Collaborative Robot

Hardware Installation Manual

Corresponding models: TM12 / TM14 Medium & Heavy Payload Series
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<th>Date</th>
<th>Revised Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>October 2018</td>
<td>Original release</td>
</tr>
<tr>
<td>02</td>
<td>December 2018</td>
<td>Updated cover page, minor text fixes</td>
</tr>
</tbody>
</table>
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?

Additional information and resources are available at:

www.adapt.com/omron-adapt-cobot-manuals

Related Manuals:

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

<table>
<thead>
<tr>
<th>Manual Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Manual</td>
<td>Contains safety information for TM Robots.</td>
</tr>
<tr>
<td>TMflow</td>
<td>Instructions for use of TMflow software.</td>
</tr>
<tr>
<td>TMvision</td>
<td>Instructions for use of TMvision software.</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>DANGER:</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Exclamation Mark]</td>
<td>WARNING:</td>
<td>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.</td>
</tr>
<tr>
<td>![Exclamation Mark]</td>
<td>CAUTION:</td>
<td>Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.</td>
</tr>
</tbody>
</table>
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.

- 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.

- If any local or national electrical regulation requires, 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 OMRON. 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 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.
WARNING:
1. Additional supports may be needed when manually releasing the brake due to gravity.
2. When manually moving each robot joint, the movement angle must be within a range of +/- 45°.
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.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><img src="image1" alt="Symbol A" /></td>
<td>Do not put your hand or fingers close to the moving parts</td>
</tr>
<tr>
<td>B</td>
<td><img src="image2" alt="Symbol B" /></td>
<td>Be careful not to be close to the moving parts and nearby areas to avoid collision</td>
</tr>
<tr>
<td>C</td>
<td><img src="image3" alt="Symbol C" /></td>
<td>Do not touch any internal electric parts to avoid electric shock</td>
</tr>
<tr>
<td>D</td>
<td><img src="image4" alt="Symbol D" /></td>
<td>Product label</td>
</tr>
</tbody>
</table>

![Diagram](image5)
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 a robot stick).
4.2.1 Robot Arm

4.2.1.1 Dimension Drawings of Robot

Shown below are the dimension drawings of the robot
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 OMRON support for any service request.
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.
Warning: Risk of crushing within the operating area of the arm.

Warning: Risk of collision within the operating area of the arm.
TM14 / TM14M Movement Range Diagram

5DOF Workspace

6DOF Workspace

Side View

Pictorial view
Operator Position

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

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

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

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

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

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

![Graph of Payload vs. Center of Gravity Offset for TM12 / TM12M](image)

**TM14 / TM14M**

![Graph of Payload vs. Center of Gravity Offset for TM14 / TM14M](image)
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.

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 strength.

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

4.2.2.1  End Module Components

TM12 / TM12M / TM14 / TM14M End Module Components

- VISION Button
- POINT Button
- FREE Button
- Analog I/O
- Digital I/O
- Indication Light Ring
- GRIPPER Button
- Camera module
- Flange (ISO 9409-1-50-4-M6)
4.2.2.2 End Flange Surface
4.2.2.3 End Mounting Caution

The TM12 / TM14 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

**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:

- **Power Button**
- **Stop Button**
- **Play/Pause Button**
- **M/A Mode Switch Button**
- **Mode Indicator Lights**
- **QR Code Label**
- **Power Indicator**
- **Emergency Switch**

**CAUTION:**
When operating the robot stick, do not use other objects than fingers to press the robot stick.
### Basic Function

<table>
<thead>
<tr>
<th>Items</th>
<th>Basic Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Switch</td>
<td>Default emergency button for the robot</td>
</tr>
<tr>
<td>Power Button</td>
<td>Power initiation (single press)/ Shutdown (long press)</td>
</tr>
<tr>
<td>Play/Pause Button</td>
<td>Play/Pause Project</td>
</tr>
<tr>
<td>Stop Button</td>
<td>Press this button to stop any project.</td>
</tr>
<tr>
<td>Power Indicator</td>
<td>This indicator shows the robot's power status.</td>
</tr>
<tr>
<td></td>
<td>Not on: Switched off</td>
</tr>
<tr>
<td></td>
<td>Flashing: Booting</td>
</tr>
<tr>
<td></td>
<td>Constant: Startup completed</td>
</tr>
<tr>
<td>Mode Indicator Lights</td>
<td>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.</td>
</tr>
<tr>
<td>QR Code Label</td>
<td>The content of the SSID is also the robot's name in TCP/IP network.</td>
</tr>
</tbody>
</table>

### Advanced Function

<table>
<thead>
<tr>
<th>Items</th>
<th>Advanced Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Switch</td>
<td>- Press and then release, wait for 3 seconds to enter Safe Start up mode.</td>
</tr>
<tr>
<td></td>
<td>- Press and then release to enter Safe Start up mode while booting.</td>
</tr>
<tr>
<td>Play/Pause Button</td>
<td>Play/pause visual calibration operation (single press)</td>
</tr>
<tr>
<td>Stop Button</td>
<td>Stop visual calibration operation (single press)</td>
</tr>
<tr>
<td>+- Button</td>
<td>- Hold to jog the robot at the HMI robot controller page (Hold to Run).</td>
</tr>
<tr>
<td></td>
<td>- Lock/ Unlock: hold down both add and subtract until the mode indicator flashes, then follow the sequence &quot;+, -&quot;,&quot;-&quot; to lock/unlock the Robot Stick (except the Power Button)</td>
</tr>
</tbody>
</table>
4.3 Operating Position of TM Robot with AGV

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

**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. We recommend using the Techman 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 should still be 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.
4.4 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.

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

<table>
<thead>
<tr>
<th>Working distance (mm)</th>
<th>Field of view (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Height</td>
<td>211.2</td>
</tr>
<tr>
<td>Width</td>
<td>281.6</td>
</tr>
<tr>
<td>Height</td>
<td>72.7</td>
</tr>
</tbody>
</table>
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
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.
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 can be found below.

The wiring diagram shows the example of switch type safety device.
The wiring diagram shows the 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 24V 1.5A 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.
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.

- **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.
- 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.

5.3.3.2 Digital Output:

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

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

Connect DO_COM terminal to the minus side of the power supply.
- Set to source output type.

Connect DO_COM terminal to the plus side of the power supply.
5.3.4 Analog In

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

5.3.5 Analog Out

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

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 TM Flow. No other device than those listed above should be connected. Please be noted that the external storage device should be named “TMROBT”.

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.

<table>
<thead>
<tr>
<th>8-pin digital I/O connector of Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pin</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8-pin digital I/O connector of Robot</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pin</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>
### 5-pin analog I/O connector of Cable

<table>
<thead>
<tr>
<th>Pin</th>
<th>Wire Color</th>
<th>Wire Color</th>
<th>Pin Define</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Black</td>
<td>+24V</td>
<td>24V output</td>
</tr>
<tr>
<td>2</td>
<td>Brown</td>
<td>DI_3</td>
<td>Digital Input3</td>
</tr>
<tr>
<td>3</td>
<td>Red</td>
<td>DO_3</td>
<td>Digital Output3</td>
</tr>
<tr>
<td>4</td>
<td>Orange</td>
<td>AI Analog</td>
<td>Input</td>
</tr>
<tr>
<td>5</td>
<td>Yellow</td>
<td>+0V</td>
<td>GND</td>
</tr>
</tbody>
</table>

### 5-pin analog I/O connector of Robot

<table>
<thead>
<tr>
<th>Pin</th>
<th>Wire Color</th>
<th>Wire Color</th>
<th>Pin Define</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Black</td>
<td>+24V</td>
<td>24V output</td>
</tr>
<tr>
<td>2</td>
<td>Brown</td>
<td>DI_3</td>
<td>Digital Input3</td>
</tr>
<tr>
<td>3</td>
<td>Red</td>
<td>DO_3</td>
<td>Digital Output3</td>
</tr>
<tr>
<td>4</td>
<td>Orange</td>
<td>AI Analog</td>
<td>Input</td>
</tr>
<tr>
<td>5</td>
<td>Yellow</td>
<td>+0V</td>
<td>GND</td>
</tr>
</tbody>
</table>
5.4.2 Connecting Tool End Digital Output

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

![Diagram of digital output connection]

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.

![Diagram of digital input connection]

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.)

![Diagram of analog input connection]
5.5 Control Box Interfaces

**CAUTION:**
The ETHERCAT interface can only be used to connect ETHERCAT devices. Improper connection may cause the robot to stop.
5.6 Control Box Power Interface and Robot Interface

5.6.1 Control Box Power Interface

TM12 / TM14:

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.

The power supply should be equipped with the following:

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

We recommend that you install a master switch on the equipment power supply for robot applications for servicing and inspection.
TM12 / TM14 Series electrical specifications:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Minimum value</th>
<th>Typical value</th>
<th>Maximum value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>100</td>
<td>-</td>
<td>240</td>
<td>VAC</td>
</tr>
<tr>
<td>External mains fuse</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td>(100V~120V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External mains fuse</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>(220V~240V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input frequency</td>
<td>43</td>
<td>-</td>
<td>63</td>
<td>Hz</td>
</tr>
</tbody>
</table>

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

TM12M / TM14M Series electrical specifications:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Minimum Value</th>
<th>Typical value</th>
<th>Maximum value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>22</td>
<td>-</td>
<td>60</td>
<td>V (DC)</td>
</tr>
<tr>
<td>Power consumption</td>
<td>300</td>
<td>1500</td>
<td></td>
<td>W</td>
</tr>
</tbody>
</table>

*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 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.

![Robot Interface Diagram]

**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 a flexible installation, contact OMRON.

5.6.3 Control Box EMO (Emergency Off) Interface

Control Box EMO (SEMI Series only) interface is as below: SEMI Emergency Off Switch is connected with control box through EMO interface.

![Control Box EMO Diagram]

**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 set up. 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. Unload 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. Unload 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 OMRON support as soon as possible.

If the items received do not match your order, contact your OMRON support immediately. Inspect each item for external damage as it is removed from its container. If any damage is evident, contact your OMRON support (see HOW Can I Get Help? on 1.2)

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:

Robot arm carton:

![Robot arm carton image]

Control box carton:

![Control box carton image]
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 vendor.

The robot arm carton contains:
The control box carton contains:

- Control box
- Calibration Plates
  (Contains one large and one small calibration plate)
- IO cables
  (2 packs)
  8-pin digital I/O, 5-pin analog I/O
- TM Landmark
  (Contains two TM Landmark)
Power cable of the control box (TM12 / TM14)
(4 cables, Type B, I, G, F)

Power cable of the control box (TM12M / TM14M)
(1 cable)

Ground Wire
(1 pack)

SEMI Emergency OFF Switch
(SEMI Series only)
(1 pack)
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 these instructions 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 land mark
- Remove the power cable of the control box
- Remove the control box (At least two people should remove the control box from the carton. For the correct holding positions, as shown below)
- Connect the power cable to the control box
- Place the control box near the robot base
The control box should be carried by at least two people. One should hold on to the control box handles, while the other should carry the foot stands. Before handling, the cable of the robot stick should not be pulled to avoid any performance degradation.

**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. Prepare four screws (M10 *4) that used to attach the robot to the base near the robot base in advance. If the base is designed with corresponding pinholes, mount them to the base.

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.

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. Before the Robot Base is fastened with screws tightly, the Robot Arm should always be supported to avoid tipping.
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.

**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:

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

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**

<table>
<thead>
<tr>
<th></th>
<th>TM14</th>
<th>TM12</th>
<th>TM14M</th>
<th>TM12M</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>32.6 Kg</td>
<td>33.3 Kg</td>
<td>32.6 Kg</td>
<td>33.3 Kg</td>
</tr>
<tr>
<td><strong>Payload</strong></td>
<td>14 kg</td>
<td>12 kg</td>
<td>14 kg</td>
<td>12 kg</td>
</tr>
<tr>
<td><strong>Reach</strong></td>
<td>1100 mm</td>
<td>1300 mm</td>
<td>1100 mm</td>
<td>1300 mm</td>
</tr>
<tr>
<td><strong>Typical Speed</strong></td>
<td>1.1m/s</td>
<td>1.3m/s</td>
<td>1.1m/s</td>
<td>1.3m/s</td>
</tr>
<tr>
<td><strong>Joint ranges</strong></td>
<td>J1,J6</td>
<td>+/- 270°</td>
<td>J2,J4,J5</td>
<td>+/- 180°</td>
</tr>
<tr>
<td></td>
<td>J3</td>
<td>+/- 163°</td>
<td>J3</td>
<td>+/- 163°</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>J1~J2</td>
<td>120°/s</td>
<td>J3</td>
<td>180°/s</td>
</tr>
<tr>
<td></td>
<td>J4~J5</td>
<td>150°/s</td>
<td>J4~J5</td>
<td>150°/s</td>
</tr>
<tr>
<td></td>
<td>J6</td>
<td>180°/s</td>
<td>J6</td>
<td>180°/s</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>+/- 0.1 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Degrees of freedom</strong></td>
<td>6 rotating joints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I/O ports</strong></td>
<td>Control box</td>
<td>Tool conn.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital in</td>
<td>16</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital out</td>
<td>16</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog in</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog out</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I/O power supply</strong></td>
<td>24V 1.5A for control box and 24V 1.5A for tool</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IP classification</strong></td>
<td>Robot Arm: IP54 ; Control Box: IP32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>Typical 300 watts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>The robot can work in a temperature range of 0-50°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>100-240 VAC, 50-60 Hz</td>
<td>DC22~60VDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I/O Interface</strong></td>
<td>3×COM, 1×HDMI, 3×LAN, 4×USB2.0, 2×USB3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Certification</strong></td>
<td>CE, SEMI S2 (optional)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Robot Vision</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Eye in Hand (Built in)</strong></td>
<td>1.2M/5M pixels, color camera</td>
<td></td>
<td>1.2M/5M pixels, color camera</td>
<td></td>
</tr>
<tr>
<td><strong>Eye to Hand (Optional)</strong></td>
<td>Support Maximum 2 GigE cameras</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Authorized Distributor:

Controllers & I/O
- Machine Automation Controllers (MAC) • Motion Controllers
- Programmable Logic Controllers (PLC) • Temperature Controllers • Remote I/O

Robotics
- Industrial Robots • Mobile Robots

Operator Interfaces
- Human Machine Interface (HMI)

Motion & Drives
- Machine Automation Controllers (MAC) • Motion Controllers • Servo Systems
- Frequency Inverters

Vision, Measurement & Identification
- Vision Sensors & Systems • Measurement Sensors • Auto Identification Systems

Sensing
- Photoelectric Sensors • Fiber-Optic Sensors • Proximity Sensors
- Rotary Encoders • Ultrasonic Sensors

Safety
- Safety Light Curtains • Safety Laser Scanners • Programmable Safety Systems
- Safety Mats and Edges • Safety Door Switches • Emergency Stop Devices
- Safety Switches & Operator Controls • Safety Monitoring/Force-guided Relays

Control Components
- Power Supplies • Timers • Counters • Programmable Relays
- Digital Panel Meters • Monitoring Products

Switches & Relays
- Limit Switches • Pushbutton Switches • Electromechanical Relays
- Solid State Relays

Software
- Programming & Configuration • Runtime

Note: Specifications are subject to change.