

Medium & Heavy Payload Series Hardware Installation Manual

Corresponding models : TM12/14 Series



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Revision History Table

Revision	Date	Revised Content
01	October 2018	Original release
02	December 2018	Updated cover page, minor text fixes
03	July 2019	Minor text fixes. Added cables length
04	August 2019	Updated Table of Rated Torque and Limit for Repeated Peak Torque. Added X Model information.

1. Product Description

1.1 Product Description

The TM Robot is a six-axis robot with power and force limiting function, which features simple programming, innovative integrated vision capabilities together with the latest safety functionality.

1.2 How Can I Get Help?

You can access information sources on the corporate website:

<http://www.ia.omron.com/>

Related Manuals:

This manual covers the hardware installation, operation and user maintenance of TM Robot. See the following table for additional available manuals.

Manual Title	Description
Safety Manual	Contains safety information for TM Robots.
TMflow	Instructions for use of TMflow software.
TMvision	Instructions for use of TMvision software.

Table 1: Manual Title & Description

2. Safety Information

2.1 Overview

The user shall read, understand and abide by the safety information provided in this manual before using the TM Robot.

2.2 Warning and Caution Symbols

The Table below shows the definitions of the warning and caution levels described in each paragraph of this Manual. Pay close attention to them when reading each paragraph, and observe them to avoid personal injuries or equipment damage.



DANGER:

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.

Table 2: Warning and Caution Symbols

2.3 Safety Precautions




DANGER:

This product can cause serious injury or death, or damage to itself and other equipment, if the following safety precautions are not observed.

- All personnel who install, operate, teach, program, or maintain the system must read the “Hardware installation Manual”, “Software Manual”, and “Safety Manual” according to the software and hardware version of this product, and complete a training course for their responsibilities in regard to the robot.



Read Manual and Impact Warning labels

- All personnel who design the robot system must read the “Hardware installation Manual”, “Software Manual”, and “Safety Manual” according to the software and hardware version of this product, and must comply with all local and national safety regulations for the location in which the robot is installed.
- The TM Robot shall be used according to its intended use.
- Results of the risk assessment may require the use of additional risk reduction measures.
- Power to the robot and its power supply must be locked out and tagged out or have means to control hazardous energy or implement energy isolation before any maintenance is performed.
-  Dispose of the product in accordance with the relevant rules and regulations of the country or area where the product is used.

2.4 Validation and Liability

The information contained herein neither includes how to design, install, and operate a complete robotic arm system, nor involves the peripherals which may affect the safety of the complete system. The integrators of the robot should understand the safety laws and regulations in their countries and prevent major hazards from occurring in the complete system.

This includes but is not limited to:

- Risk assessment of the whole system
- Adding other machines and additional safety mechanisms based on the results of the risk assessment
- Building appropriate safety mechanisms in the software
- Ensuring the user will not modify any safety-related measures
- Ensuring all systems are correctly designed and installed
- Clearly labeling user instructions
- Clearly marked symbols for installation of the robot arm and the integrator contact details
- Collecting all documents into the technology folder, including the risk assessment, and this manual



CAUTION:

This product is a partly complete machine. The design and installation of the complete system must comply with the safety standards and regulations in the country of use. The user and integrators of the robot should understand the safety laws and regulations in their countries and prevent major hazards from occurring in the complete system.

2.5 Limitations on Liability

Even if the safety instructions are followed, any safety-related information in the Manual shall not be considered as a guarantee that the product will not cause any personal injury or damage.

2.6 General Safety Warning

1. The actual noise measured in a factory setting is about 49.3 dB under without production. (Condition: leave

machine body 1m distance and at 1.6m height from the floor and 80% of maximum speed). If the sound pressure is over 80 dB(A) while operating, wear proper ear protection.

2. Environmental Conditions:

- Ambient air temperature: 0°C ~ +50°C
- Ambient relative humidity: < 85%
- Transportation & Storage condition: -20°C ~ +60°C
- Transportation & Storage humidity: < 75%
- The robot needs to be protected from shock or vibration
- Observe ESD precautions when installing or removing robot.

2.7 Risk Assessment

Before installing or using this product, the user must first carry out the necessary risk assessment based on the conditions of use; meanwhile please also closely study the potential remaining risk addressed by the Corporation. Refer to and abide by the relevant chapters in Safety Manual in accordance with its' software and hardware version.

2.8 Emergency Stop

If any accidents occur during the operation of the robot, the user can stop all movement by pressing the Emergency Switch. When the robot stops, the user must ensure that all fault conditions are eliminated before manually restarting the robot. The Emergency Switch is only used in critical conditions. To stop the robot during normal operations use the Stop Button on the system controller. When the user presses the emergency switch, the TM Robot product will disconnect the power of robot and activate the brake after the robot motion is stopped. The indication light ring of the robot will not display light, and the three lights from the Robot Stick will be constantly blinking.

Once the risk assessment has been conducted, if an Emergency Switch needs to be installed then the selected device must comply with the requirements of ISO 60204-1. Emergency Stop act, factory reset and any other circumstances, please refer and abide by the relevant chapters in the Safety Manual in accordance with its software and hardware version.

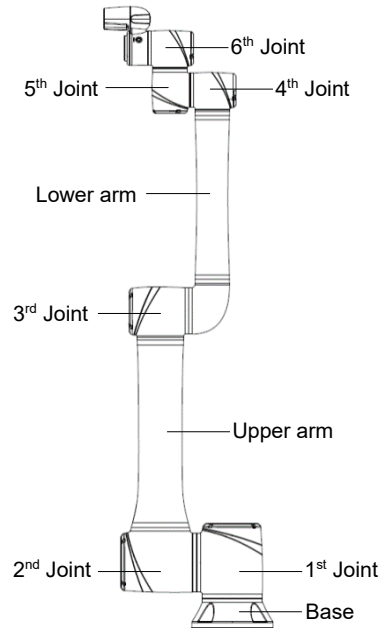
2.9 Movement without Drive Power

Robot without Drive Power could be found in three circumstances: Emergency stop, when disengaging packaging posture to initial booting, and power loss. The first two could enter Safe Start up Mode by means of releasing the Emergency Switch; the latter one is when robot loses external power. Regarding how to operate as well as safety precautions please refer and abide by the relevant chapters in the Safety Manual.

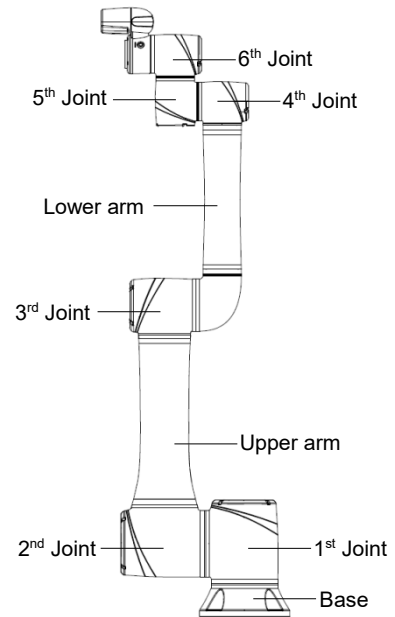
If the robot loses power, and joints need to be moved in order to clear error conditions, you will need to release the

brake for each joint as follows:

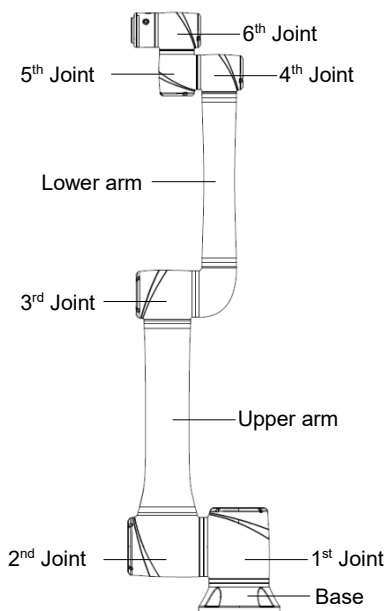
1. Remove joint cover screws (M3, Torx-T10) and joint cover.
2. Release the brake by pushing the pin on the brake solenoid shown in the following three figures.



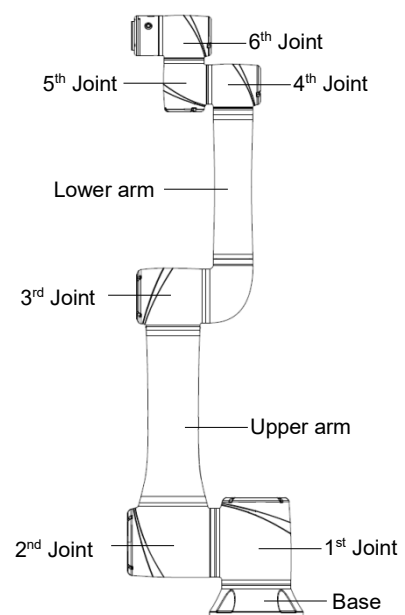
TM12 / TM12M



TM14 / TM14M

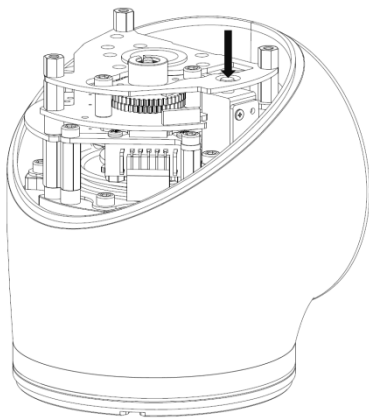


TM12X

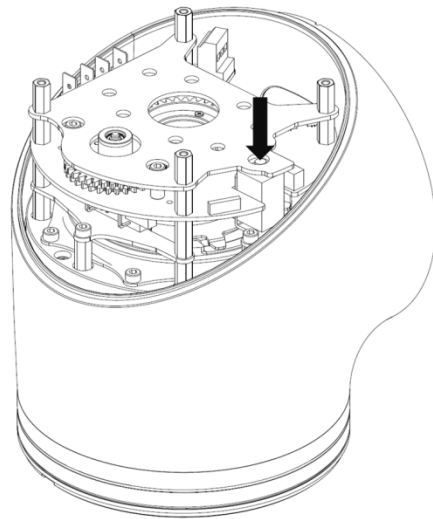


TM14X

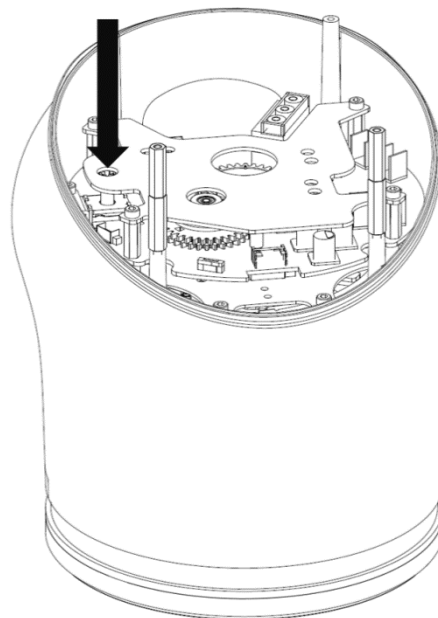
Figure 1: References of Joints by Models



4th / 5th /6th Joint



3rd Joint



1st / 2nd Joint

Figure 2: Reference of Brake Solenoid by Joints



WARNING:

1. Due to gravity, additional support is recommended when manually releasing the brake.
2. When manually moving each robot joint, the movement angle must be within a range of $\pm 45^\circ$.

2.10 Labels

The following labels, especially the warning ones, are attached to the locations where specific dangers may occur. Be sure to comply with description and warnings of the labels when operating to keep the manipulator safely. Do not tear, damage, or remove the labels. Be very careful if you need to handle the parts where the labels are attached.




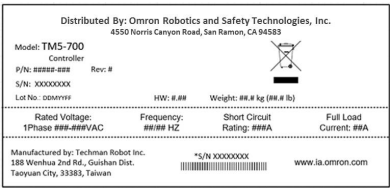
A		Do not put your hand or fingers close to the moving parts
B		Be careful not to be close to the moving parts and nearby areas to avoid collision
C		Do not touch any internal electric parts to avoid electric shock
D		Product label

Table 3: Denotation of Labels

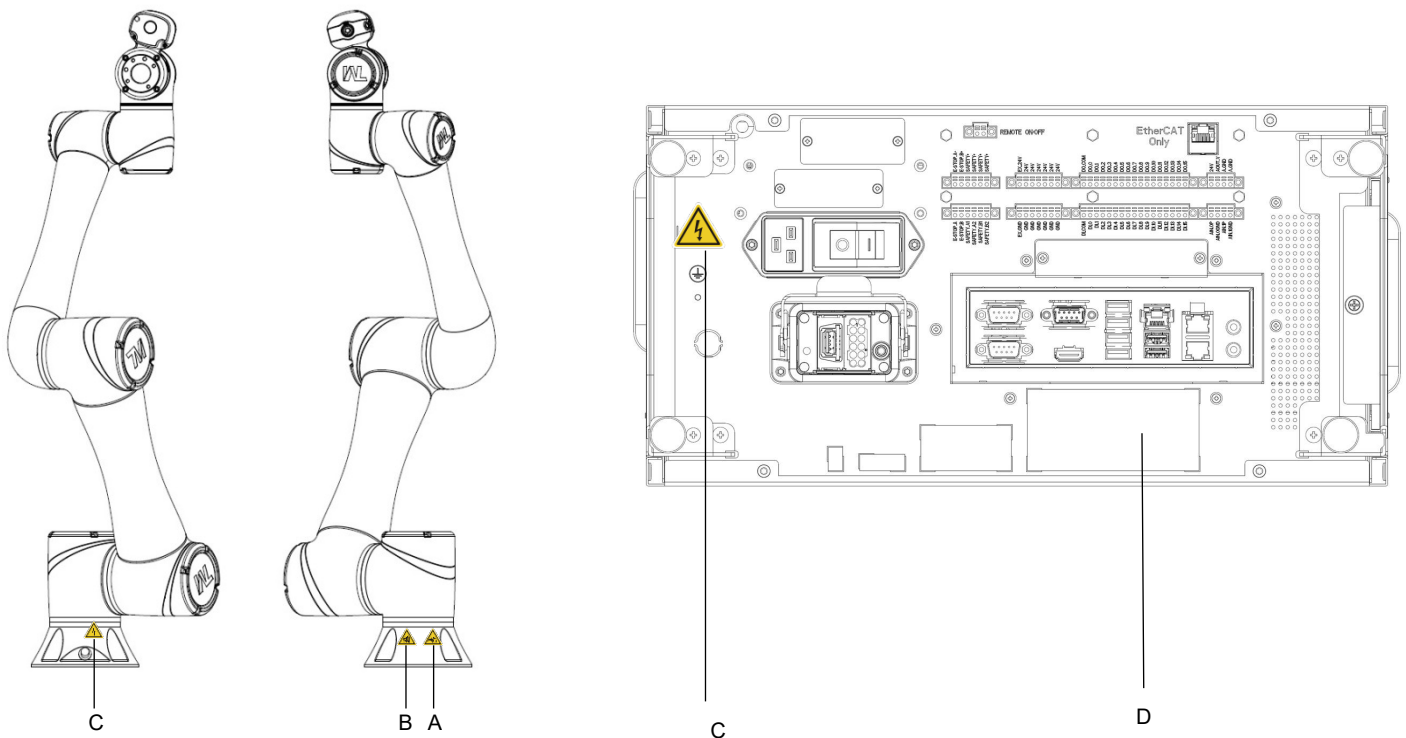


Figure 3: Locations of Labels

3. Transportation and Storage

Transport the TM Robot using its original packing materials. If you will need to transport the TM Robot after unpacking, store the packing materials in a dry place. Hold both arms of the TM Robot during transportation. Support the arms while tightening the base screws.

Lift the control box by its handles. Store the cables before transportation.



WARNING:

Pay attention to your posture when moving the arm and control box cartons to avoid back injury. Omron will not be liable for any injuries caused during transportation.



WARNING:

This product must be shipped and stored in a temperature-controlled environment, within the range -20°C to 60°C (-4°F to 140°F). The recommended humidity is up to 75 percent, non-condensing. It should be shipped and stored in the supplied package, which is designed to prevent damage from normal shock and vibration, You should protect the package from excessive shock and vibration.

The product must always be stored and shipped in an upright position in a clean, dry area that is free from condensation. Do not lay the package on its side or any other non-upright position: this could damage the product.

4. System Hardware

4.1 Overview

This chapter introduces the mechanical interface of the TM Robot System.

4.2 System Overview

TM Robot is made up of the robot arm and control box (including the Robot Stick).

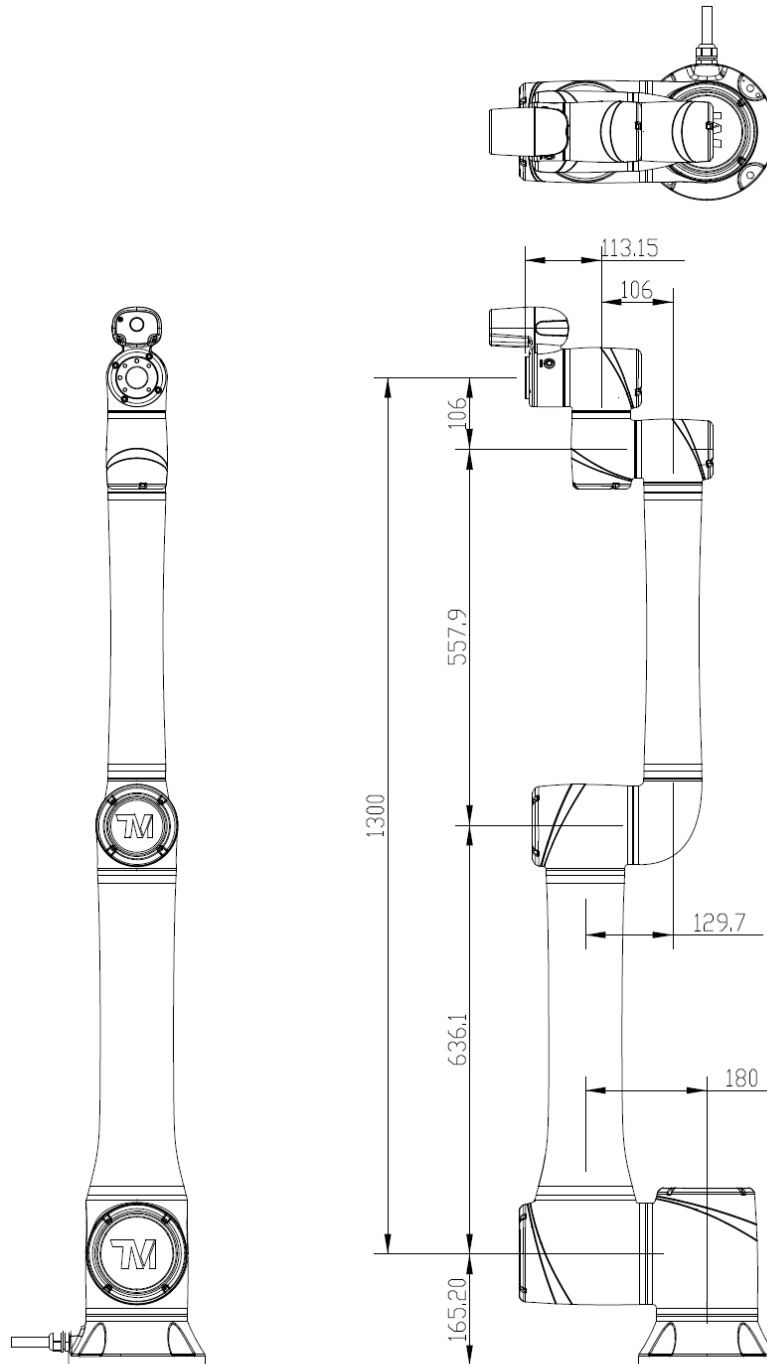


Figure 4: System Overview

4.2.1 Robot Arm

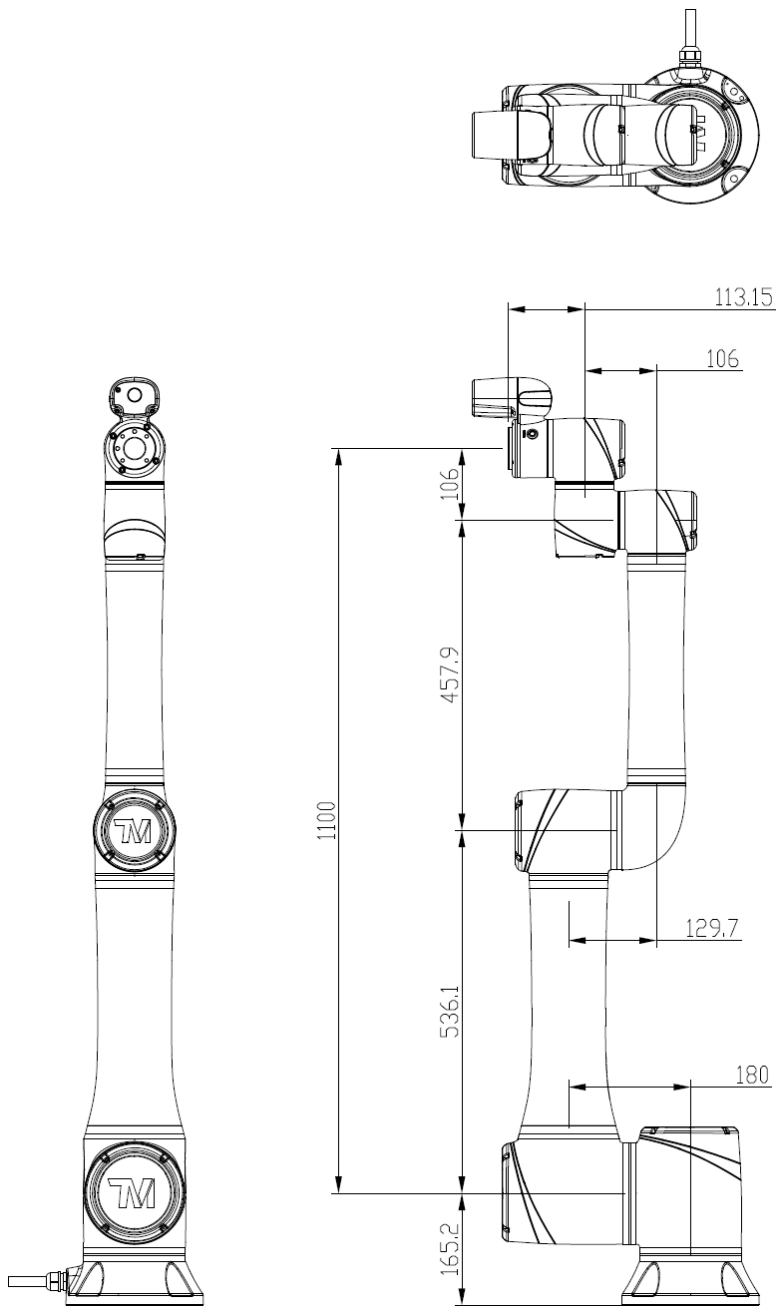
4.2.1.1 Dimension Drawings of Robot

Shown below is the dimension diagram of the robot



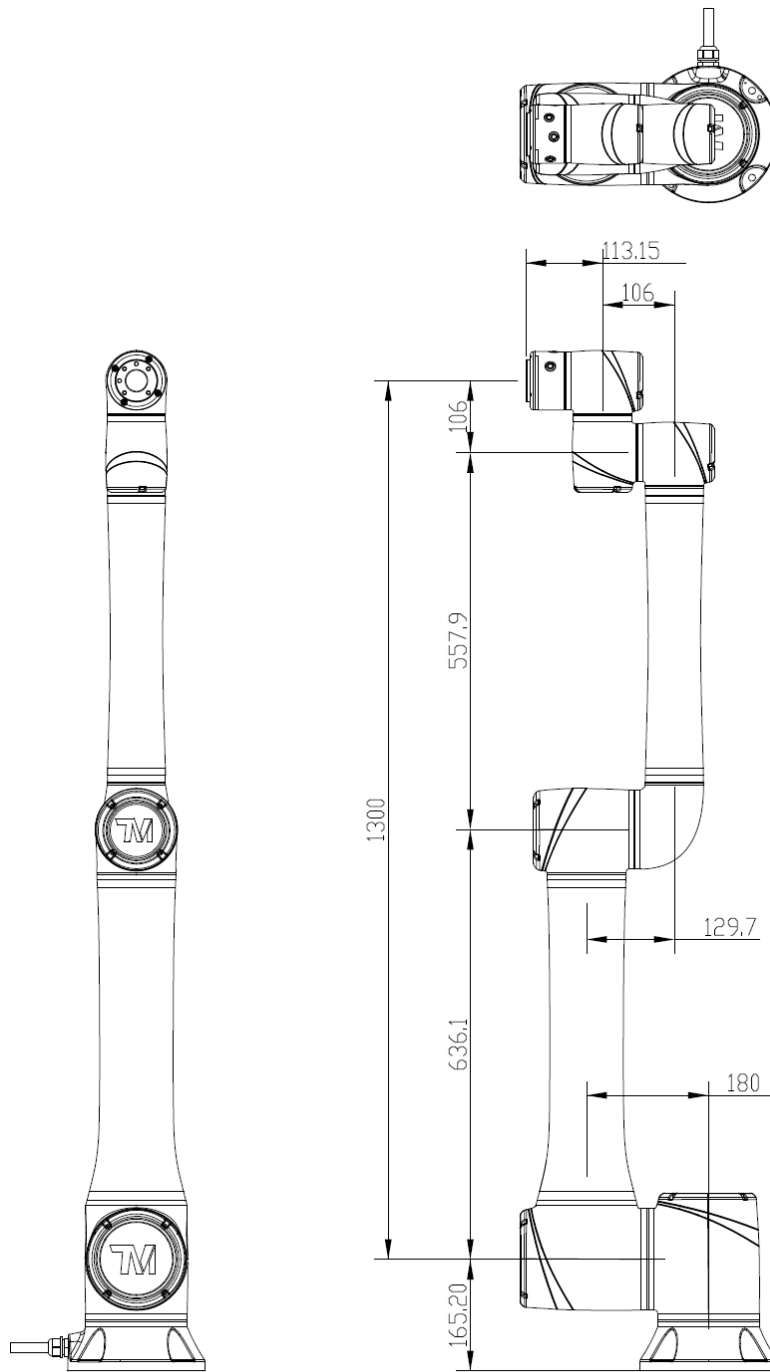
TM12 / TM12M

Figure 5: Dimension of TM12 / TM12M



TM14 / TM14M

Figure 6: Dimension of TM14 / TM14M



TM12X

Figure 7: Dimension of TM12X

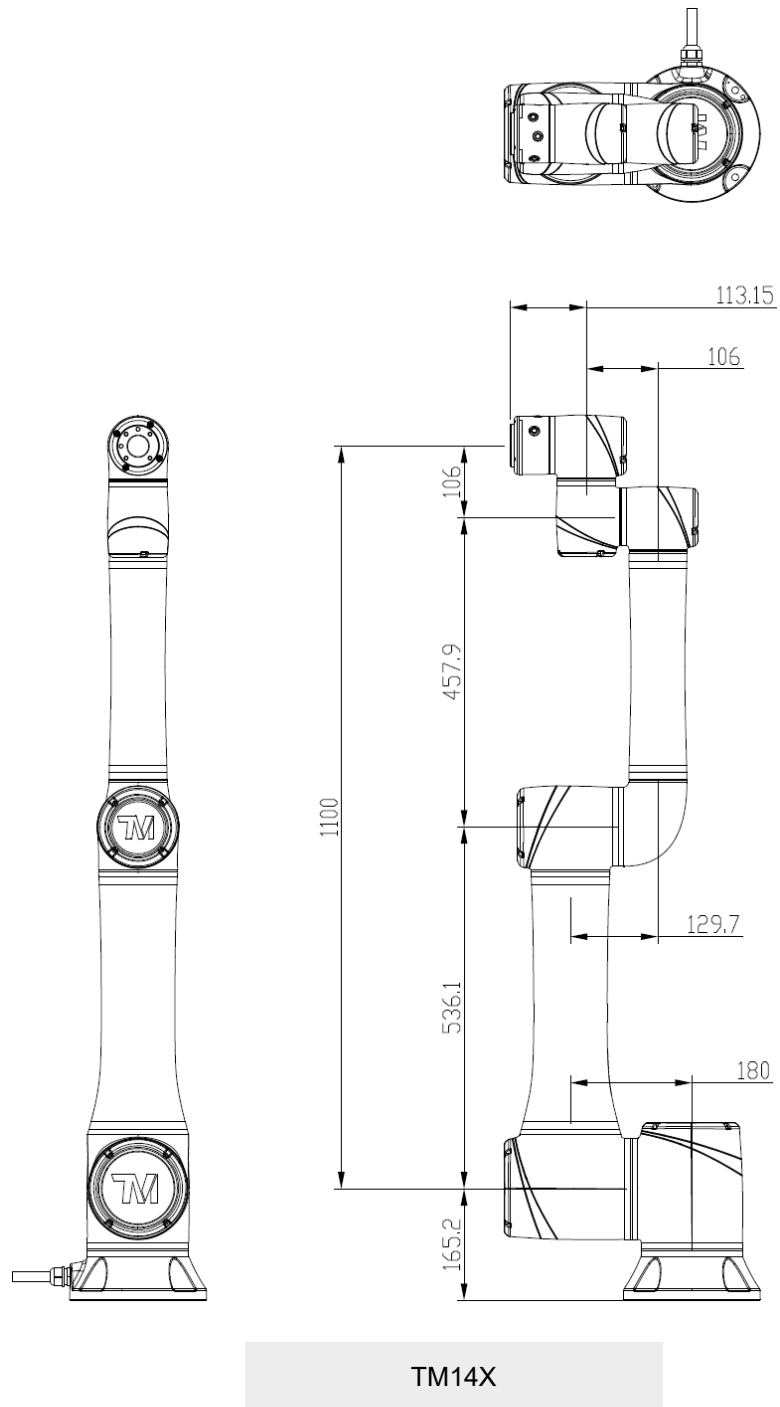
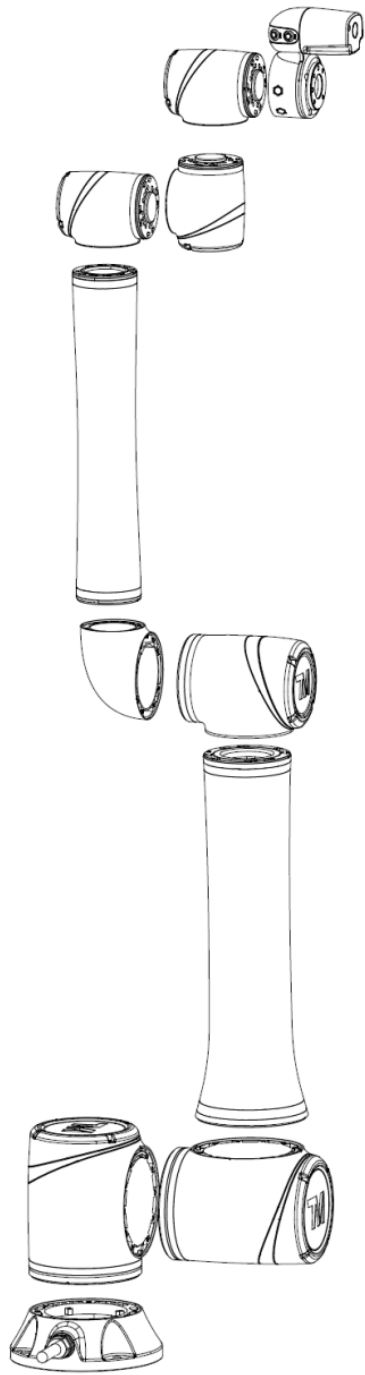


Figure 8: Dimension of TM14X

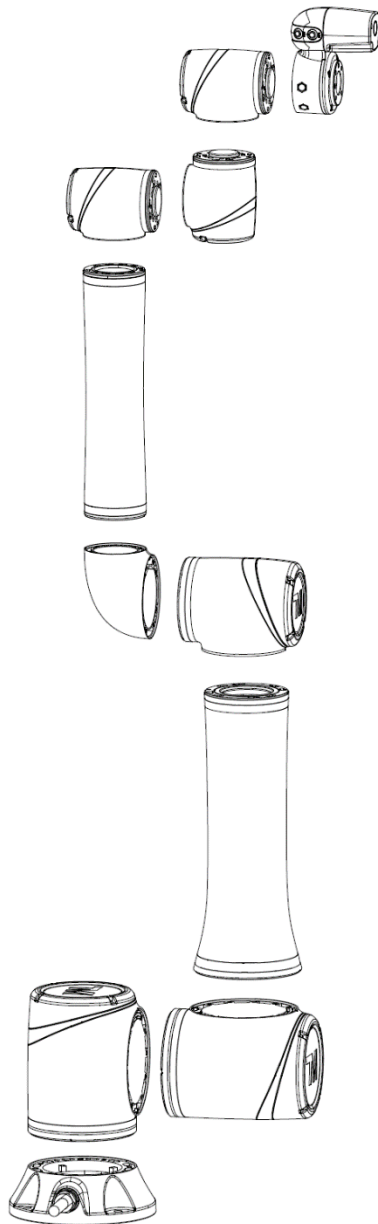
4.2.1.2 Robot Assembly Diagram

Shown below is an illustration of the robot components. To avoid safety risks, please do not attempt to disassemble any component on your own. Please contact your local corporation support for any service request.



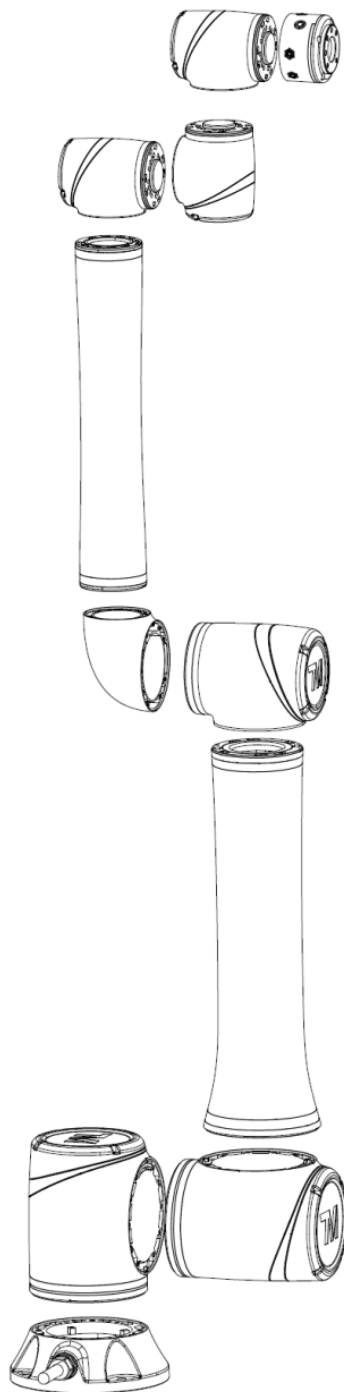
TM12 / TM12M

Figure 9: Assembly of TM12 / TM12M



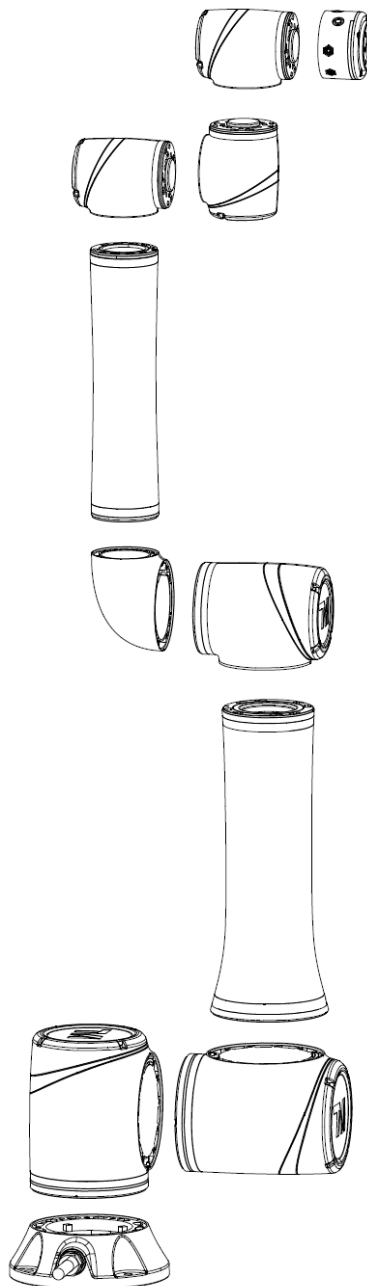
TM14 / TM14M

Figure 10: Assembly of TM14 / TM14M



TM12X

Figure 11: Assembly of TM12X



TM14X

Figure 12: Assembly of TM14X

4.2.1.3 Range of Motion

The working spherical (radius) range from the base is 1300 mm for the TM12 series and 1100 mm for the TM14 series.

DANGER:

With the exception of an individual being in full control of robot motion during hand-guiding, personnel shall be outside the safeguarded space when the robot is in motion while in manual mode (i.e.teaching).



The emergency stop on the Robot Stick shall be readily accessible during manual mode. At least one emergency switch is installed outside of the motion range of the robot. When no motion limit is set for the robot, the motion range of the robot is equal to the maximum motion range of the robot arm. You can set a motion limit to avoid the situation whereby all operations have to be out of the maximum motion range of the robot arm.

The Robot Stick should be placed in an area that the robot cannot reach. The user should also make sure that the movement of the robot will not be within any area where personnel will enter to press any buttons on the Robot Stick.

TM12 / TM12M/ TM12X Movement Range Diagram

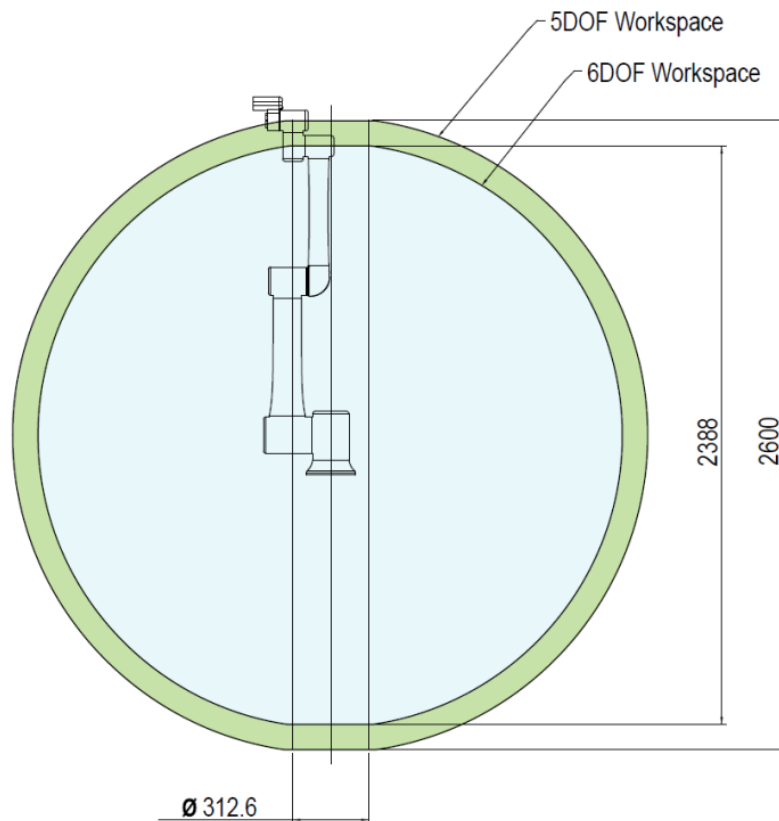


Figure 13: Side View of TM12 / TM12M / TM12X Movement Range Diagram

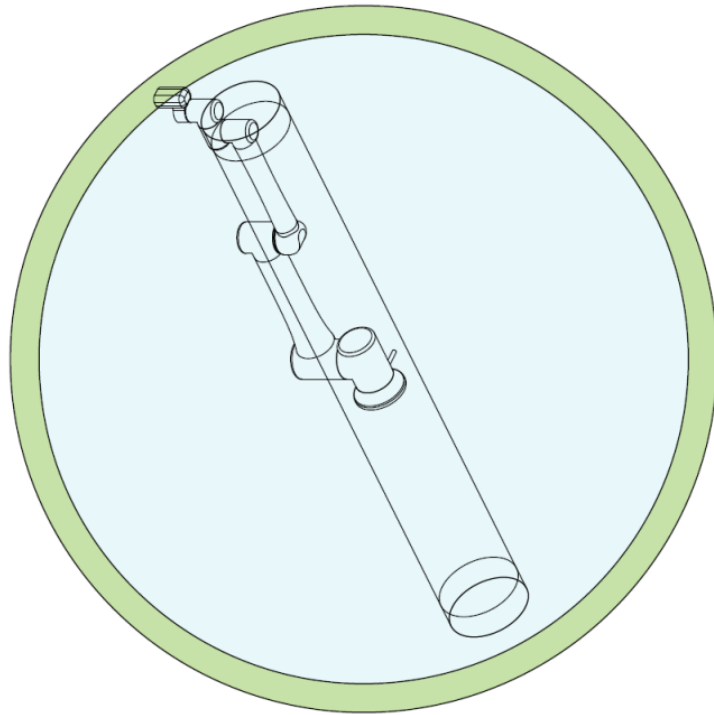
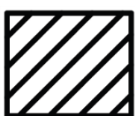
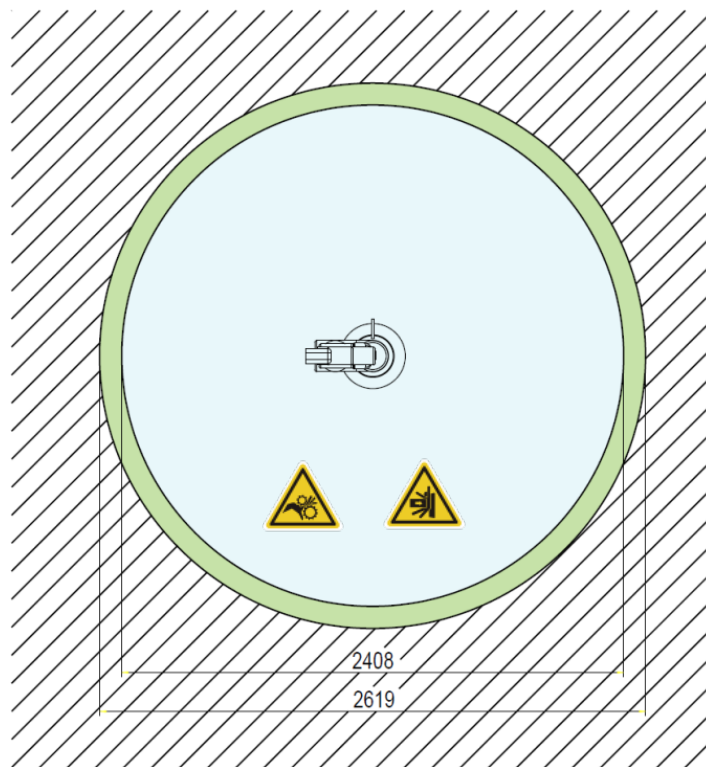


Figure 14: Pictorial view of TM12 / TM12M / TM12X Movement Range Diagram



Operator Position



Warning: Risk of crushing within the operating area of the arm.



Warning: Risk of collision within the operating area of the arm.

Figure 15: Top view of TM12 / TM12M / TM12X Movement Range Diagram

TM14 / TM14M /TM14X Movement Range Diagram

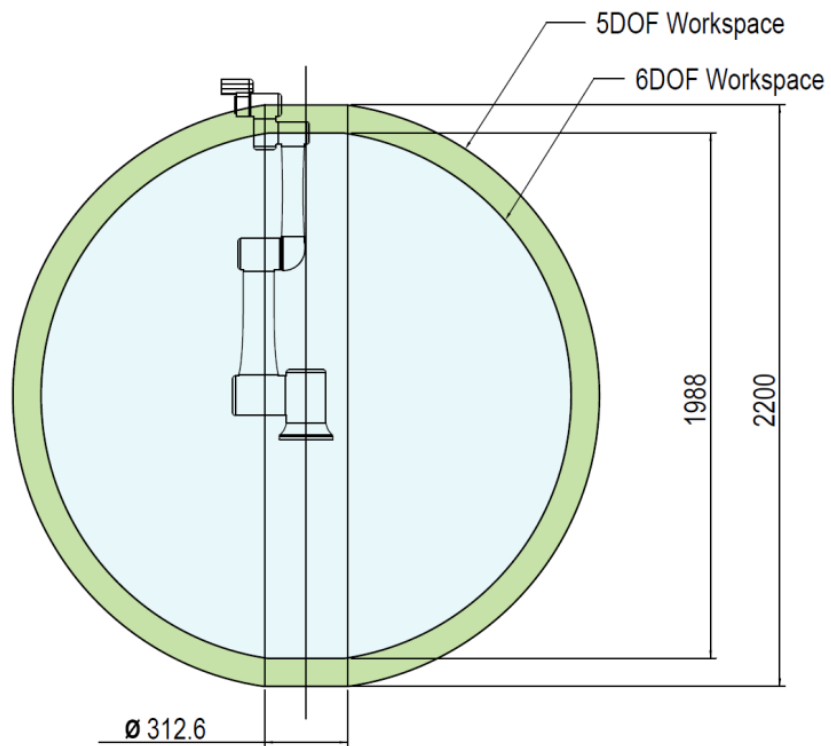
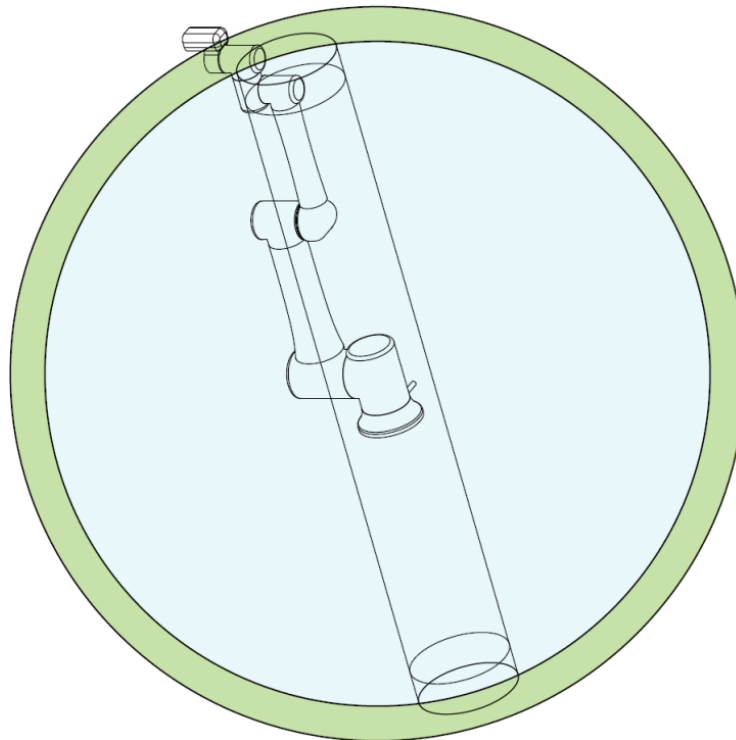
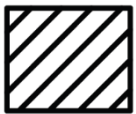
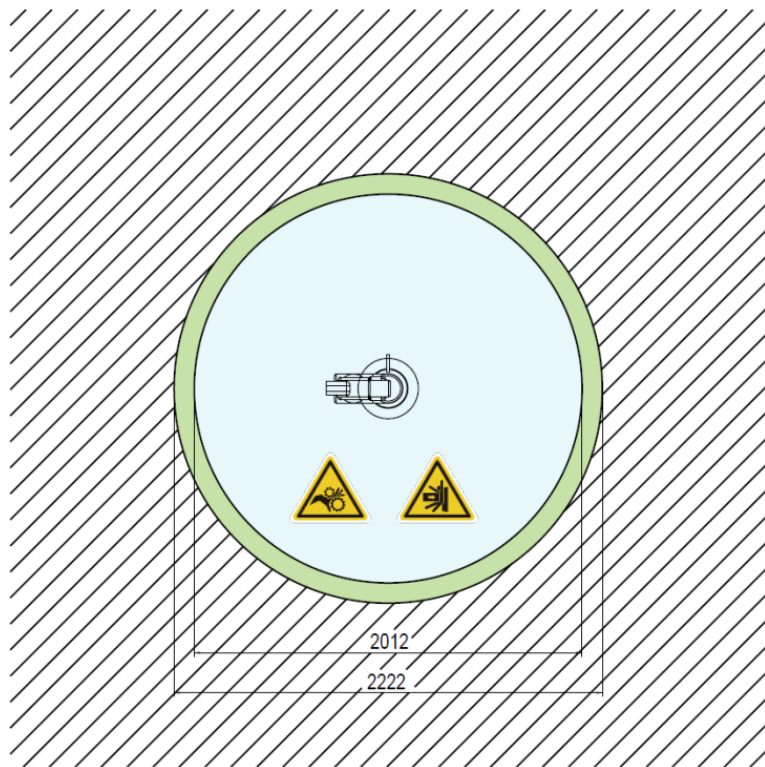


Figure 16: Side view of TM14 / TM14M/ TM14X Movement Range Diagram



Pictorial view

Figure 17: Pictorial view of TM14 / TM14M / TM14X Movement Range Diagram



Operator Position



Warning: Risk of crushing within the operating area of the arm.

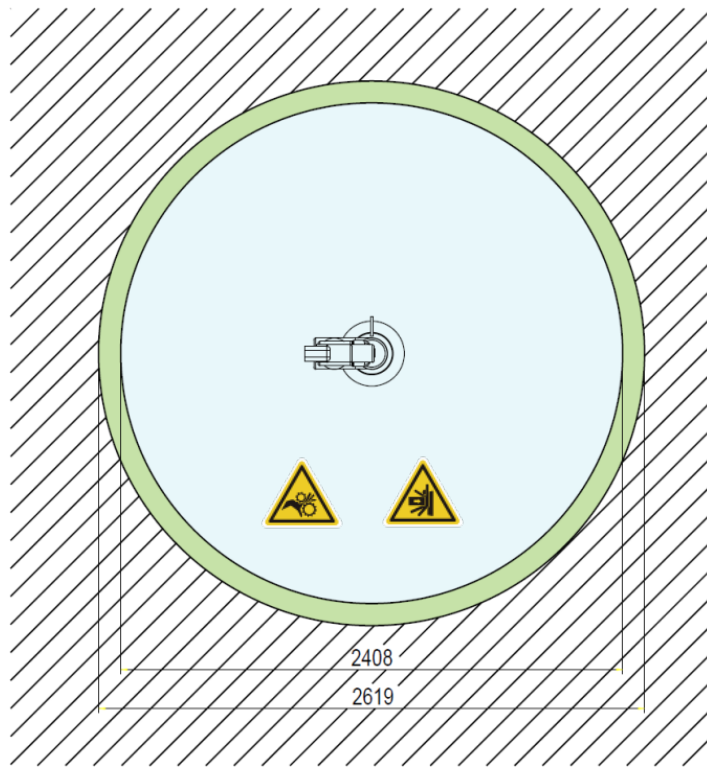


Warning: Risk of collision within the operating area of the arm.

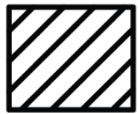
Figure 18: Top View of TM14 / TM14M / TM14X Movement Range Diagram

4.2.1.4 Robot Hazard Zone Diagram and Operator Position Diagram

Shown below is an illustration of the robot hazard zone and operator position diagrams. Do not operate the robot while anyone is inside of the hazard zone to avoid safety risks.



TM12 / TM12M / TM12X



Operator Position

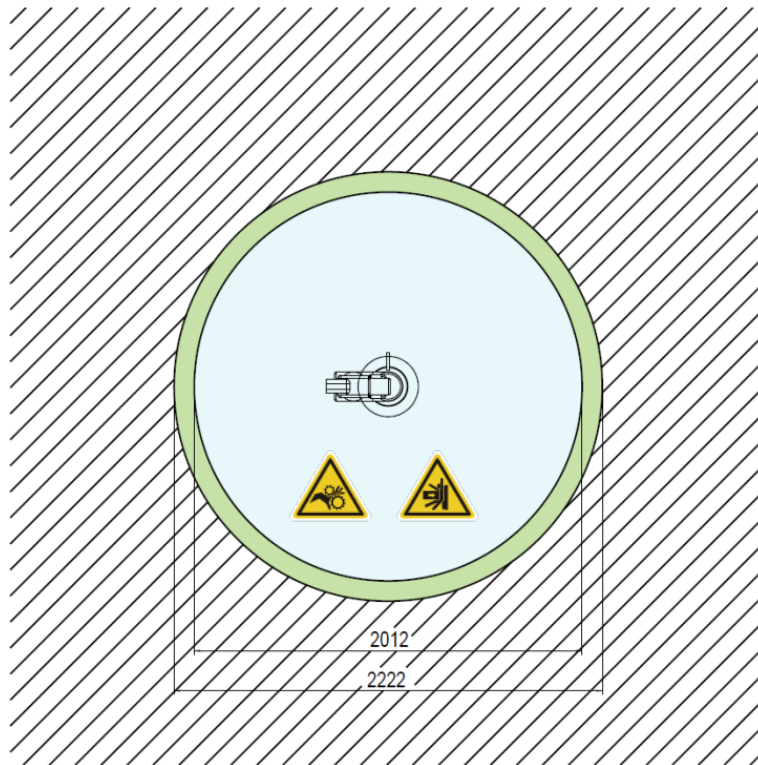


Warning: Risk of crushing within the operating area of the arm.

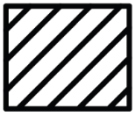


Warning: Risk of collision within the operating area of the arm.

Figure 19: Robot Hazard Zone Diagram and Operator Position Diagram of TM12 / TM12M TM12X



TM14 / TM14M / TM14X



Operator Position



Warning: Risk of crushing within the operating area of the arm.



Warning: Risk of collision within the operating area of the arm.

Figure 20: Robot Hazard Zone Diagram and Operator Position Diagram of TM14 / TM14M / TM14X

4.2.1.5 Payload

The maximum allowed payload of the robot arm is related to its center of gravity offset, which is defined as the distance from the center point of tool flange to the payload's center of gravity.

The following figure shows the relationship between payload and the center of gravity offset:

TM12 / TM12M / TM12X

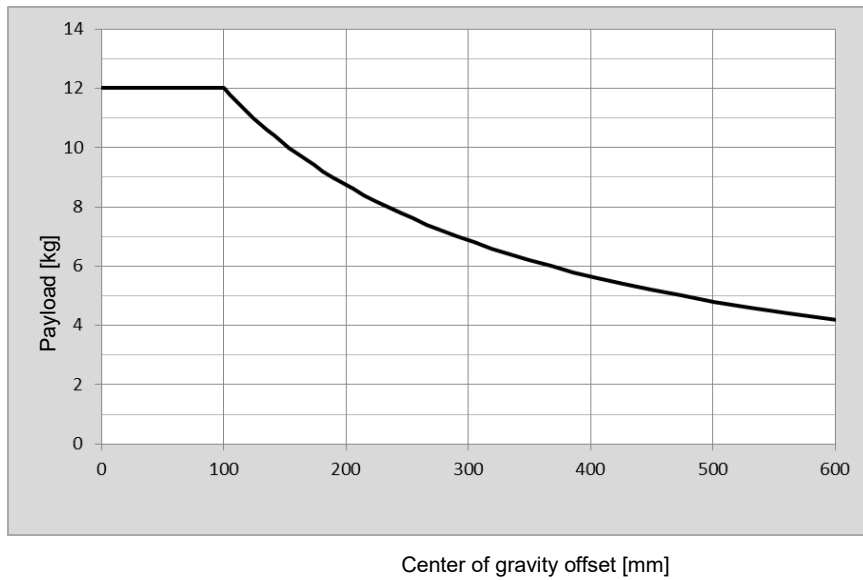


Figure 21: Relationship between Payload and the Center of Gravity Offset in TM12 / TM12M / TM12X

TM14 / TM14M / TM14X

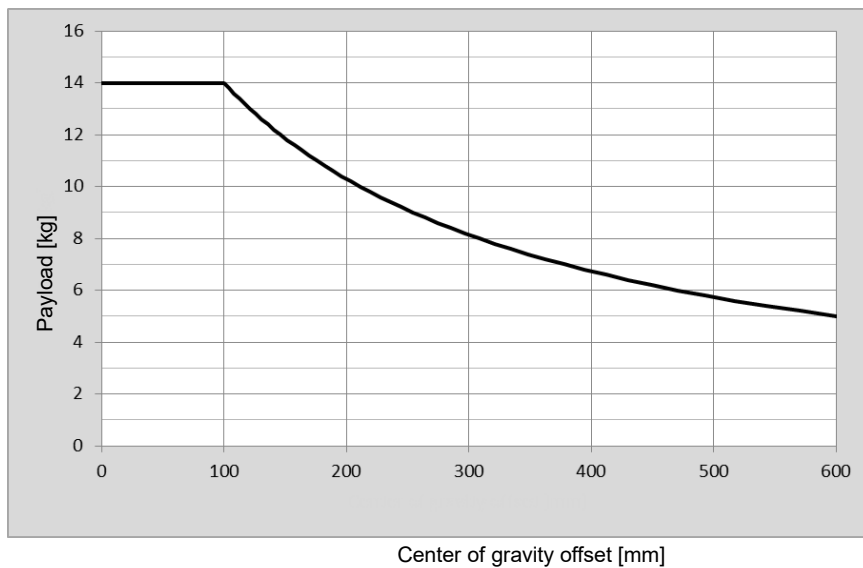


Figure 22: Relationship between Payload and the Center of Gravity Offset in TM14 / TM14M / TM14X

Refer the table below for the rated torque and the limit of repeated peak torque of the robot. Exceeding torque may reduce the life of the robot or damage the robot.

Model	TM12 Series		TM14 Series	
Item	Rated torque	Limit for repeated peak torque	Rated torque	Limit for repeated peak torque
J1	311	353	311	353
J2	311	353	311	353
J3	118	157	118	157
J4	34	54	41	54
J5	34	54	41	54
J6	34	54	34	54
Unit: Nm				

Table 4: Rated Torque and Limit for Repeated Peak Torque of Medium & Heavy Payload Robot Series



WARNING:

Use the total weight of the end-effector and the payload to stay within the payload rating of the robot. Ensure that the system never exceeds that maximum payload. You should perform a full risk assessment that includes the end-effector and payload samples, to ensure the safety of the entire system.

4.2.1.6 Robot Arm Installation

The robot can be secured to another surface with the use of (4) M10 screws and washers. The mounting pattern is shown below. The recommended tightening torque is 40 Nm.

Optional - Two openings for 6 mm position pins are provided for more secure position mounting.

Ensure the strength of the mounting surface and its surround area before installations for upside down mounting and side mounting such as on the ceiling or the wall. Wherever the installation takes place, the robot setting remains equivalent.

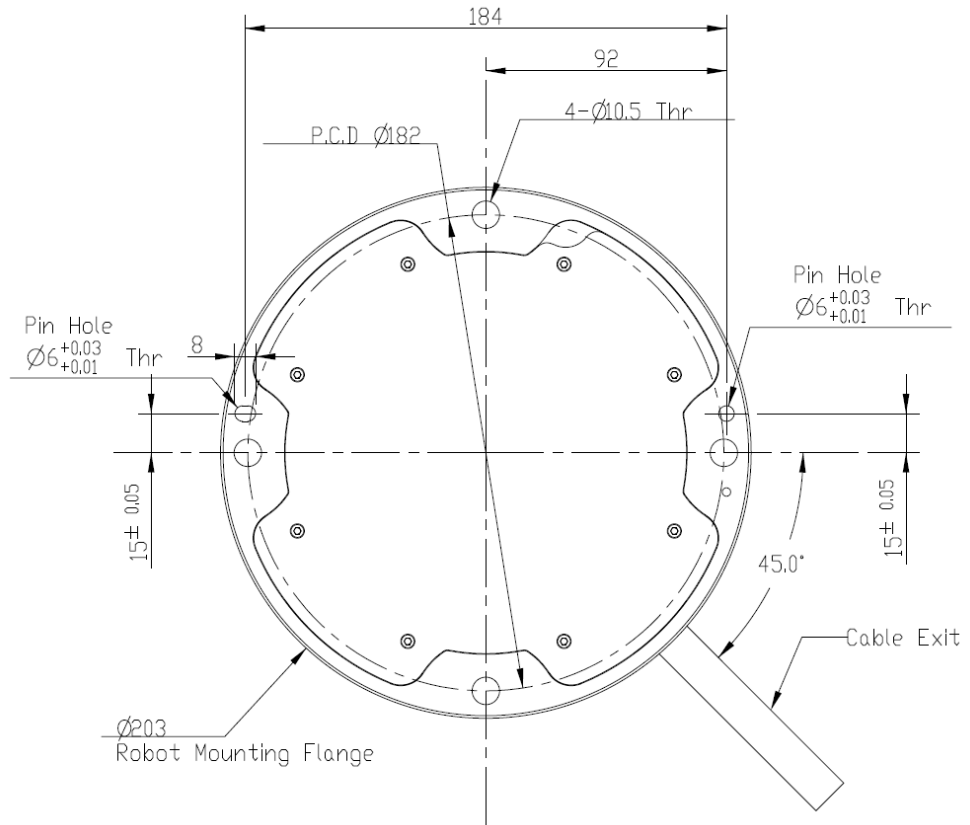


DANGER:

1. The TM Robot must be securely and tightly screwed down before use. The strength of the mounting surface must be sufficient.

When operating at high speed, the robot can generate up to 710 N reaction force to the mounting surface and screws. In order to avoid decreased performance caused by robot slip or vibration, the recommended mounting surface should be a steel plate at least 25 mm thick, its flatness should be 0.1 mm or less, its surface roughness should be Rz25 or less. The recommended screw should be M10 x L35 mm, at least 8.8 in strength.

2. Do not immerse TM Robot in water. Installation in water or a humid environment will permanently damage the robot.



BOTTOM VIEW OF ROBOT BASE

Figure 23: Bottom View of Robot Base

4.2.2 Robot End Module

4.2.2.1 End Module Components

TM12 / TM12M / TM14 / TM14M End Module Components

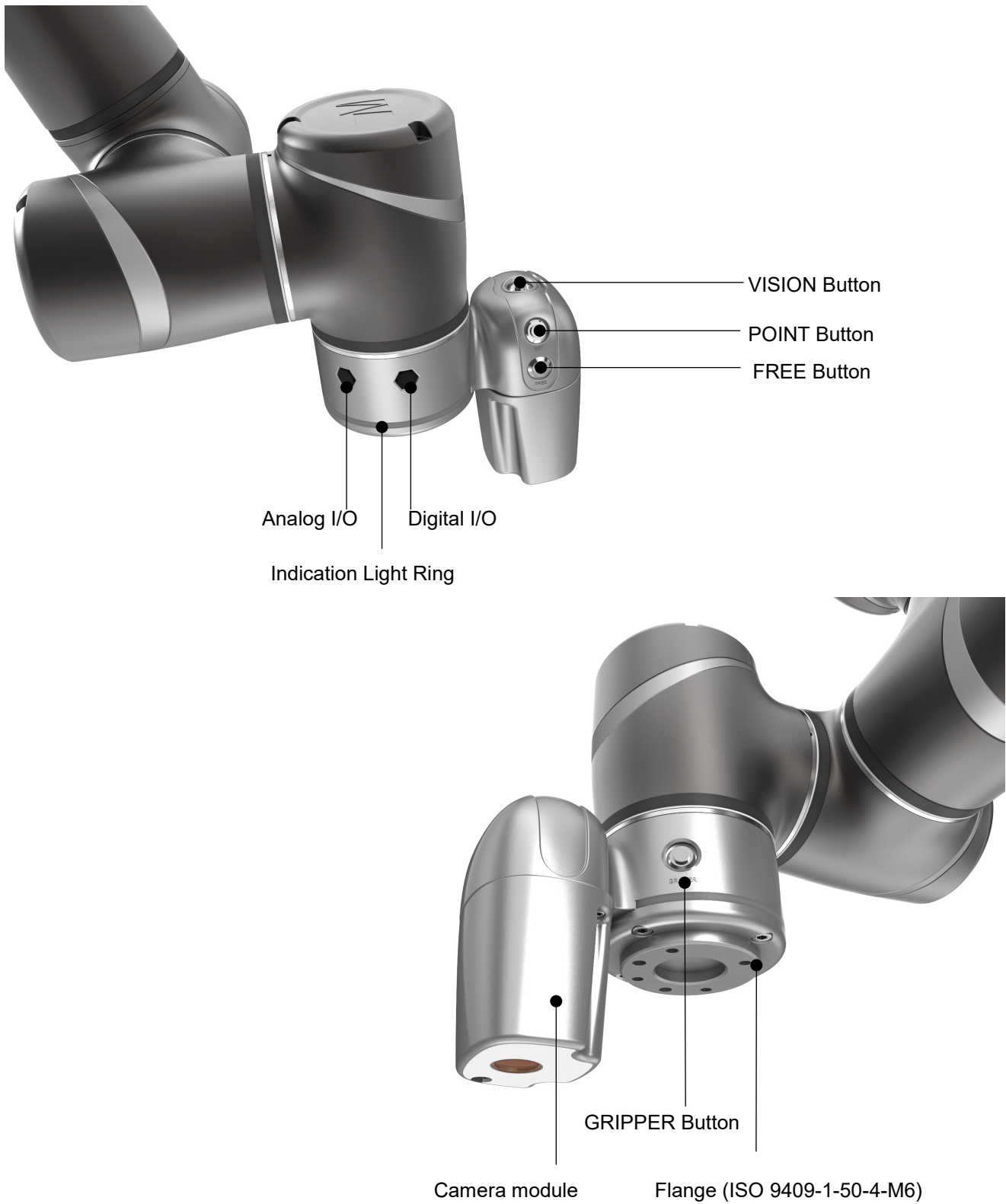


Figure 24: References of TM12 / TM12M / TM14 / TM14M End Module Components

TM12X / TM14X End Module Components

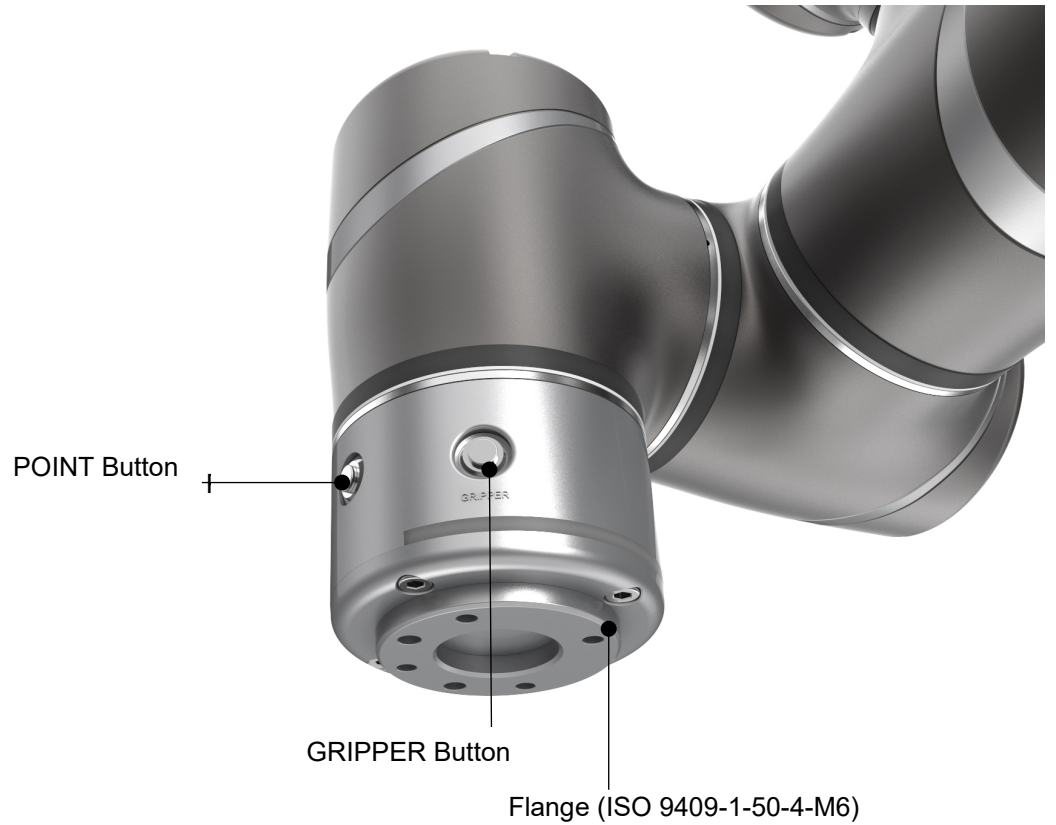
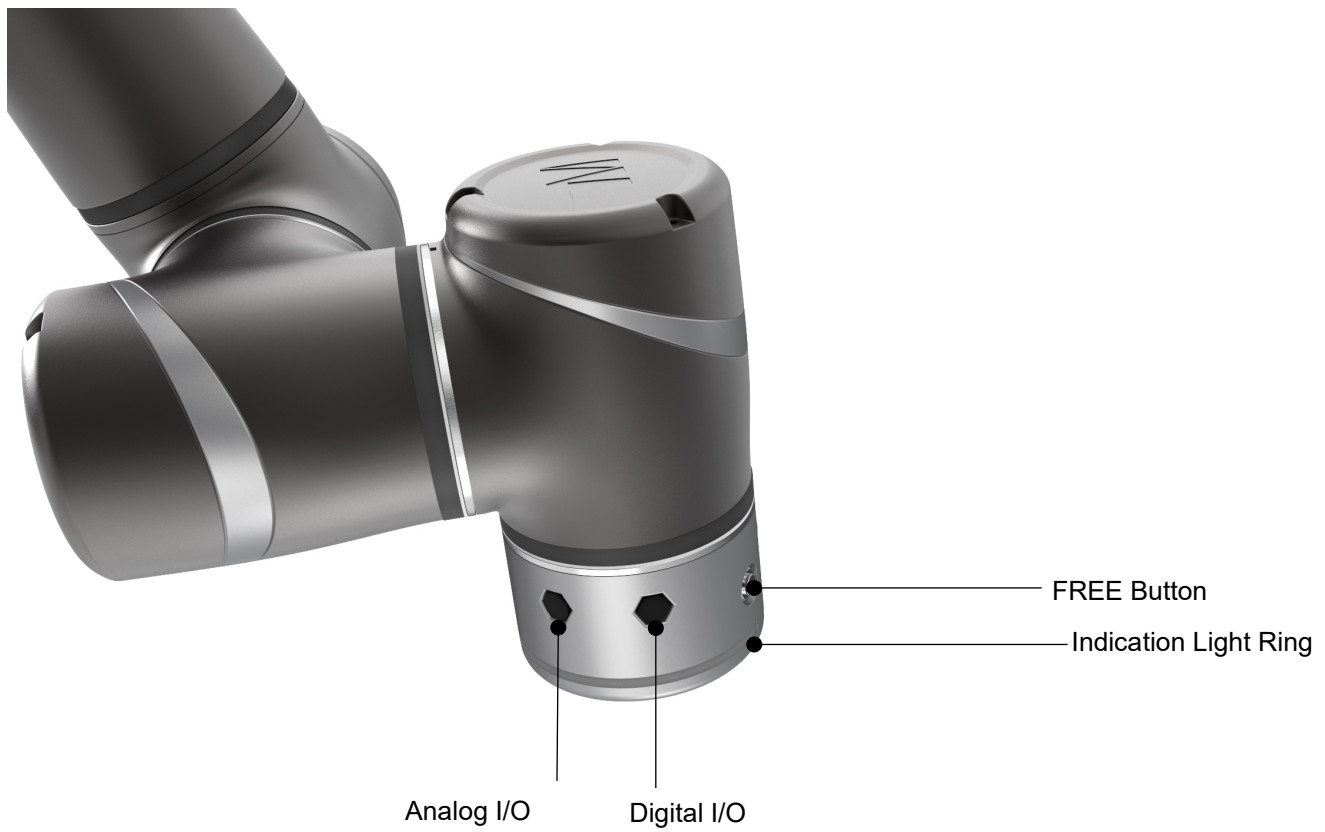


Figure 25: Reference of TM12X / TM14X End Module Components

4.2.2.2 End Flange Surface

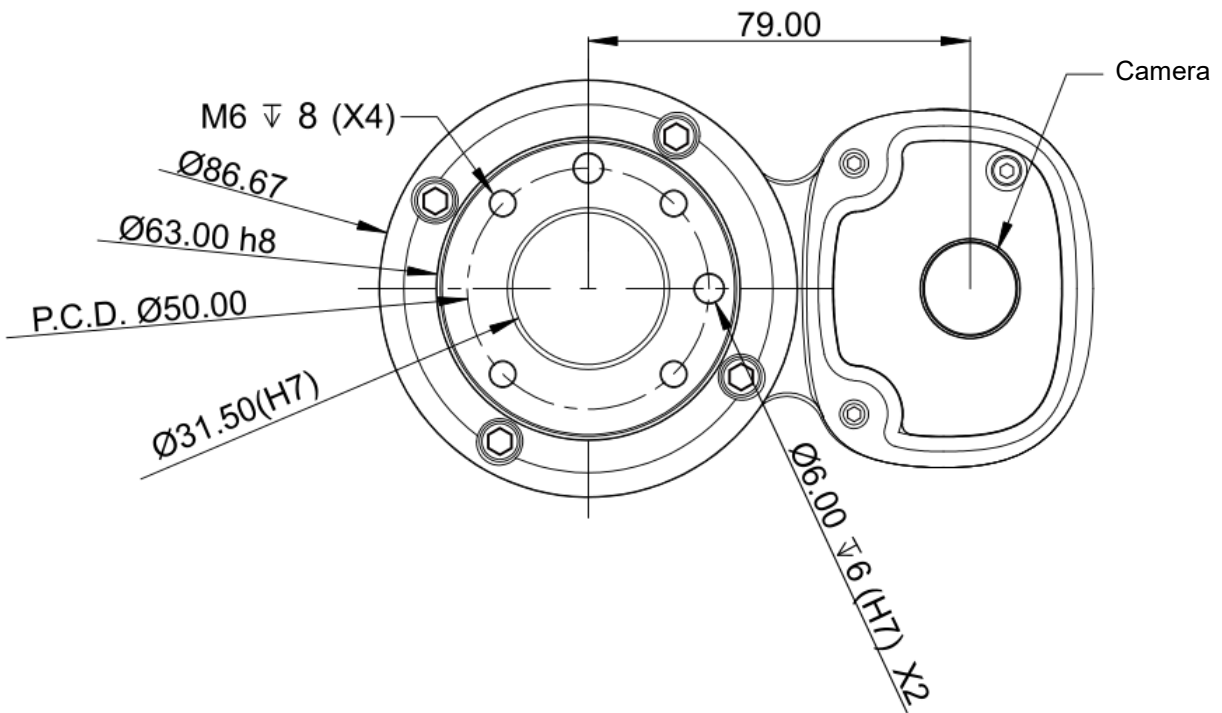
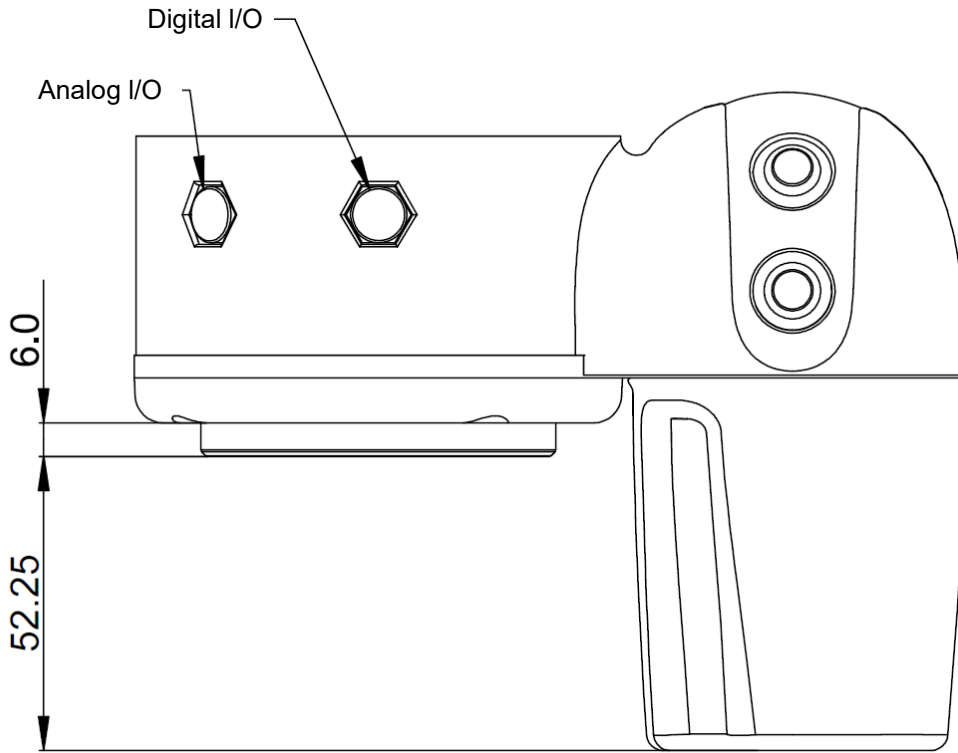


Figure 26: References of End Flange Surface

4.2.2.3 End Mounting Caution

The TM12/14 series uses four M6 threaded holes on the end flange and four M6 screws for mounting tools. A tightening torque of 9 Nm is recommended. If your application requires higher precision, you can use two positioning pins with a diameter of 6 mm for a more secure mounting.



DANGER:

Tools must be properly tightened when using this product. Improper tightening may cause the tool or part to fall out, or even cause personal injury and death.

4.2.2.4 End Indication Light Ring Table

The Indication Light Ring of the TM Robot has several colors which represent different modes and error status. Refer to the Software Manual for the definition of the light colors.

4.2.3 Control Box

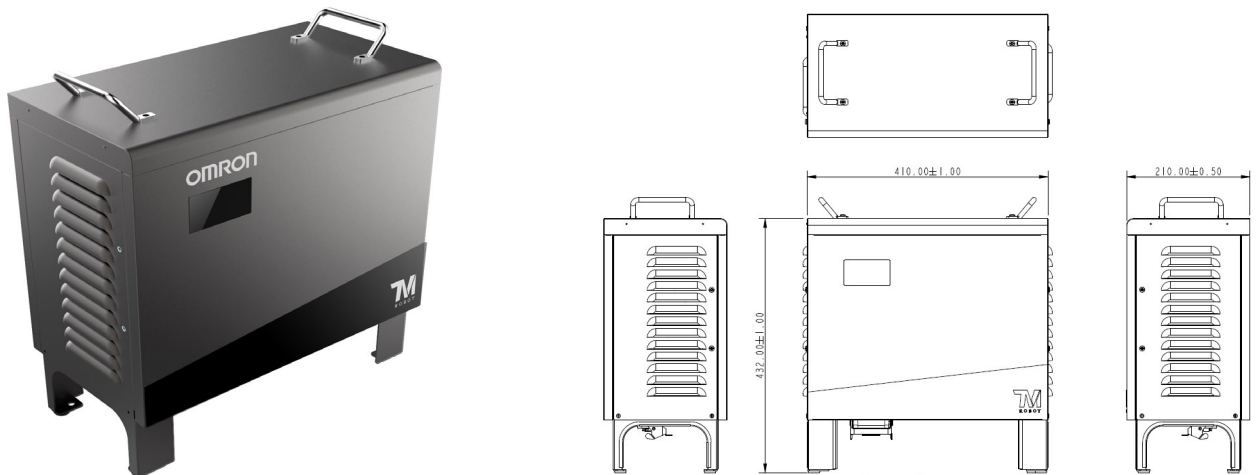


Figure 27: The Exterior and Diagram of the Control Box



CAUTION:

The control box can be placed on the floor or in your working cell. Note that 5cm clearance should be left at both sides for air flow.

4.2.3.1 Robot Stick

The Robot Stick has 6 function buttons, 3 indicator lights, 1 Emergency Switch, and 1 QR-code. Their functions are as follow:

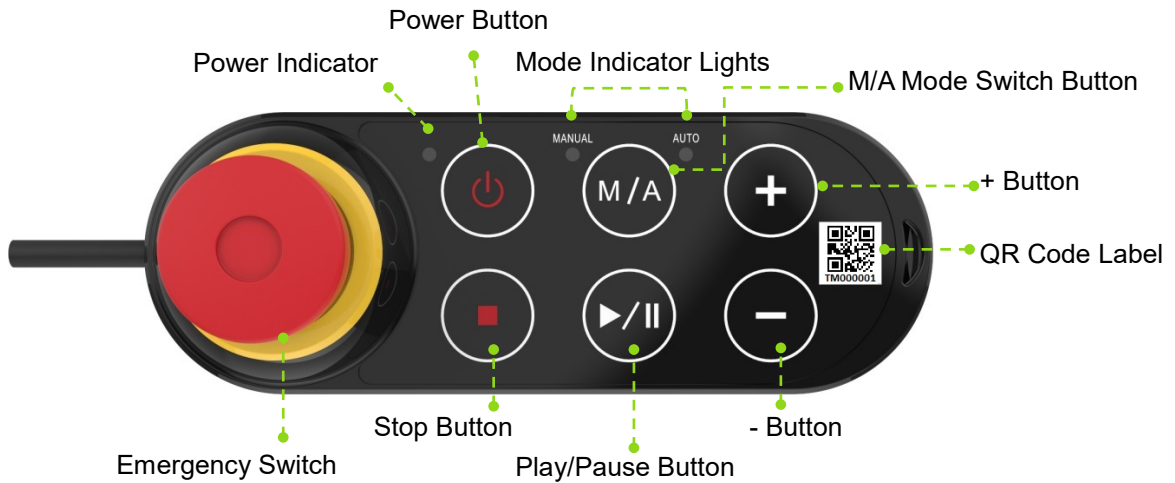


Figure 28: Robot Stick



CAUTION:

When operating the Robot Stick, do not use other objects than fingers to press the Robot Stick.

Items	Basic Function
Emergency Switch	Default emergency button for the robot
Power Button	Power initiation (single press)/ Shutdown (long press)
M/A Mode Switch Button	Toggle Manual/Auto Mode (single press). See Safety Manual for details.
Play/Pause Button	Play/Pause Project (single press)
Stop Button	Press this button to stop any project.
+/- Button	Adjust project speed (single press) under Manual Trial Run Mode. See Safety Manual for details.
Power Indicator	This indicator shows the robot's power status. Not on: Switched off Flashing: Booting Constant: Startup completed
Mode Indicator Lights	One is Manual Mode, the other one is Auto Mode. They show the robot's current operating mode. Once boot up is complete only one will always be on.
QR Code Label	The content of the SSID is also the robot's name in TCP/IP network.

Table 5: Robot Stick Basic Functions

Items	Advanced Function
Emergency Switch	- Press and release, and then wait for 3 seconds to enter Safe Start up Mode. - Press and release to enter Safe Start up Mode while booting.
Play/Pause Button	Play/pause visual calibration operation (single press)
Stop Button	Stop visual calibration operation (single press)
+/- Button	- Hold to jog the robot at the HMI robot controller page (Hold to Run). See Safety Manual for details. - Lock/ Unlock: hold down both add and subtract until the mode indicator flashes, then follow the sequence "-", "+, -, -, +" to lock/unlock the Robot Stick (except the Power Button)

Table 6: Robot Stick Advanced Functions

CAUTION:

The Robot Stick is magnetic so that it can be attached to steel surfaces. However, the risk of falling or rotating caused by poor attachment should be taken into account. It is recommended using the Robot Stick Stand (official accessory) to secure the Robot Stick. The Robot Stick Stand should be fixed with screws. Always attach the Robot Stick when it is not in use. The Robot Stick should be placed in a way such that the signal cables are routed to avoid damage caused by pulling.



DANGER:

1. The control box, cables, power signal cables, and Robot Stick cannot be used when any of them is in contact with liquids. This may result in personal injury or death.
2. The control box has an IP32 rating but is not recommended to be used in dusty and humid environments. Particular attention should be paid to environments with conductive dust (such as metal particles).
3. Be noted that the control box can only be at standing pose to have IP32 rating.



4.3 Operating Position of TM Robot with AGV/AMR

When TM Robot is placed on an AGV/AMR and while the AGV/AMR is in operation, the user should pause the TM Robot and the TM Robot itself should not exceed the footprint of the AGV/AMR.

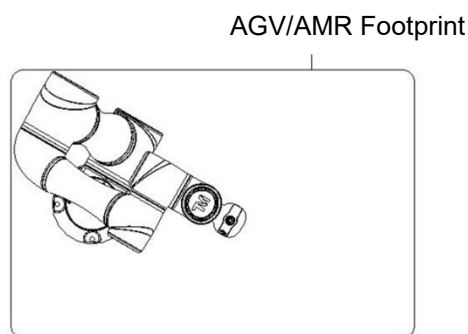


Figure 29: Top View of TM Robot Placed on the AGV/AMR

4.4 Working distance and field of view of TM Robot's EIH camera

The field of view of TM Robot's EIH camera varies linearly in accordance with the working distance. The minimum working distance is about 100 mm and the maximum working distance is about 300 mm. The zero working distance point is approximately 49 mm in front of the flange surface and right behind the center of the protection lens.

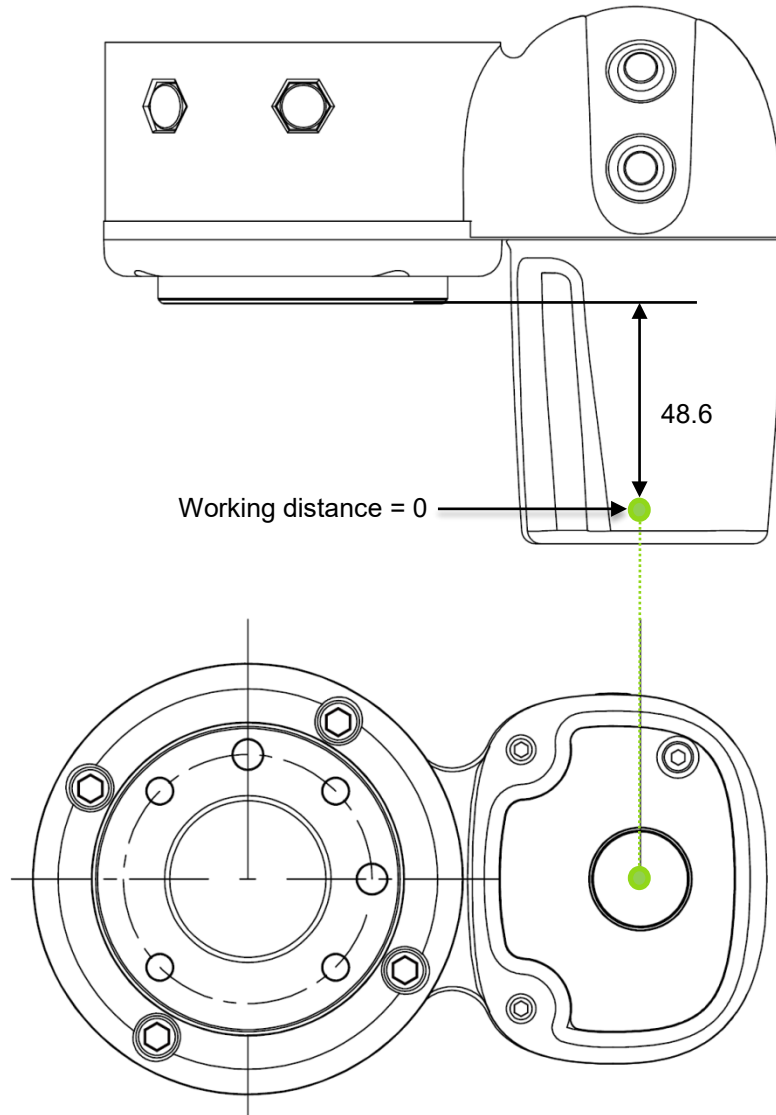


Figure 30: Working Distance and Field of View of TM Robot's EIH camera

The relation between the working distance and the field of view is listed below.

Working distance (mm)	300	100
Field of view (mm)		
Width	281.6	96.9
Height	211.2	72.7

Table 7: The Relation between the Working Distance and the Field of View

5. Electrical Interface

5.1 Overview

This chapter introduces all electrical interfaces of the robot arm and control box.

5.2 Electrical Warnings and Cautions

The application design and installation of the robot should comply with the following warnings.



DANGER:

1. Ensure all pieces of the equipment are kept dry. If water enters the equipment, disconnect the power and contact your supplier.
2. Only use the original cables included with the robot. If you need longer cables, contact your supplier.
3. Ensure that the robot is properly grounded. If the grounding is not correct, it may cause a fire or electric shock.



WARNING:

The I/O cables used for the link between the control box and other equipment should not be longer than 30 meters, unless testing shows that longer cables are feasible.

5.3 Control Box



WARNING:

Except for USB ports, other interfaces have to be installed while arm is powered off. Do not install while arm is on to avoid abnormal shutdown.

Control Box I/O configuration

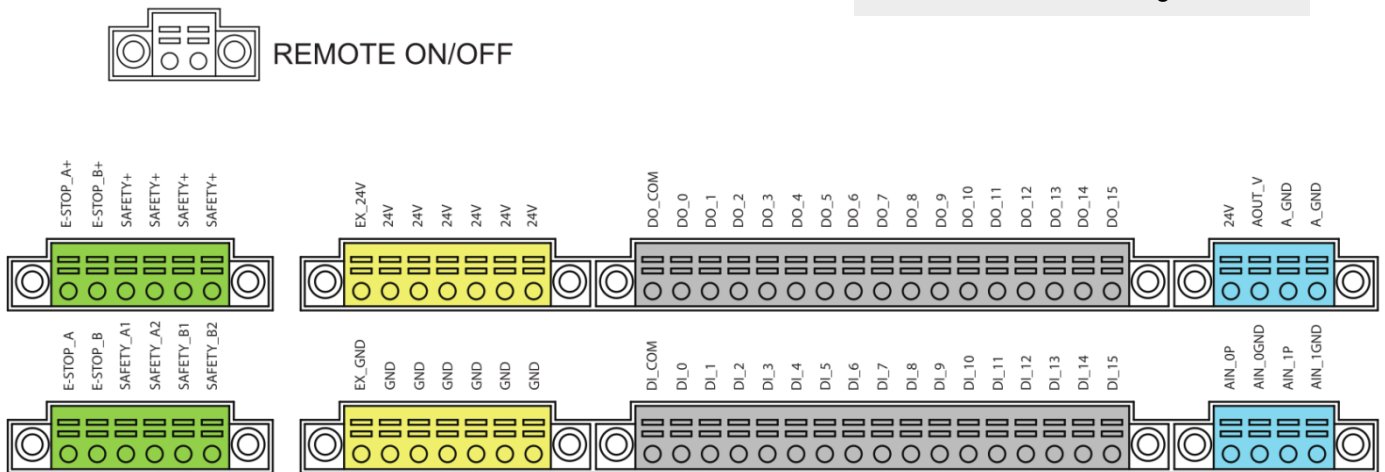


Figure 31: Control Box I/O Configuration (1/2)

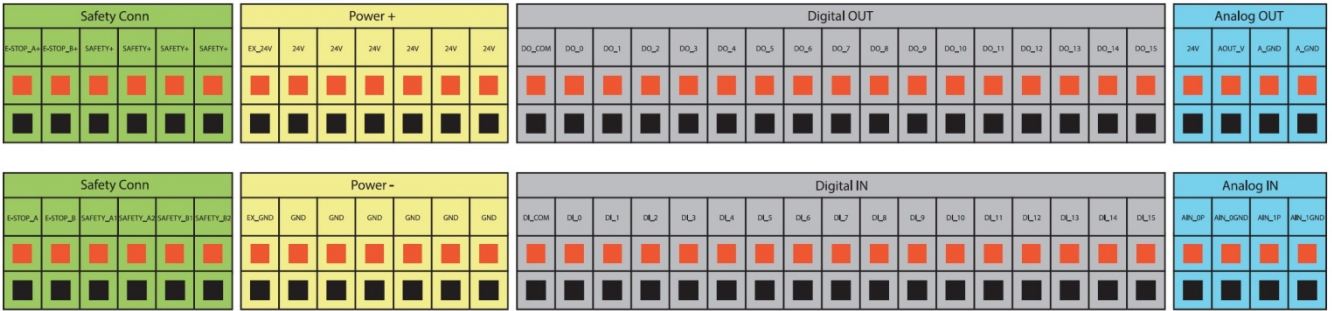
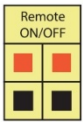


Figure 32: Control Box I/O Configuration (2/2)

5.3.1 Safety Connector

Provides extension ports for Emergency Stop (ESTOP) & Safeguard Port.

1. ESTOP is a N.C. contact (Normally closed). When any connected ESTOP switch is OPEN, the robot enters the Emergency STOP state.
2. Safeguard A Port is a N.C. contact (Normally closed). When Safety A switch is OPEN, the robot enters the Safeguard Pause state.
3. Safeguard B Port is a N.C. contact (Normally closed). When Safety B switch is OPEN, the robot enters the Safeguard Collaborative Mode state.

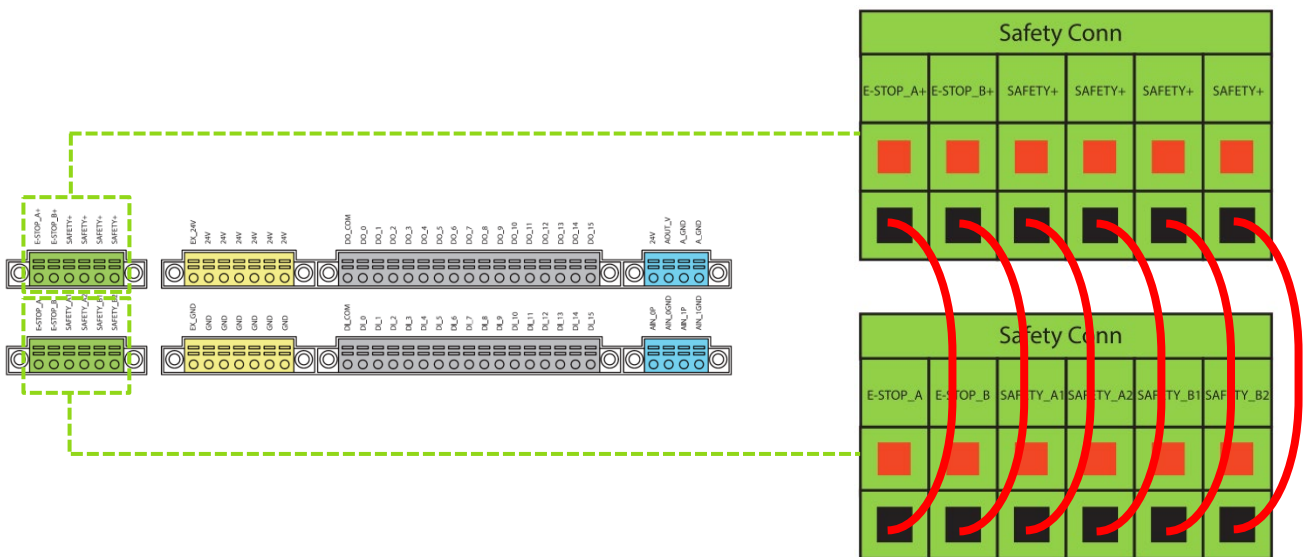


Figure 33: Safety Connector

Application settings of the arm safety device

If the safety device is used to work with the safety connectors on the TM Robot, the safety relay can be connected to the safety connector to work as the normally closed switch triggered by the safety device. If direct connection between safety device and safety connector on the TM Robot is preferred, use a safety device with PNP outputs. The PNP outputs can be connected to either “SAFETY_A1 and SAFETY_A2” or “SAFETY_B1 and SAFETY_B2” to trigger the collaborative mode or pause the robot motion. The PNP outputs can also be connected to “ESTOP_A and ESTOP_B” to trigger the emergency stop. The example circuit wiring diagram follows.

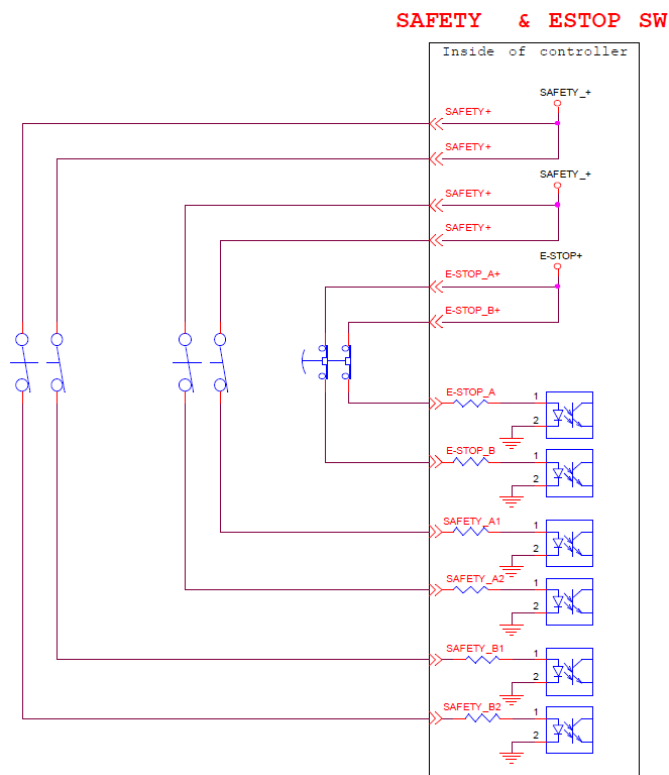


Figure 34: The Wiring Diagram Example of Switch Type Safety Device.

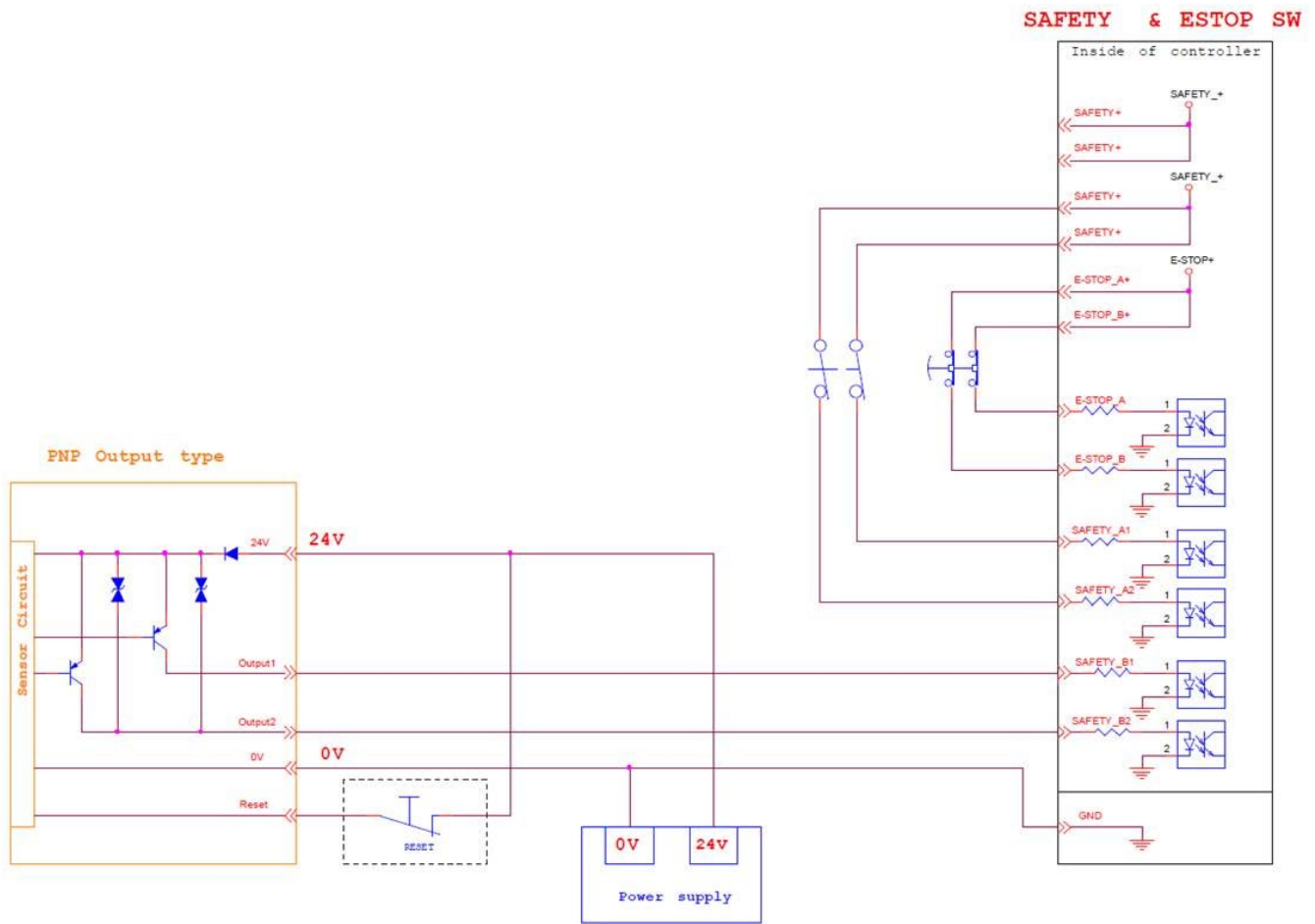


Figure 35: The Wiring Diagram Example of PNP Output Type Safety Device

5.3.2 Power Connector

1. During boot, the control box will check for an external 24V input. If none is found then it will switch to the internal 24V supply.
2. The control box itself offers a 24V1.5A output (24_EX). If the 24V load exceeds 1.5A, it enters Safe Mode and disables the 24V output.
3. EX24V provides an external 24V input port. If the load exceeds 1.5A an external power supply can be used instead. The load on EX24V must not exceed 3.5A.

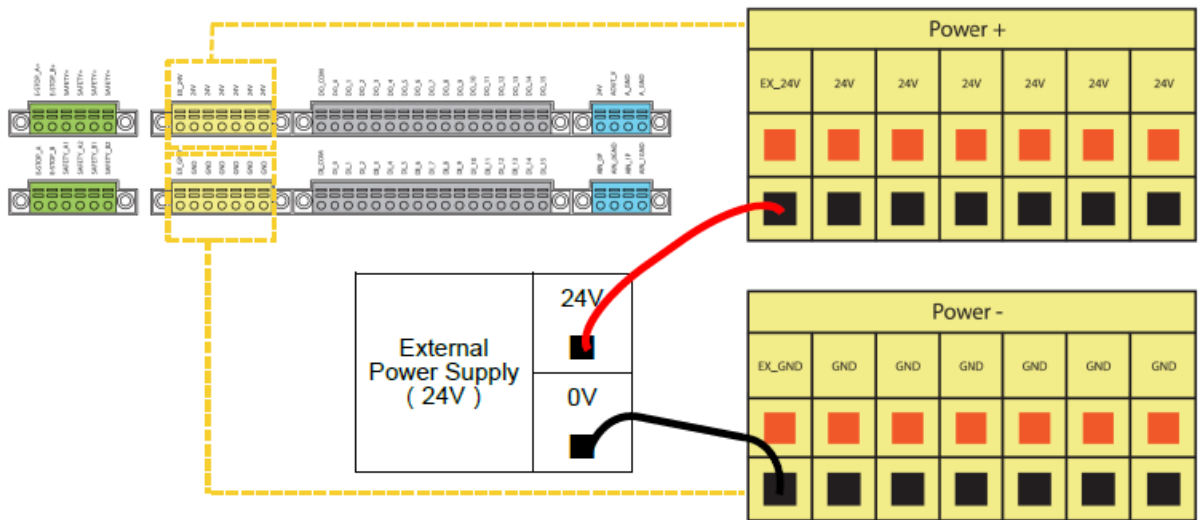


Figure 36: Power Connector

5.3.3 Digital In/Out

Digital input/output each has 16 channels, and its application is connected to the following sections.

5.3.3.1 Digital Input

Inputs can be set to either sink input or source input by selection.

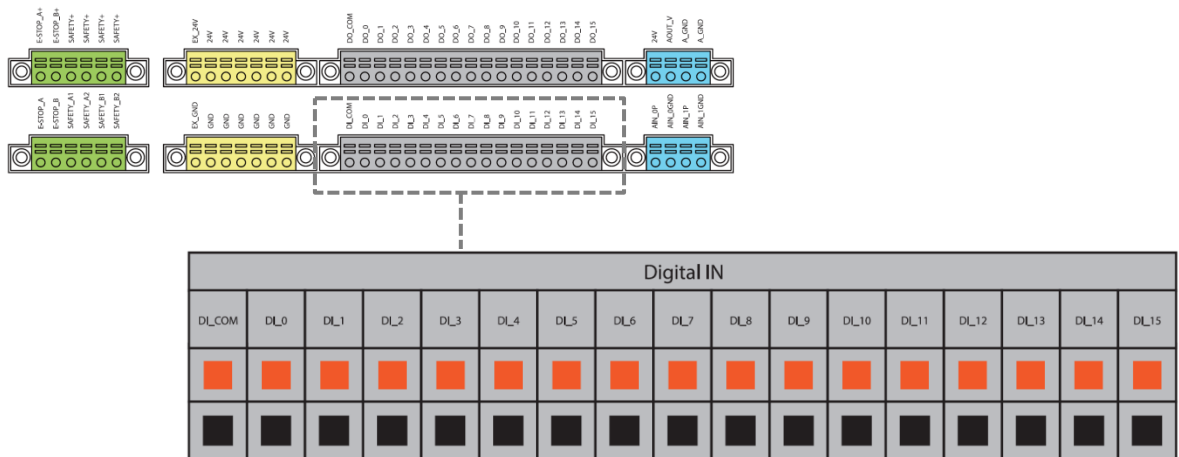


Figure 37: Digital Input

- Set to sink input type

When a device such as a transistor output type sensor is connected, NPN open collector transistor output can be used.

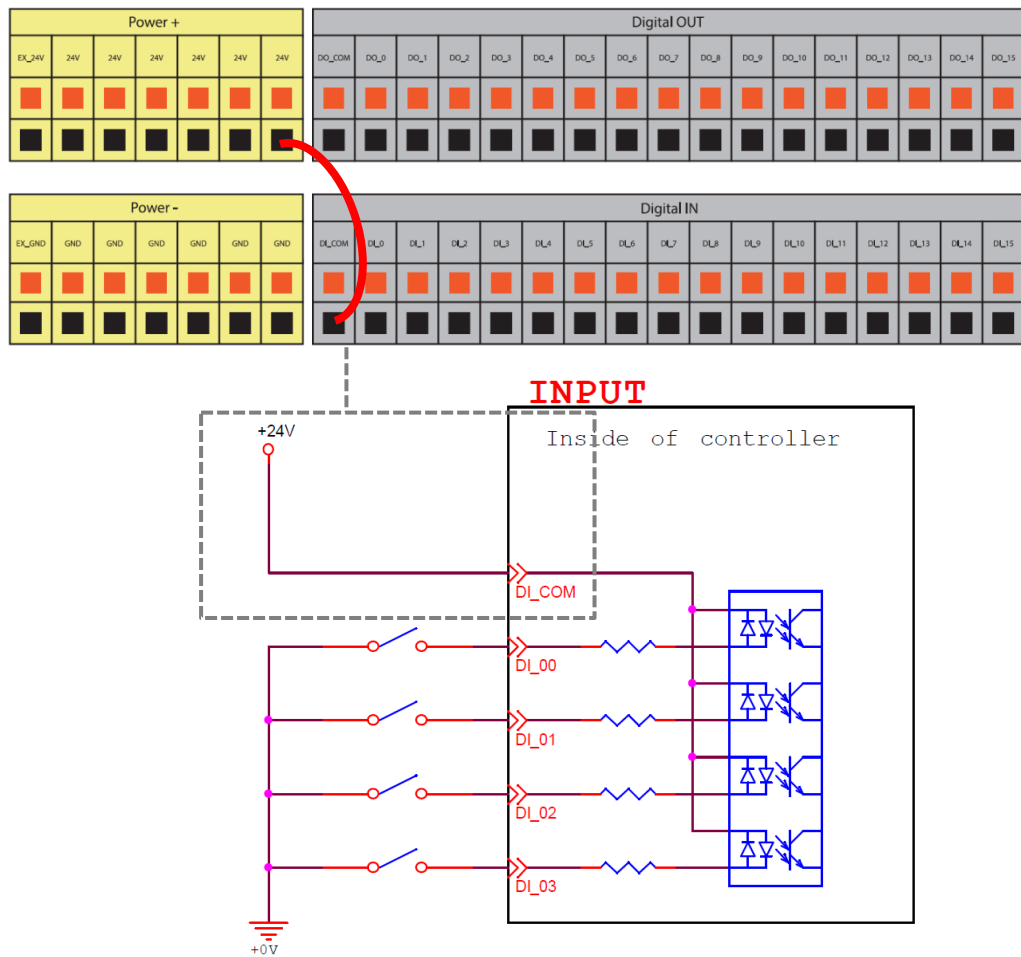


Figure 38: Set to Sink Input Type

- Set to Source input type

When a device such as a transistor output type sensor is connected, PNP open collector transistor output can be used.

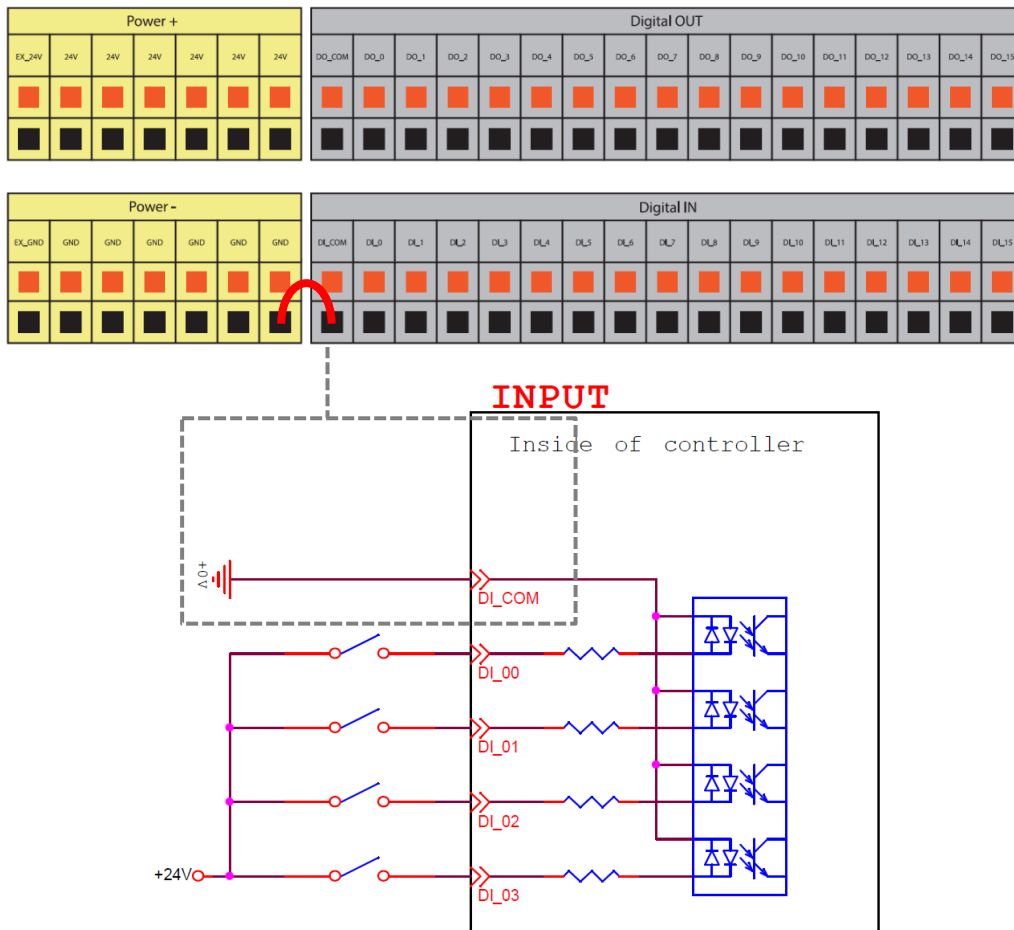


Figure 39: Set to Source Input Type

5.3.3.2 Digital Output:

The maximum drive current is 300mA per channel. If the load exceeds 300mA, a relay should be used to drive it.

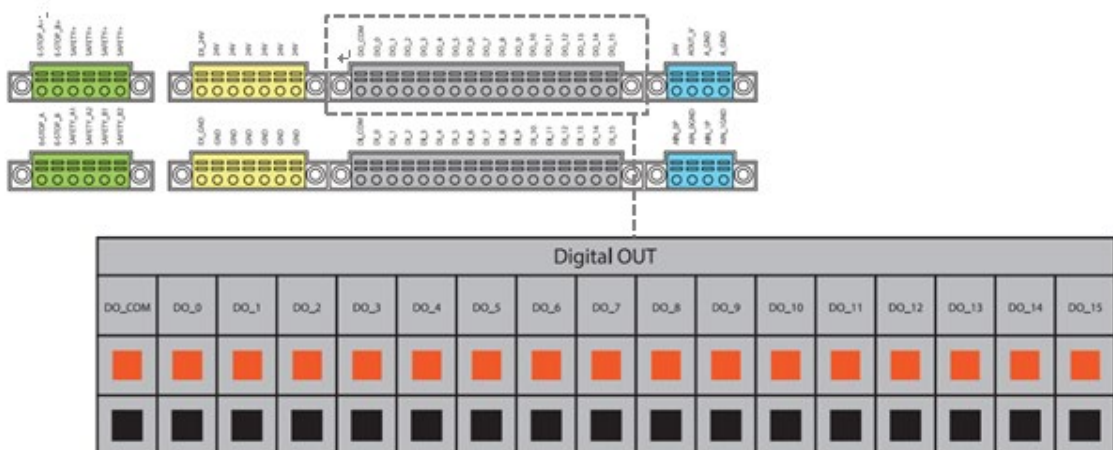


Figure 40: Digital Output

Outputs can be set to either sink output or source output by selection.

- Set to sink output type.

Connect DO_COM terminal to the minus side of the power supply.

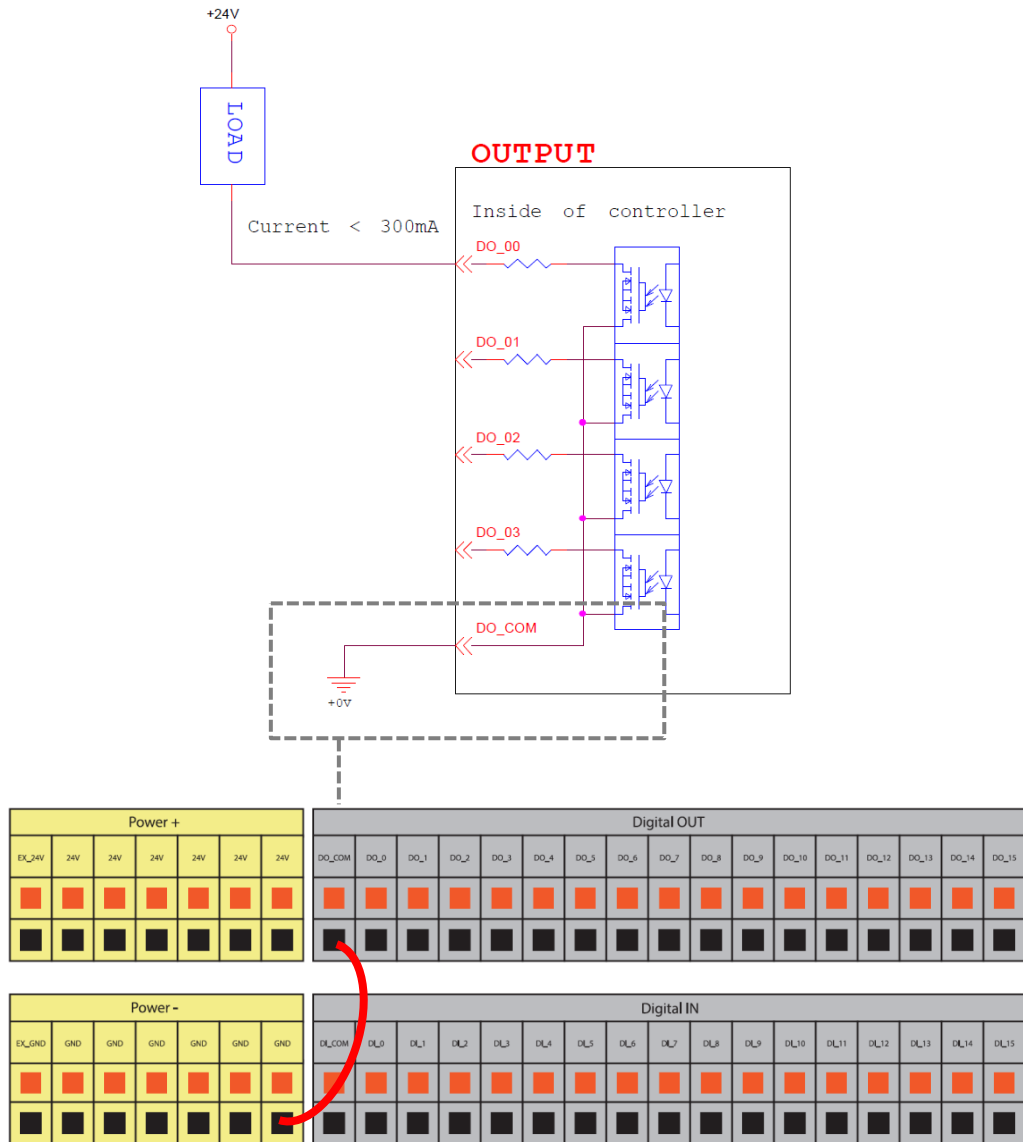


Figure 41: Set to Sink Output Type

- Set to source output type.

Connect DO_COM terminal to the plus side of the power supply.

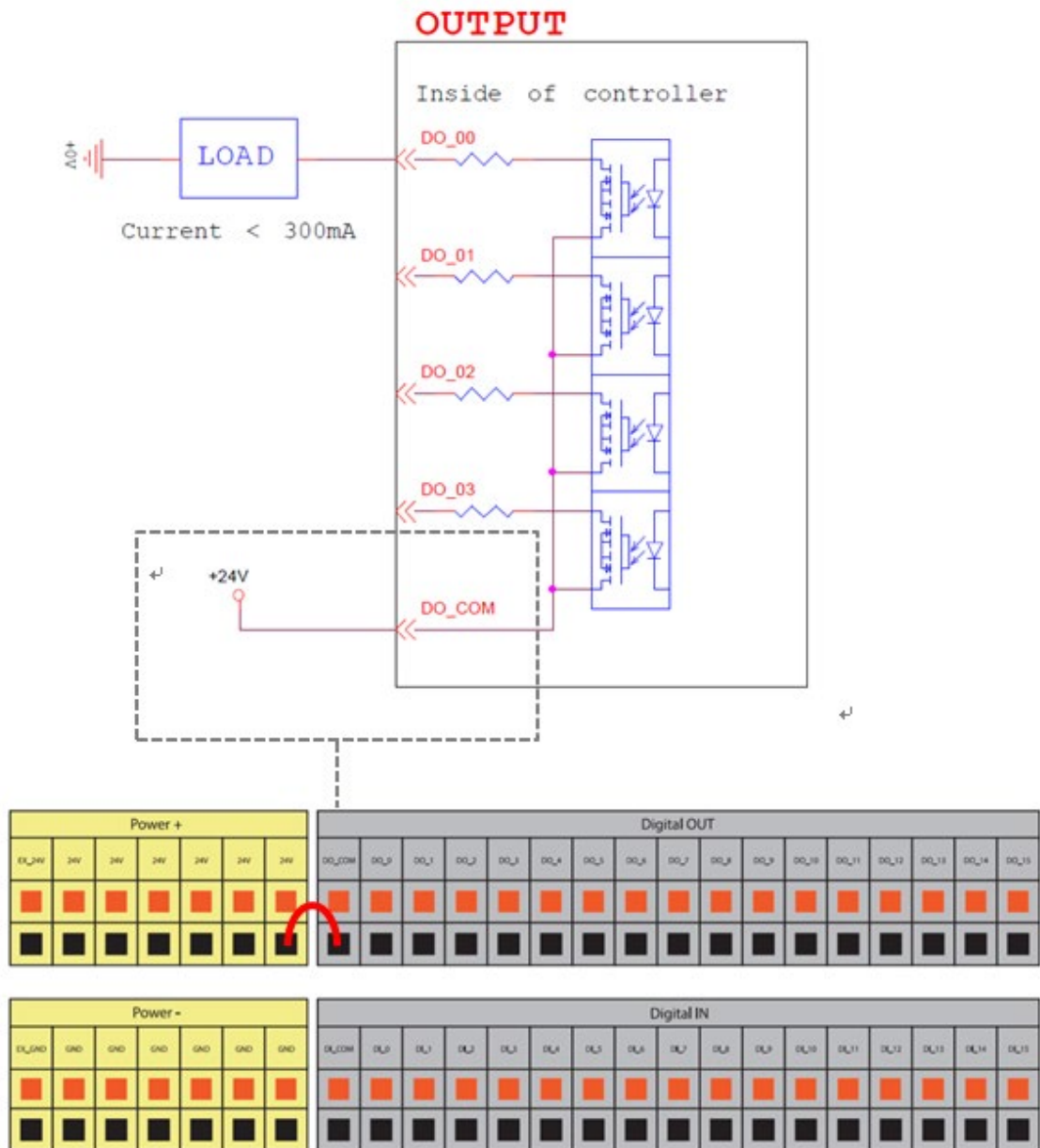


Figure 42: Set to Source Output Type

5.3.4 Analog In

Analog In only supports a voltage mode and detection range of $-10.00\text{ V} \sim +10.00\text{ V}$.

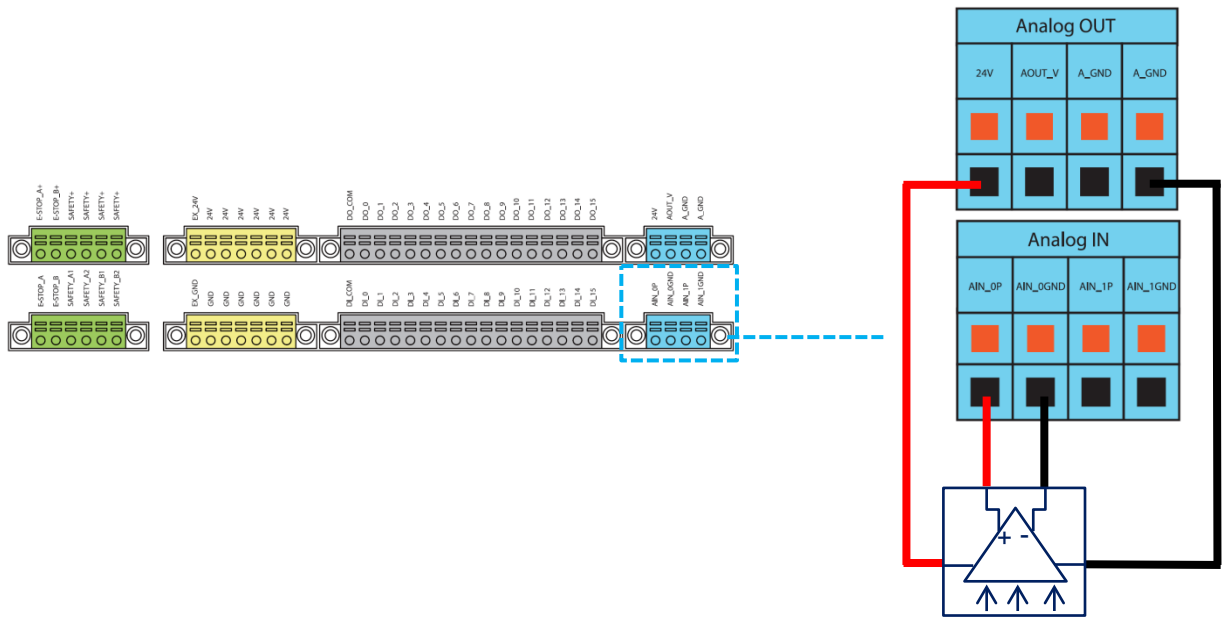


Figure 43: Analog In

5.3.5 Analog Out

Analog Out only supports a voltage mode and detection range of -10.00 V ~ +10.00 V.

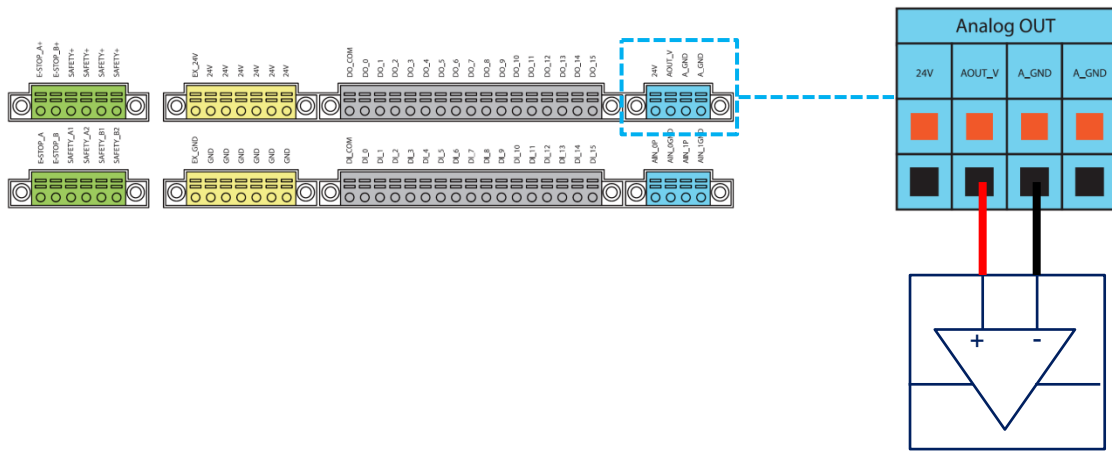
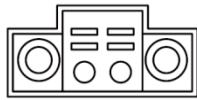


Figure 44: Analog Out

5.3.6 System Remote Power ON/OFF

The function of Remote ON/OFF shares the same functionality of the Robot Stick Power Button.



REMOTE ON/OFF

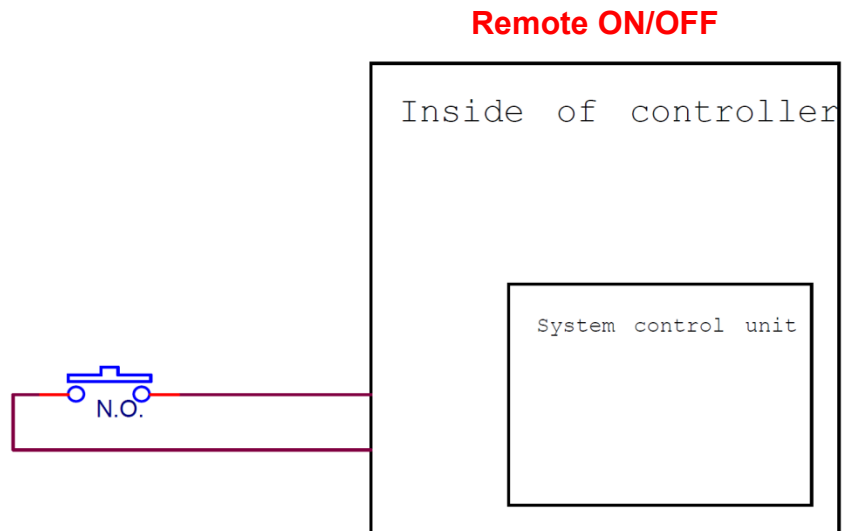


Figure 45: System Remote Power ON/OFF

5.3.7 EtherCAT: For EtherCAT Slave I/O Expansion



WARNING:

The robot must be powered off when installing the EtherCAT Slave. Do not plug or unplug the connector while the robot is on.

5.3.8 USB Port

The USB port of the control box is used for connecting the keyboard, mouse and external storage devices. External storage devices should only be used for the import/export functions of TMflow. No other device than those listed above should be connected. Please be noted that the external storage device should be named "TMROBOT".

5.4 Tool End I/O Interface

There are two small connectors on the tool end of the robot: a 8-pin connector and a 5-pin connector. The 8-pin connector is for digital I/O. The 5-pin connector is for analog I/O.

5.4.1 I/O Terminals

The tool end 24V has a maximum output current of 1.5A. If overloading, overload protection is activated and the robot will turn off the 24V output power.

Pin	Wire color	Pin define	
1	Brown	+24v	24V output
2	Red	DI_0	Digital Input0
3	Orange	DI_1	Digital Input1
4	Yellow	DI_2	Digital Input2
5	Green	DO_0	Digital Output0
6	Blue	DO_1	Digital Output1
7	Purple	DO_2	Digital Output2
8	Black	Gnd	Gnd

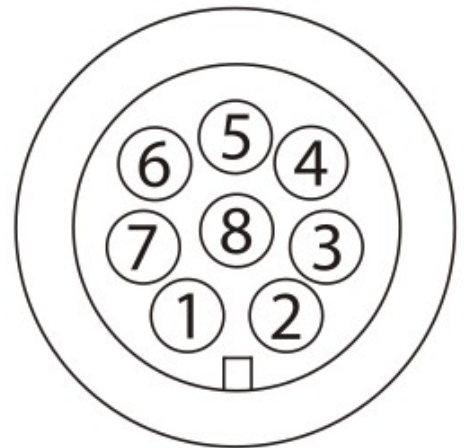


Table 8: 8-pin Digital I/O Connectors of Cable

Pin	Wire Color	Pin Define	
1	Brown	+24v	24V output
2	Red	DI_0	Digital input0
3	Orange	DI_1	Digital input1
4	Yellow	DI_2	Digital input2
5	Green	DO_0	Digital output0
6	Blue	DO_1	Digital output1
7	Purple	DO_2	Digital output2
8	Black	Gnd	Gnd



Table 9: 8-pin Digital I/O Connector of Robot

Pin	Wire Color	Pin Define	
1	Black	+24V	24V output
2	Brown	DI_3	Digital Input3
3	Red	DO_3	Digital Output3
4	Orange	AI Analog	Input
5	Yellow	+0V	GND

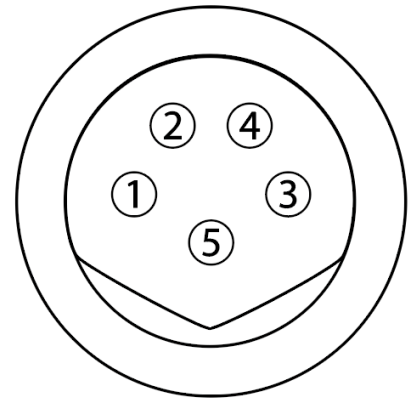


Table 10: 5-pin Analog I/O Connector of Cable

Pin	Wire Color	Pin Define	
1	Black	+24V	24V output
2	Brown	DI_3	Digital Input3
3	Red	DO_3	Digital Output3
4	Orange	AI Analog	Input
5	Yellow	+0V	GND

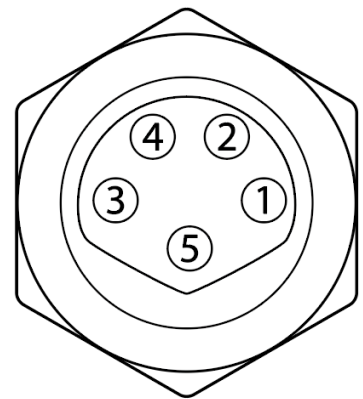


Table 11: 5-pin Analog I/O connector of Robot

5.4.2 Connecting Tool End Digital Output

The following figure shows how to connect the tool end digital output:

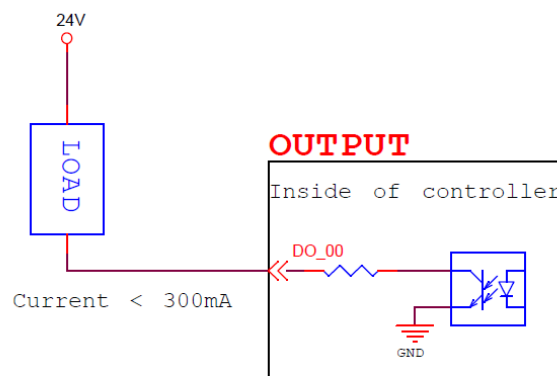


Figure 46: Connecting Tool End Digital Output

5.4.3 Connecting Tool End Digital Input

The following figure shows how to connect the tool end digital input:

NOTE: If sensors are connected directly then they should be of the NPN type.

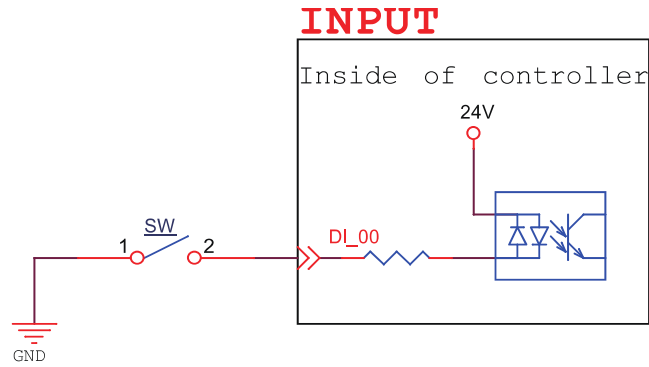


Figure 47: Connecting Tool End Digital Input

5.4.4 Connecting Tool End Analog Input

Input range of -10.00 V ~ +10.00 V.

The following figure shows how to connect the tool end Analog input:

(Because AIN_GND is connected to ground, when AIN is a dead contact, a pressure difference will occur, which is a normal phenomenon.)

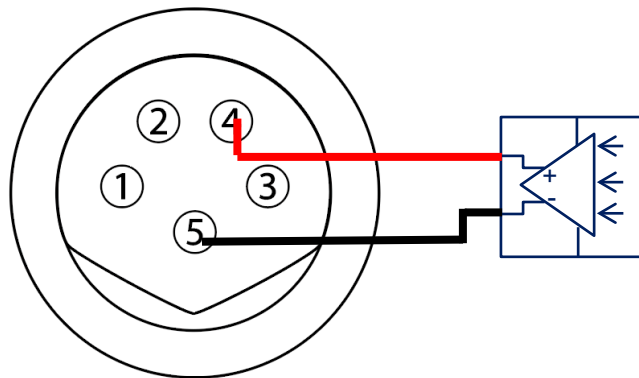


Figure 48: Connecting Tool End Analog Input

5.5 Control Box Interfaces

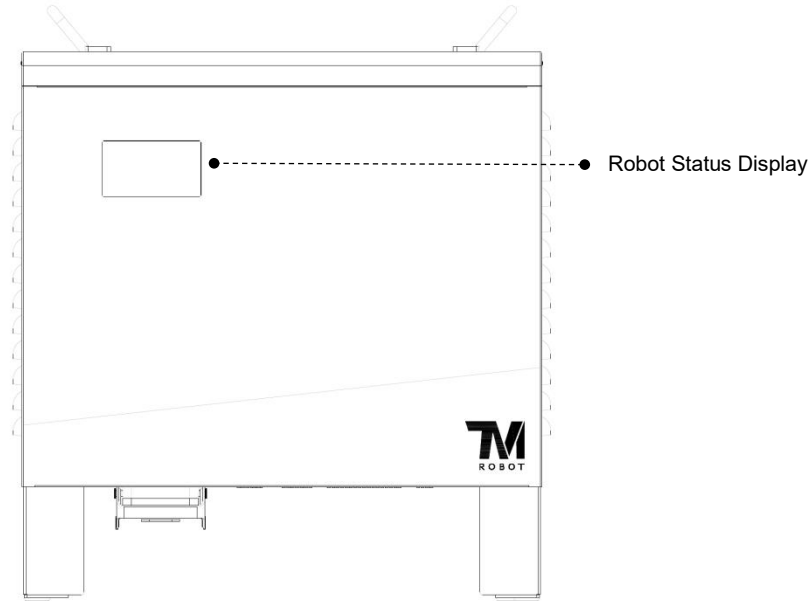


Figure 49: Front View of the Control Box



CAUTION:

The ETHERCAT interface can only be used to connect ETHERCAT devices. Improper connection may cause the robot to stop.

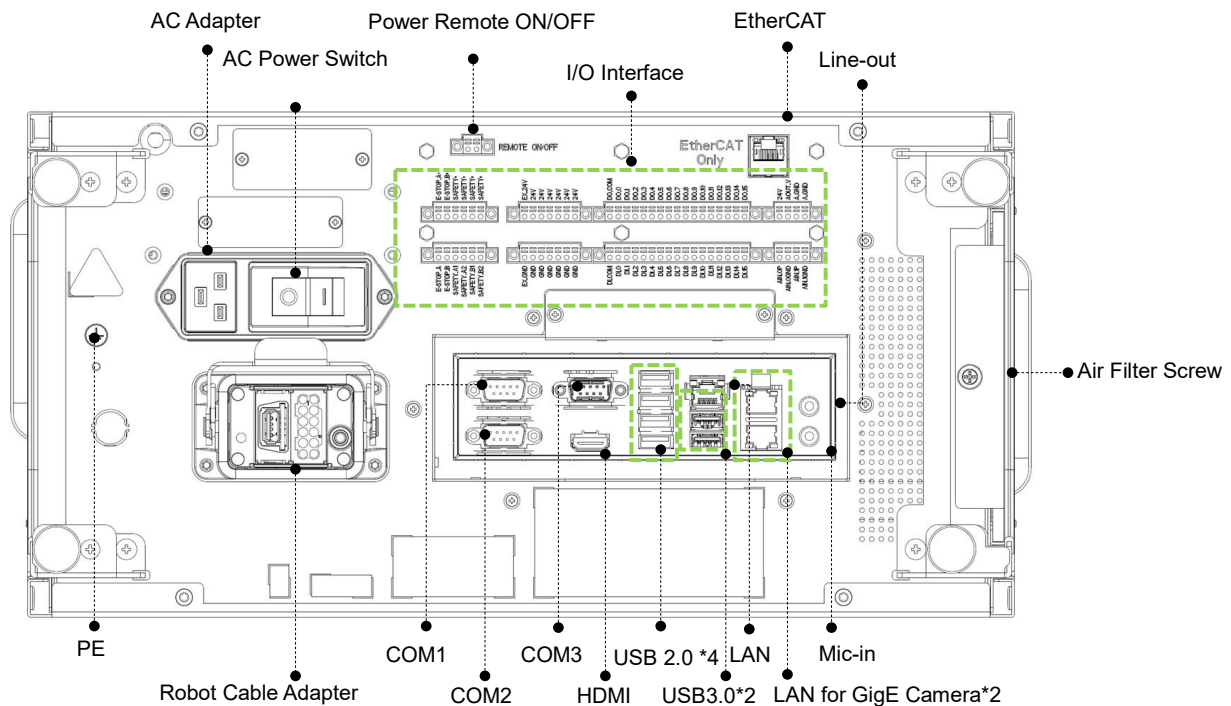


Figure 50: Interfaces of the TM12 / TM14/ TM12X / TM14X Series

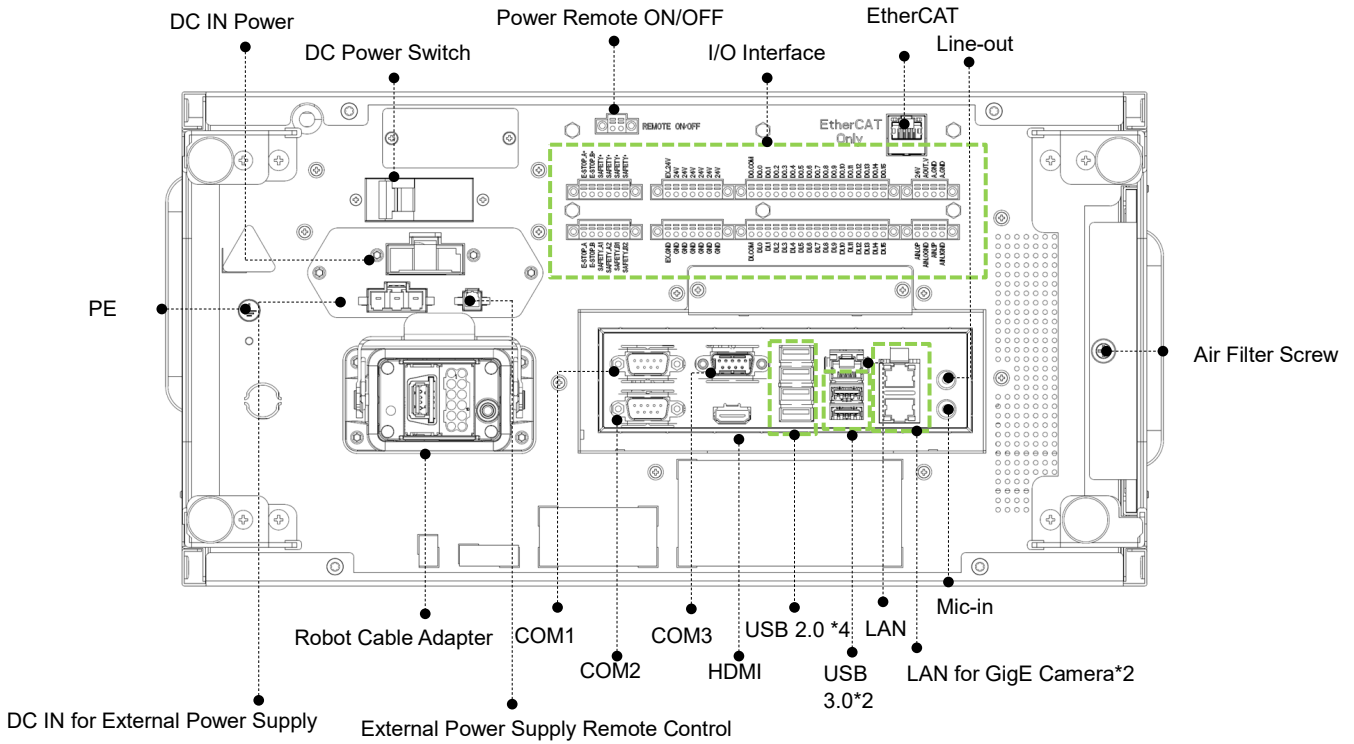


Figure 51: Interfaces of the TM12M / TM14M Series

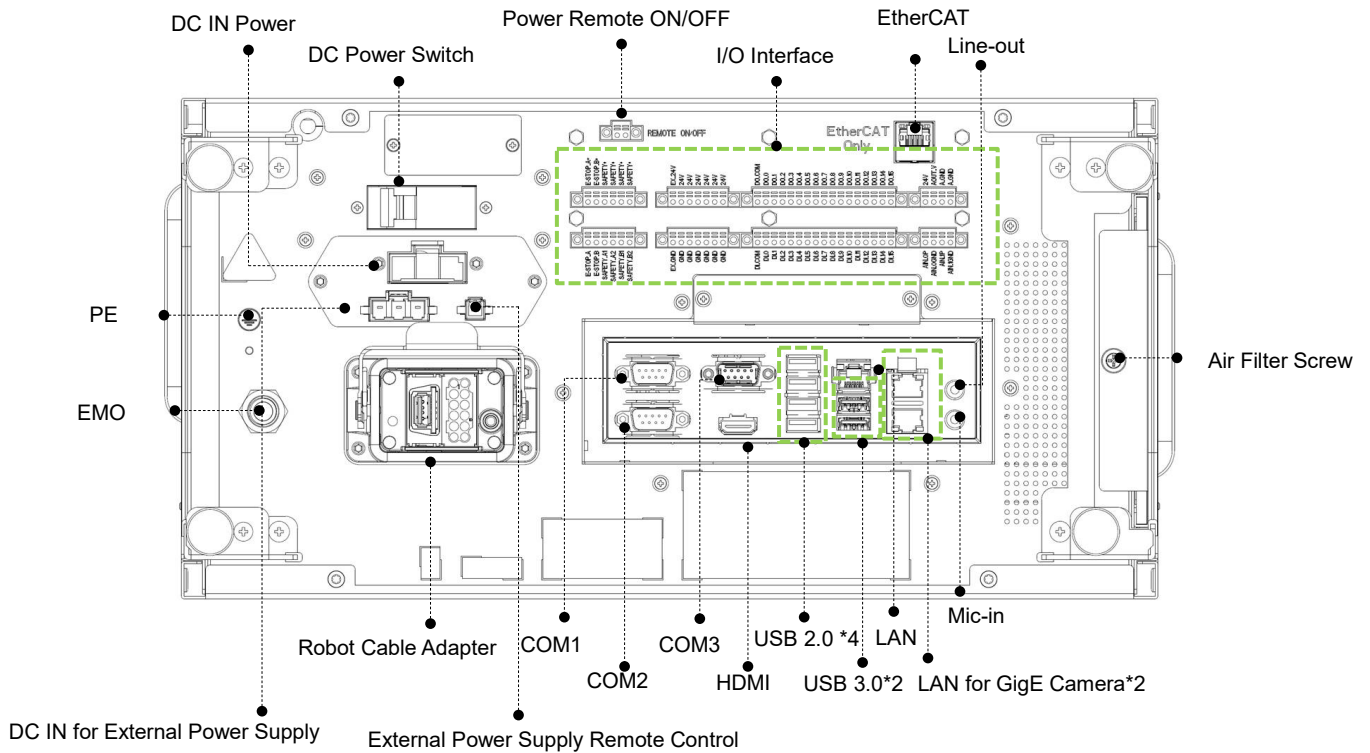


Figure 52: Interfaces of the TM12M SEMI / TM14M SEMI Series

5.6 Control Box Power Interface and Robot Interface

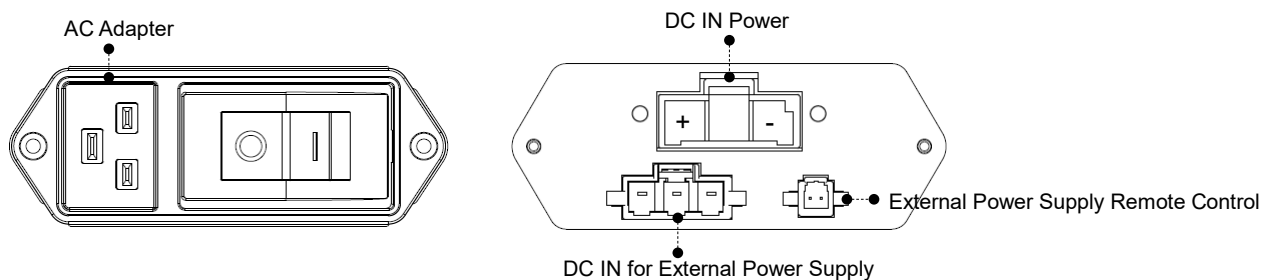
5.6.1 Control Box Power Interface

TM12 / TM14 / TM12X / TM14X:

The power cable of the control box has an IEC plug. The local power plug is connected to the IEC plug.

TM12M / TM14M:

The power cable of the control box has Hirose (HRS) DF60 series connector.



AC Adapter : IEC plug

DC IN Power Connector : (HRS) DF60-3EP-10.16C

DC IN for External Power Supply Connector : Please contact with the Corporation for purchasing

External Power Supply Remote Control Connector : Please contact with the Corporation for purchasing

Figure 53: Control Box Power Interfaces

The power supply should be equipped with the following:

- Ground
- Main fuse
- Residual current device (RCD)

It is recommended to install a master switch on the equipment power supply for robot applications for servicing and inspection.

Parameters	Minimum value	Typical value	Maximum value	Unit
Input voltage	100	-	240	VAC
External mains fuse (100V~120V)	-	-	15	A
External mains fuse (220V~240V)	-	-	10	A
Input frequency	43	-	63	Hz

Table 12: TM12 / TM14 / TM12X / TM14X Series Electrical Specifications

*If using AC100V~AC199V power supply, the Robot will automatically limit the total output power

Parameters	Minimum Value	Typical value	Maximum value	Unit
Input voltage	22	-	60	V (DC)
Power consumption		300	1500	W

Table 13: TM12M / TM14M Series Electrical Specifications

*If using DC22~47V power supply, the Robot will automatically limit the total output power



DANGER:

1. Ensure that the robot is correctly grounded (electrical grounding).
2. Ensure that the input current of the control box is protected by the Residual Current Device (RCD) and appropriate fuses.
3. Ensure that all cables are correctly connected before the control box is energized. Always use genuine Techman power cables correctly.

5.6.2 Robot Interface

The following figure shows the connection interface of the robot. The cables of the robot are connected to the control box through the interface.

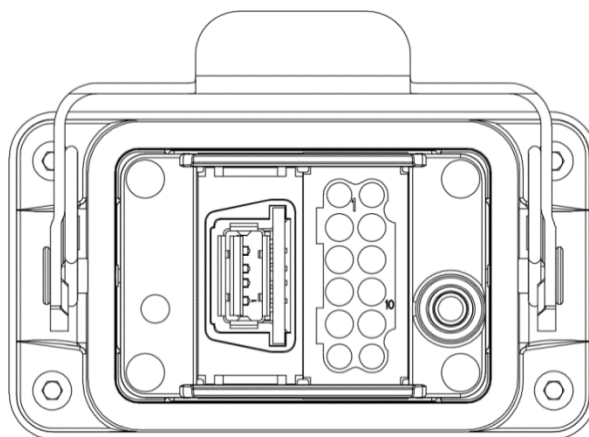


Figure 54: Robot Interface



WARNING:

1. When the robot is turned on, do not disconnect cables of the robot. When cables of the robot are not connected to the connection interface, do not turn on the robot.
2. Do not extend or modify the original cables of the robot.
3. The cables of the robot are only suitable for a fixed installation. If you require more than a fixed installation, contact Omron.

5.6.3 Control Box EMO (Emergency Off) Interface (SEMI series only)

The Control Box EMO interfaces of the SEMI Series are shown as below. The SEMI Emergency Off switch is connected with control box through the EMO interface. Please remove the padlock on the power interface to insert the power cable.

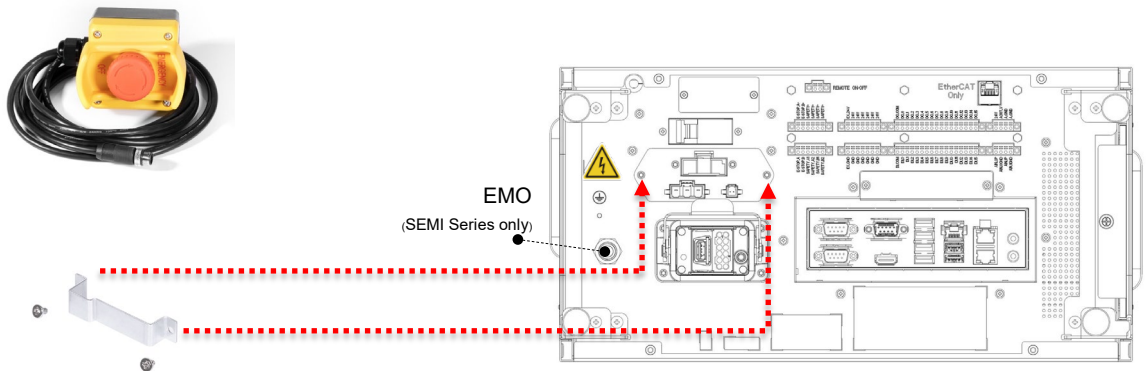


Figure 55: the TM12M SEMI / TM14M SEMI Series
Control Box EMO (Emergency Off) Interface



CAUTION:

For SEMI Series, when SEMI Emergency Off Switch is not connected with EMO, the TM Robot cannot be booted.



WARNING:

When SEMI Emergency Off Switch is pressed, all power will be cut off immediately.

6. Unboxing & Installation

6.1 Overview

These instructions guide the user of the TM Robot through the first setup. The user must thoroughly read and understand this Guide before performing the operations of this Chapter. Fail to do so may cause serious danger.



WARNING:

If this is your first time using the TM Robot, please follow instructions in this chapter to perform installation and initial set up. If the robot has been implemented in the working environment, please note the following:

1. To avoid potential hazards after changing the original environment setting, verify with current responsible operator and to back up all necessary software settings and hardware wirings scheme.
2. Remove all of the control box's external I/O connections including the analog I/O, EtherCAT port and network port. Remove all air lines or external power lines connected to the optional equipment before Commissioning.
3. Remove all of the control box's connections to external devices / external storage devices through USB interface, Serial port, and network interface.
4. Remove any object/end effector attached to the end flange, and any electrical connection between the end effector and end module / control box of the robot.
5. Remove any hardware attached to the robot arm.

6.2 Inspecting the Equipment

6.2.1 Before Unpacking

Carefully inspect all shipping crates for evidence of damage during transit. If any damage is indicated, request that the carrier's agent be present at the time the container is unpacked.

6.2.2 Upon Unpacking

Before signing the carrier's delivery sheet, compare the actual items received (not just the packing slip) with your equipment purchase order and verify that all items are present and that the shipment is correct and free of visible damage,

If the items received do not match the packing slip. or are damaged, do not sign the receipt. Contact your corporation support as soon as possible.

If the items received do not match your order, contact your corporation support immediately.

Inspect each item for external damage as it is removed from its container. If any damage is evident, contact your corporation support (Refer to 1.2 How Can I Get Help?)

Retain all shipping containers and packaging materials. These items may be necessary to settle claims or at a later date, to relocate equipment. .

6.3 Unboxing

6.3.1 Carton Types

The TM Robot product is packed in 2 cartons: the robot arm carton, and the control box carton, as shown below.

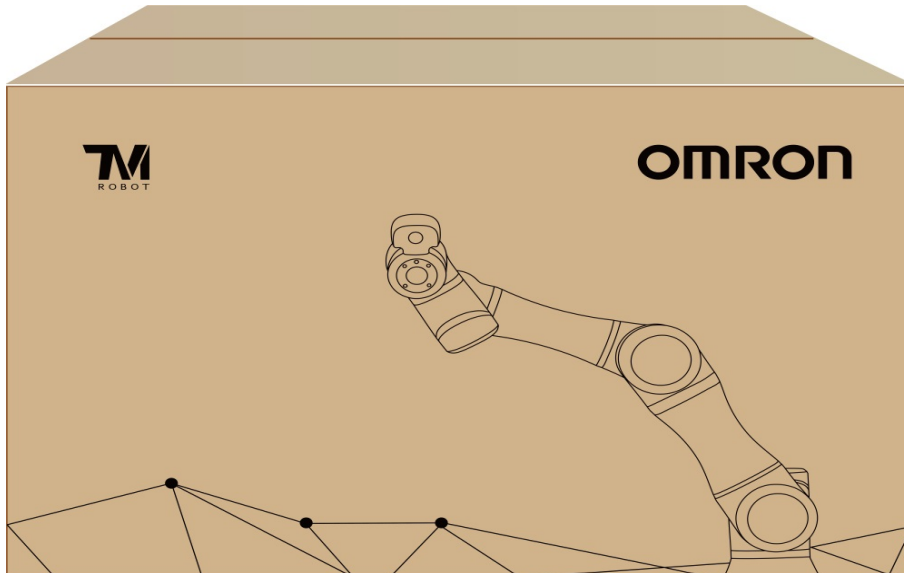


Figure 56: Robot Arm Carton

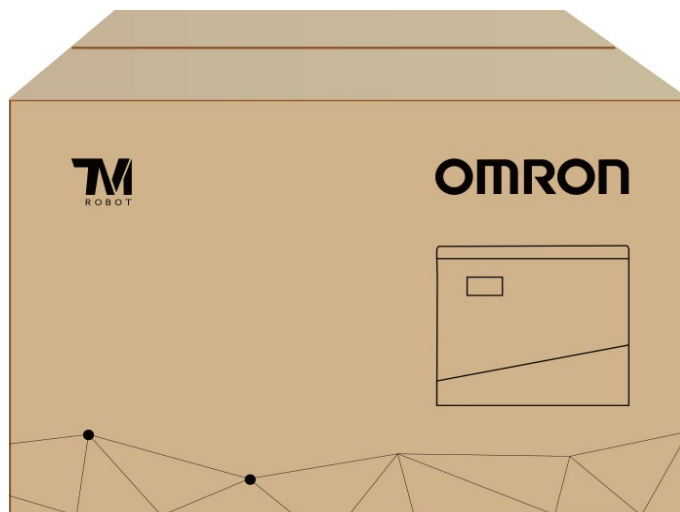


Figure 57: Control Box Carton

6.3.2 Contents of Each Carton


Each carton has the following contents. Check them when you unpack the cartons for the first time. If any item is missing, contact your corporation support.

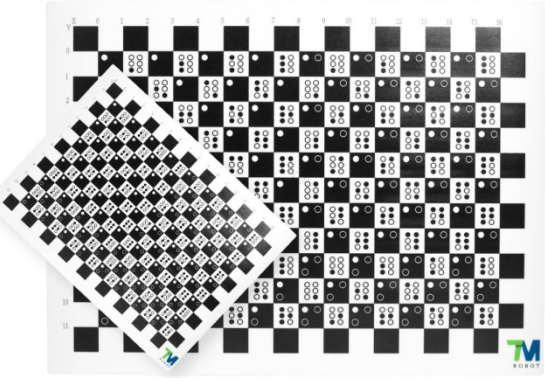

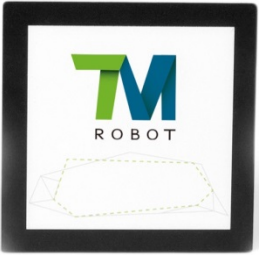


The robot arm carton contains:

 A black Omron robot arm with a silver end effector. The Omron logo is visible on the upper arm section.	<p>Robot arm</p> <p>Cable length of the Robot Stick: 300 cm Weight of TM12: 33.3 kg Weight of TM14: 32.6 kg</p>
 A yellow emergency stop switch with a red button in the center. The button has "EMERGENCY OFF" written on it. A black cable is attached to the side.	<p>SEMI Emergency OFF Switch (SEMI Series only)</p> <p>(1 pack) Cable length: 300 cm</p>

Table 14: The Robot Arm Carton Contents

The control box carton contains:

 A black Omron control box with a silver handle on top. The Omron logo is on the front, and the TM ROBOT logo is on the bottom right corner.	<p>Control box</p> <p>Weight: 14 kg</p>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------

	<p>Calibration Plates</p> <p>(Contains one large and one small calibration plate)</p> <p>*The Calibration Plate comes only with TM Robots fitted with the hand-eye camera. No Calibration Plate includes in the following series: TM12X / TM14X</p>
	<p>IO cables</p> <p>(2 packs)</p> <p>8-pin digital I/O, 5-pin analog I/O</p> <p>Cable length: 100 cm</p>
	<p>TM Landmark</p> <p>(Contains two TM Landmark)</p> <p>*The TM Landmark comes only with TM robots fitted with the hand-eye camera. No TM Landmark includes in the following series: TM12X/ TM14X</p>
	<p>Power cable of the control box (TM12 / TM14)</p> <p>(4 cables, Type B, I, G, F)</p> <p>Cable length: 180 cm</p>
	<p>Power cable of the control box (TM12M / TM14M)</p> <p>(1 cable)</p> <p>Cable length: 120 cm</p>



	<p style="text-align: center;">Ground Wire</p> <p>(1 pair) Cable length: 300 cm</p>
	<p style="text-align: center;">Jumper Wire</p> <p>(1 pair) Wire length: 3 cm</p>

Table 15: The Control Box Carton Contents

6.4 Installing Your Robot

The TM Robot arm cannot stand independently after being removed from the carton. Therefore, prepare the mounting base with the corresponding holes as described in Subsection 4.2.1.6 “Robot Arm Installation” in this Guide in advance. Then follow the instructions below to install the robot.



WARNING:

At the installation site, at least two people should simultaneously perform installation of the robot; otherwise you risk robot arm damage or personal injury. Do not install the robot alone.



WARNING:

Do not attempt to move any robot links until the robot has been secured in position. Failure to comply could result in the robot falling and causing either personnel injury or equipment damage.

6.4.1 Remove the Control Box

After checking the contents, remove the contents in order and perform installation.

Control box carton:

- Remove the calibration plates and landmark
- Remove the power cable of the control box
- Remove the control box (At least two people should remove the control box from the carton. Refer the figure below for the correct holding positions.)

- Connect the power cable to the control box
- Place the control box near the robot base



Figure 58: Moving the Control Box (1/2)

The control box should be carried by at least two people. One should hold on to the control box handles, while the other should hold the foot stands. Before handling, the cable of the Robot Stick should not be pulled to avoid any performance degradation.



Figure 59: Moving the Control Box (2/2)



WARNING:

At this stage, do not connect the power cable of the control box to any electrical outlet, or it may cause equipment damage.

6.4.2 Verification Before Removal of the Robot Arm

The TM Robot arm cannot stand independently after being removed from the carton. Place four screws (M10 *4) to be used to attach the bottom of the robot near the mounting surface in advance. If the mounting surface has alignment holes, insert the alignment pins into these holes.

6.4.3 Removal of the Robot Arm and Tightening

At least two people should remove the robot arm from the carton. For the correct holding positions, see the figure shown below. Place the robot on the mounting base. If it is designed with connection pins, align the pinholes of the robot base module. Tighten two locking screws with washers for the robot base that are diagonally across from each other, then tighten the other two locking screws.

Follow the tightening torque recommended in Subsection 4.2.1.6 "Robot Arm Installation" in this Guide.



Figure 60: Moving the Robot Arm (1/2)

The Robot Arm itself should be handled with at least two people. One person should carry the Lower arm and Upper arm, and the other should hold on to the position between the base and 1st Joint as well as the 6th Joint. Until the Robot Base is fastened with screws tightly, the Robot Arm should always be supported to avoid tipping.



Figure 61: Moving the Robot Arm (2/2)



WARNING:

When the robot is installed to the base, make sure two people work together to install it. If it is designed with pinholes, pay attention to your safety to avoid pinching. If you do not have connection parts at hand, such as the connecting pins, screws, do not leave the robot without completely tightening it (with the 4 screws completely tightened). One person should continuously support the robot arm while the other person goes to get required parts. Otherwise, the robot arm may tip, result in equipment damage or personal injury.

6.4.4 Connect the Robot and Control Box

Connect the power cable from the control box to the robot, and then connect the power cable from AC power to the control box to boot up the controller.

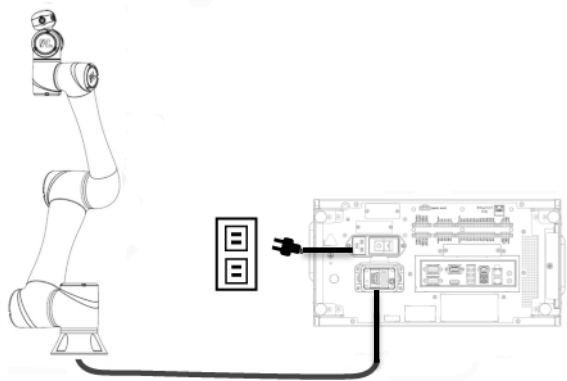


Figure 62: Connecting the Robot and the Control Box



WARNING:

1. Ensure that all cables are correctly connected before the control box is energized. Always use genuine power cables correctly.
2. When the robot is turned on, do not disconnect cables of the robot. When cables of the robot are not connected to the connection interface, do not turn on the robot.
3. Do not extend or modify the original cables of the robot.

7. Maintenance and Repair

The following table gives a summary of the preventive maintenance procedures and guidelines:

Item	Period	Remark
Warning, Safety labels	1 week	Ensure labels are present and legible. Replace them if necessary.
Check Filter (on the control box)	1 month	Please replace every 3 months.
Check Emergency Switch	1 month	Press the Emergency Switch and the IO E-Stop in open-loop status. Verify that each shuts off power.
Check Safeguard ports(A, B)	1 month	When the Safeguard A Port is in the open-loop state, the indication light of current mode will be constantly flashing. When the Safeguard B Port is in the open-loop state, the purple light will be alternating between the indication light of the current mode.
Check Robot Mounting screws	3 months	Follow 4.2.1.6 Robot Arm Installation
EMO button (SEMI version only)	6 months	Press the EMO button. Verify that power shuts off.

Table 16: Summary of the Preventive Maintenance Procedures and Guidelines

Only the legal distributor or authorized service center should repair the TM Robot. The user should not repair it himself or herself.



DANGER:

Before performing maintenance or service, record the details of each setting for the robot for normal operation. When maintenance or service is complete, make sure that each setting satisfies the original conditions before resuming status, including but not limited to:

- Safety Software Settings
- Safety I/O
- Preset operation project
- TCP Settings
- I/O Settings
- I/O Wiring

Appendix A. Technical Specifications

Model		TM14	TM12	TM14X	TM12X	TM14M	TM12M	TM14MX	TM12MX
Weight		32.6Kg	33.3Kg	32.3Kg	33Kg	32.6Kg	33.3Kg	32.3Kg	33Kg
Maximum Payload		14kg	12kg	14kg	12kg	14kg	12kg	14kg	12kg
Reach		1100mm	1300mm	1100mm	1300mm	1100mm	1300mm	1100mm	1300mm
Typical Speed		1.1m/s	1.3m/s	1.1m/s	1.3m/s	1.1m/s	1.3m/s	1.1m/s	1.3m/s
Joint ranges	J1,J6	+/- 270°	+/- 270°	+/- 360°	+/- 360°	+/- 270°	+/- 270°	+/- 360°	+/- 360°
	J2,J4,J5	+/- 180°	+/- 180°	+/- 360°	+/- 360°	+/- 180°	+/- 180°	+/- 360°	+/- 360°
	J3	+/- 163°	+/- 166°	+/- 163°	+/- 166°	+/- 163°	+/- 166°	+/- 163°	+/- 166°
Speed	J1~J2	120°/s							
	J3	180°/s							
	J4~J5	150°/s	180°/s	150°/s	180°/s	150°/s	180°/s	150°/s	180°/s
	J6	180°/s							
Repeatability		+/- 0.1 mm							
Degrees of freedom		6 rotating joints							
I/O ports		Control box				Tool conn.			
	Digital in	16				4			
	Digital out	16				4			
	Analog in	2				1			
	Analog out	1				0			
I/O power supply		24V 1.5A for control box and 24V 1.5A for tool							
IP classification		IP54 (Robot Arm); IP32 (Control Box)							
Power consumption		Typical 220 watts							
Temperature		The robot can work in a temperature range of 0-50°C							
Power supply		100-240 VAC, 50-60 Hz				DC22V~DC60V			
I/O Interface		3×COM, 1×HDMI, 3×LAN, 4×USB2.0, 2×USB3.0							
Communication		RS232, Ethernet, Modbus TCP/RTU (master & slave)							
Programming Environment		TMflow, flowchart based							
Certification		CE, SEMI S2 (optional)							
Robot Vision									
Eye in Hand (Built in)		1.2M/5M pixels, color camera	N/A		1.2M/5M pixels, color camera	N/A			
Eye to Hand (Optional)		Support Maximum 2 GigE cameras							

Table 17: Technical Specifications

OMRON Corporation Industrial Automation Company
Kyoto, JAPAN

Contact: www.ia.omron.com

Regional Headquarters

OMRON EUROPE B.V.

Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ASIA PACIFIC PTE. LTD.

No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON ELECTRONICS LLC

2895 Greenspoint Parkway, Suite 200 Hoffman Estates,
IL 60169 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ROBOTICS AND SAFETY TECHNOLOGIES, INC.

4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.

Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

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