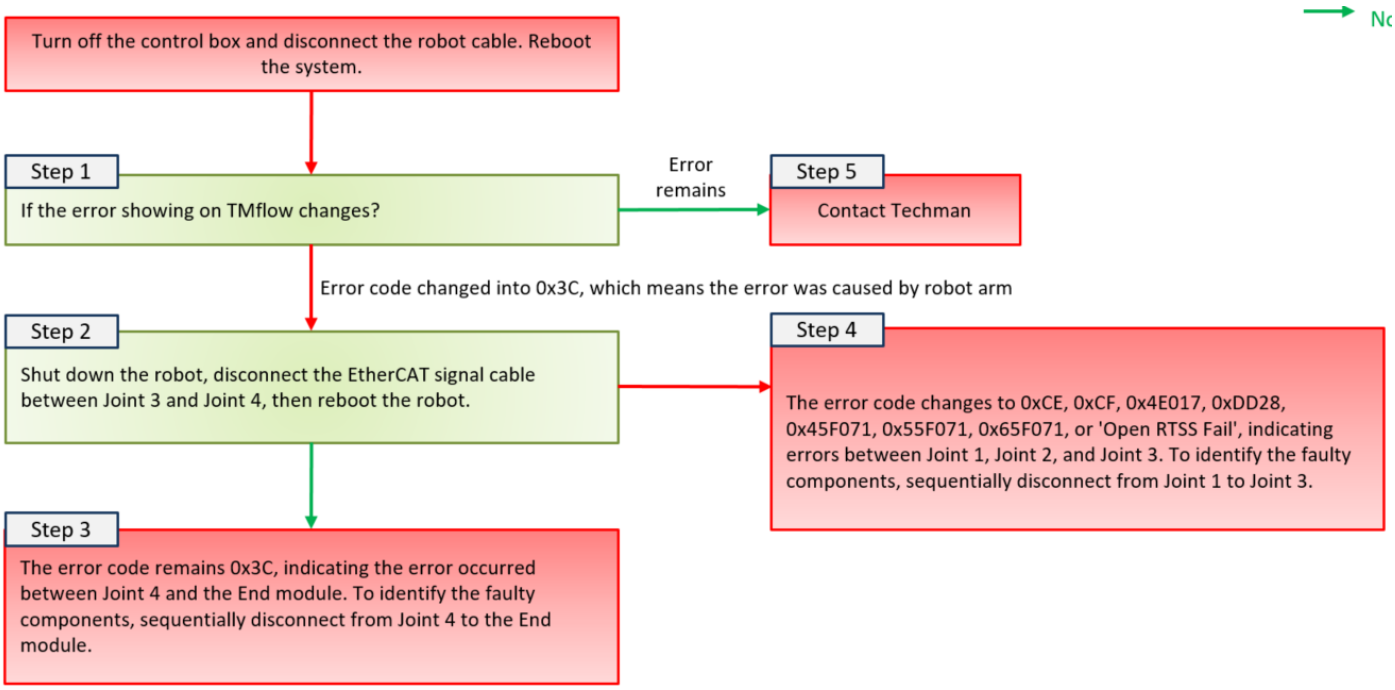
Possible causes

The error may be caused by following reasons/components:

1. Joint
2. Patriot power board

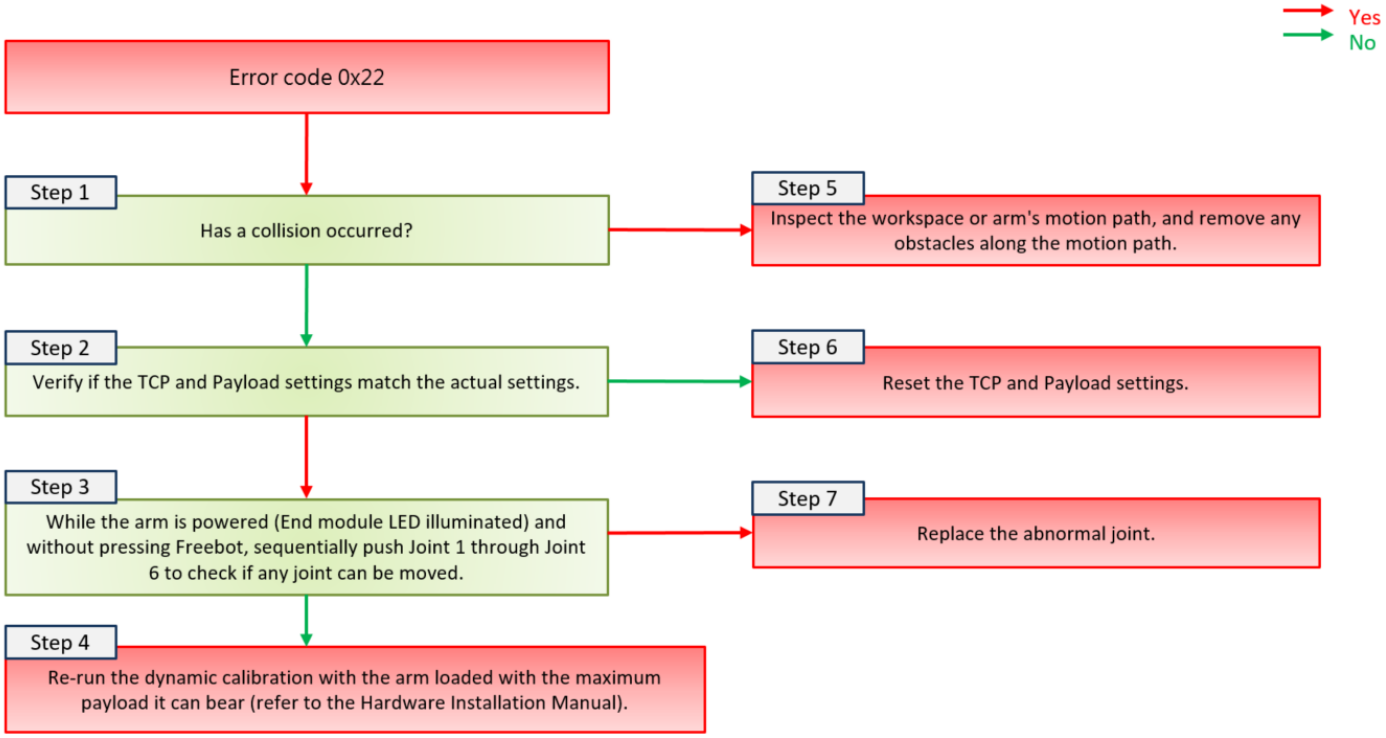
Symptom photos Or Error codes 0xCE, 0xCF, 0x4E017, 0xDD28, 0x45F071, 0x55F071, 0x65F071, Open RTSS Fail

Notices When addressing this trouble shooting, we recommend starting by disconnecting the robot and control box, and check if the error code changes. This step will help you identify and narrow down the range of components that need to be checked.



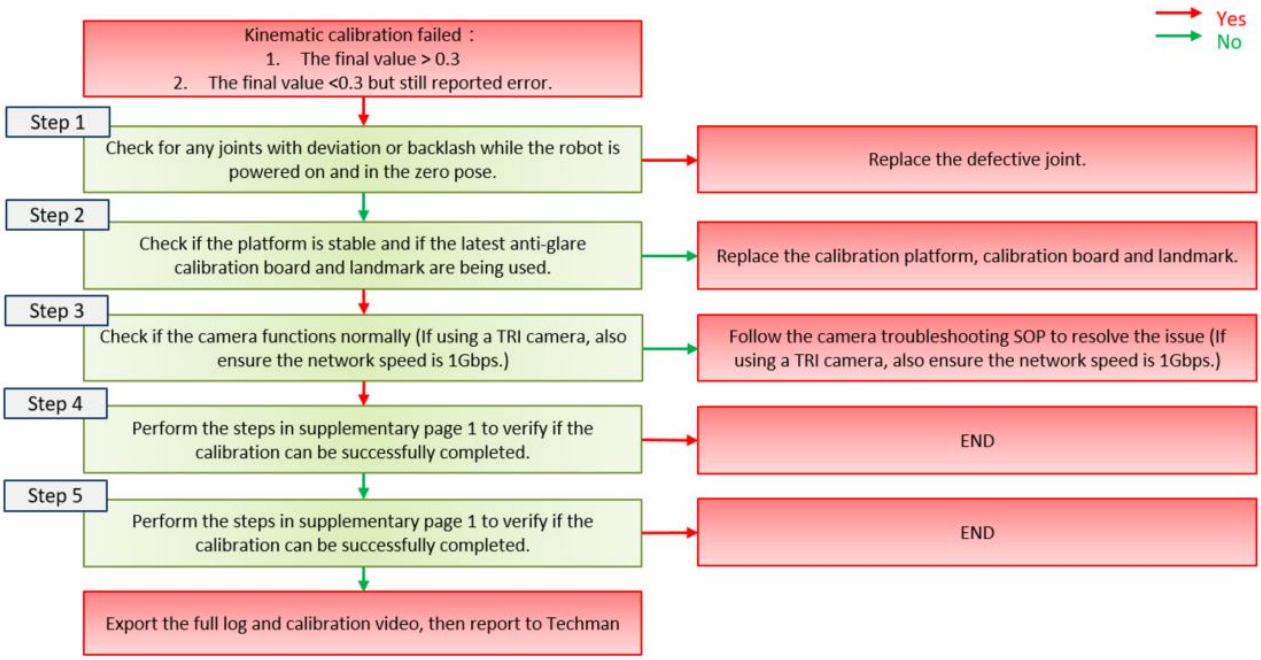
10.8 Torque errod

Symptom description	During robot operation, it displays that torque limits exceed the standard.
Possible causes	The error may be caused by following reasons/components: 1. TCP settings do not match reality 2. Obstacle or interference detected along the arm's motion path 3. Abnormality in joint 4. Safety parameter abnormality
Symptom photos Or Error codes	0x22, 0xFF08, 0xFF0B, 0xFF0E, 0xFF11, 0xFF14, 0xFF17, 0xFFCF
Notices	When addressing this trouble shooting, it is recommended to first check whether there is any interference with other objects along the arm's motion path. Prolonged interference or collisions may lead to a shortened lifespan of the Harmonic Drive within the joint."



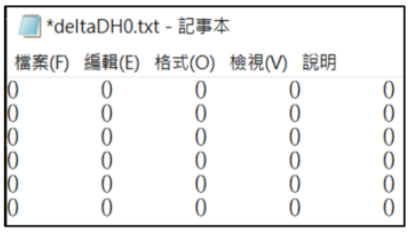
10.9 Kinematic calibration failed

Description	Kinematic calibration failed
Possible causes	1. Camera malfunction. 2. Landmark abnormality. 3. Joint malfunction or incorrect joint assembly.
Error code	NA



9. Kinematic calibration failed _ supplementary page 1

1. Navigate to the path: D:\Robotfile
2. Back up the following files and delete them: deltaDH0.bin, deltaDH0.txt, Driveroffset0.bin, Driveroffset0.txt
3. In the D:\Robotfile directory, create the following files: EEPROMUPDATE1.txt & EEPROMUPDATE0.txt
4. Create a new file named DeltaDH0.txt, and enter the required values:

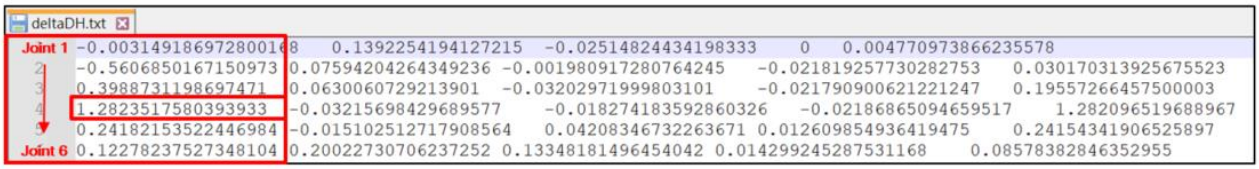


5. Create a new Driveroffset0.txt and input the following values:
   HW1 – HW3.2: -45.00000000,0.00000000,0.00000000,0.00000000,0.00000000,0.00000000
   HW5: 90.00000000,0.00000000,0.00000000,0.00000000,0.00000000,0.00000000,
6. Reboot the system and perform the calibration again.

9. Kinematic calibration failed _ supplementary page 2

1. Navigate to the path: D:\CalibrationData
2. Open deltaDH.txt and check if any values are greater than 1. If any values are greater than 1, reassemble the corresponding joint.

(For example, in the case of following image, Joint 4 needs to be reassembled.)



1. If the calibration still fails after reassembling, and the value at that position is still greater than 1, replace the joint.

10.10 Hand-eye calibration failed

Description	Hand-eye calibration failed
Possible causes	1. Landmark abnormality. 2. Camera parameter abnormality
Error code	NA