Safety Manual

Original Instruction

Software Version: 1.68

I625-E-01

Contents

Revision History Table

Revision	Date	Revised Content
01	October 2018	Original Release

1. Comprehensive Information

1.1 Overview

This chapter describes the comprehensive important safety information of TM Robot. The user and system integrator of TM Robot must read and fully understand this chapter before using this robot.

1.2 Applicable Product Version

This document is only applicable to the combination of the following software and hardware versions of TM Robot. Users can check the hardware version and software version on “Techman Robot Product Brief Information” sheet in the control box carton, or through these methods: checking the hardware version on the product label on the control box and checking the software version from the software information button in the UI of TMflow. If the software version of the robot has been upgraded and is different from the original out-of-the-box one, users should only check the software version from the UI of TMflow.

Hardware version	HW 3.00
Software version	SW 1.68

Users shall confirm whether the software and hardware version of the TM Robot is consistent with the applicable product version of this Safety Manual. The Corporation is not responsible for any safety issues caused by referring to the safety instruction of an incorrect version.

1.3 Safety Warning Symbols

The following table defines the safety warning level symbols that are marked in each paragraph in this Manual. Read carefully and comply with each paragraph to avoid harm to people or equipment.

	**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.
	**WARNING: ELECTROCUTION RISK** This identifies a hazardous electrical situation.

1.4 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.
- Observing the “Intended Use” section in “Safety Manual”
- If the installation and application does not observe human-robot collaboration regulations of the safety regulations, the user is responsible for providing safety barriers around the robot to prevent anyone from accidentally coming into contact with the robot when it is in motion.
- If any local or national electrical regulation requires, power to the robot and its power supply must be locked out and tagged out 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.

1.5 Validation and Responsibility

The information provided in this Manual does not include how to design, install and operate a complete arm application, nor does it include the peripheral devices that will affect the overall system safety. The design and installation of the complete system must comply with the standards and regulations for safety requirements in the country located. The robot integrator needs to understand safety laws and safety regulations in the local countries, in order to avoid major risks existing in the entire system.

This includes but is not limited to:

- Perform a 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
- Specifying instructions for use
- Clearly marking the installation of the robot and the contact information of the integrator
- Collecting all documents into the technology folder, including the risk assessment, and this Manual

CAUTION:
This product is a partly completed machinery. 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.

1.6 Limitation of 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.

1.7 Overall Safety Warning

The following lists the overall safety warnings. Pay attention that in addition to the contents described in this section, there are still relevant safety warnings for this section in the rest of chapters in this Manual. Read them in detail.

DANGER:

1. Before transporting, installing, operating, maintaining and repairing this product, make sure to read the product specification and operation manual in detail. Confirm that all the conditions comply with the requirements of the specification and the Manual, to avoid unintended accidents (for example: improper operation or conditions of use that exceed the product specification) that resulted in harm to the people or this product.
2. Before installing and using this product, the installer must perform the necessary risk assessment according to the conditions of use to prevent accidents from happening during the operation of the machinery (for example: collision of machinery and people during operation) that resulted in serious injury to the people due to improper condition setting.
3. In case of emergency or abnormal situation, the users shall create a procedure to secure safety and operation of the robot system.
4. Before using this product, make sure that the machinery has at least one emergency stop device capable of stopping the motion of robot in the event of an accident, and must confirm that there is no abnormality in the function and operation of the device.

WARNING:

1. Before disassembling or repairing this product, make sure that the power has been turned off and disconnected first before proceeding with the subsequent operations to avoid injury to people or damage to machinery caused by inadvertent short circuit or electric shock.
2. When operating this product, the operator shall avoid wearing loose clothing or wearing other accessories (such as: necklaces, ties, bracelets, etc.) to avoid injury caused by clothing or accessories being entangled in the machine during operation of the implement.
3. If the product malfunctions, follow the correct procedures and channel in contact with the appropriate people for proper condition elimination and maintenance. Do not attempt to repair the product yourself, to avoid damage to the machinery due to improper assembly and disassembly.
4. Before the robot is in operation, make sure that each part has been completely mounted to avoid any possibility of accidents due to poor fixation during the operation.
5. Before starting the operation of the robot, confirm that there are no persons or obstacles that may intrude into the operating area during operation. If the operating environment uses human-robot cooperative operation, be sure to complete the due risk assessment before starting the operation.

6. It is forbidden for any unauthorized person to operate this product in order to avoid any possibility of injury to the person or damage to the machinery due to improper operation.
7. Do not install or operate this product in a hazardous area (for example: strong magnetic field, hazardous gas, fire source, or flammable product) In order to prevent the machinery from causing danger during operation resulted from the impact of external conditions.

CAUTION:

1. When the person is near the robot or operate the robot, confirm the prompt of machinery warning light before performing the subsequent operations.
2. After completing editing the task flow, operate in the Manual Mode first, and confirm that all the movements in the operation process are correct before switching the operation mode to Auto Mode.
3. During the operation of machinery, do not turn off the power supply if it is not necessary to prevent possible damage to the system.
4. For the robot noise levels and related environmental conditions, refer to the “Hardware Installation Manual” for the corresponding hardware version.

1.8 Intended Use

The normal and intended use of the TM Robots does not create hazards. TM robots have been designed and constructed in accordance with the relevant requirements of IEC 60204-1. TM robots are intended for use in parts assembly and material handling for payloads (including end-effector) up to the “Maximum Payload” specification of each model.

The TM Robot focuses on the safety of human-robot cooperative operation during design, but the cooperative operation is only for application procedures that have undergone a risk assessment including robots, related peripheral equipment and working environment.

Any use or application should consider the risk assessment. If the use is different from the intended application, the Corporation will not bear any responsibility. The Corporation clearly specifies but not limited to the following contents that are not suitable for the TM Robot.

- Use in a potentially hazardous environment
- Use in any applications that may threaten human lives
- Use in any application that may cause personal injuries
- Use before completion of the risk assessment
- Use for life support
- Use when the rated performance cannot be reached
- Use when the reaction time of safety functions is insufficient

- Use with inappropriate parameters for operations
- Applications which may cause damage to the robot itself
- Restricted movement of persons
- Loss of stability/ overturning of machinery
- Excessive oscillations when moving
- Without proper design of earthquake-prevention mounting when installed in earthquake zones
- Fall of persons during access to (or at/from) the work station
- Exhaust gases/lack of oxygen at the work position
- Fire (flammability of the cab, lack of extinguishing means)
- Mechanical hazards at the work position: a) rollover; b) fall of objects, penetration by objects; c) break-up of parts rotating at high speed; d) contact of persons with machine parts or tools (pedestrian controlled machines)
- Insufficient visibility from the work positions
- Inadequate lighting
- Inadequate seating
- Insufficient means for evacuation / emergency exit
- Inadequate location of manual controls
- Inadequate design of manual controls and their mode of operation

1.9 Risk Assessment

Before installing and using this product, the user must first perform a risk assessments based on the conditions of use. Risk assessments can be in reference to the specifications of ISO 10218-2, ISO 12100 and ISO/TS 15066 documentations. The purpose of a risk assessment is to anticipate any accidents that may occur during the operation process and by means of appropriate protective measures to eliminate the occurrence of accidents or to reduce the severity of injury to persons in the event of an accident. Therefore, the risk assessment needs to include any operational actions of the machinery within the scope of the assessment. After the risk assessment is completed, the user can use external related components (i.e. sensing components, emergency stop devices, fences or railings, etc.) as well as the parameter settings of safety functions in the operating system, to prevent possible occurrence of accidents. Externally constructed safety-related components must be installed in accordance with the standards used for the risk assessment. For safety settings in the operating system as well as those for other safety components usage, carefully and completely read through this Manual completely and the "Software Manual" of corresponding software version and the "Hardware Installation Manual" of corresponding hardware version.

The Corporation clearly specifies the following potential major residual risks:

1. The finger (especially in the case of hand guiding) is caught between the rear end of the camera module and the fifth joint module, causing injury due to the excessive rotation angle of the sixth joint.
2. The palm or finger is caught injured by the motion of the robot or the hand guide teaching, which is caught between the robot end and the robot body.
3. Being hit by a robot and injured.
4. Being caught between a robot and a fixed surface or being pinched.
5. Injury caused by the loosened screws of the base of the robot.
6. Inappropriate human-robot collaborative workspace setup, or incorrect project operation may lead to the potential risk that robot will hit the human body at full speed.

WARNING:
Ensure compliance with all local and national safety and electrical codes for the installation and operation of the robot system.

WARNING:
Provide appropriately-sized Branch Circuit Protection and Lockout/Tagout Capability in accordance with the National Electrical Code and any local codes.

WARNING: ELECTROCUTION RISK
AC power installation must be performed by a skilled and instructed person. During installation, unauthorized third parties must be prevented from turning on power through the use of fail-safe lockout measures.
Failure to use appropriate power can lead to malfunction or failures of the robot or hazardous situations.

2. Safety Function

2.1 Overview

TM Robot has built in a series of safety functions, and also provides interfaces to handle other external protection devices.

2.2 General Information

The following describes common information of the TM Robot system safety functions:

2.2.1 Safety Function Definition

Safety Function Definition of TM Robot System is shown as in the following table:

Safety Function Number	Name	Robot Stopping Function	Stop Category	Structure Category	PL
SF0	Emergency Stop	Emergency Stop	Cat. 1	Cat. 3	d
SF1	External Emergency Stop	Emergency Stop	Cat. 1	Cat. 3	d
SF2	Encoder Standstill	Protective Stop	Cat. 0	Cat. 2	d
SF3	External Safeguard	Protective Stop	Cat. 2	Cat. 2	d
SF4	Joint Torque Monitoring	Protective Stop	Cat. 2	Cat. 2	d
SF5	Joint Position Limit	Protective Stop	Cat. 2	Cat. 2	d
SF6	Joint Speed Limit	Protective Stop	Cat. 2	Cat. 2	d
SF7	TCP Speed Limit	Protective Stop	Cat. 2	Cat. 2	d
SF8	TCP Force Limit	Protective Stop	Cat. 2	Cat. 2	d
SF9	External Triggered Collaborative Mode	Protective Stop	Decrease the speed to collaborative speed	Cat. 2	d

Note 1. The structure category is the safety function structure category defined in ISO 13849-1:2015.

Note 2. PL is the abbreviation of Performance Level, which is based on the definition of safety system performance level from ISO 13849-1:2015.

Note 3. Emergency stop and protective stop are defined in ISO 10218-1:2011, 5.5.2, “Emergency stop” and 5.5.3 “Protective stop”

Note 4. Definitions of stop category are specified in IEC 60204-1.

Stop Category	Description
Cat. 0	Stopping by immediate removal of power to the machine actuators.
Cat. 1	A controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved.
Cat. 2	A controlled stop with power left available to the machine actuators.

2.2.2 Stopping Time and Stopping Distance in the Safety System

Safe stopping time definition is the time required when the emergency stop button is pressed or when any one of the safety protection function is triggered until the arm completely stops the motion. In this system, pressing the emergency stop button will apply Cat. 1 safety stop, while the triggering of built-in safety protection function or external safety protection device will be a Cat. 2 stop.. Under certain circumstances, the user or system integrator must perform risk assessment with this time combined. Because the robot has speed during this time, that is, it can also transmit energy, which may cause harm to people or equipment. The stopping time and stopping distance of the Cat.1 stop function of this product in different speeds and different end payloads are shown in Appendix B.

2.2.3 Software Safety Setting Permissions

The permission to change safety setting of the TM Robot should be carefully set by the permissions management function. The user must log in with Administrator permission and set all levels of permissions appropriately before it can start the use. The administrator permissions shall be managed by the user and is not the responsibility of the Corporation. In addition, the user should keep the TM Robot in a network that is not subject to malicious attack or intrusion when using a network connection. The Corporation is not liable for the possible harm caused by malicious attacks or intrusion of network to modify the permissions management system or safety setup.

2.3 Explanation of Safety Functions

2.3.1 SF0 Emergency Stop and SF1 External Emergency Stop

The SF0 Emergency Stop refers to the built-in Emergency Switch on the Robot Stick of the TM Robot, and the SF1 External Emergency Stop refers to the Emergency Stop Port on the control box, which can be used to connect with additional emergency switch.

When an accident occurs during the operation of the robot, the user can stop movement by pressing the emergency switch. After movement of the robot is stopped, the user must confirm that all accident conditions have been eliminated before manually releasing the Emergency Switch to reactivate the robot. The Emergency Stop should only be used when a critical condition occurs. To stop the action of robot under normal operation, use the Stop Button on the Robot Stick to achieve the purpose of stopping the operation. After the risk assessment is completed, if there is a requirement of installing an emergency switch, the selected device must comply with the requirements of the ISO 60204-1. The safety level of the two safety functions SF0 and SF1 is PLd Cat. 3. When user adds emergency switch on Emergency Stop Port, they should choose those emergency switches that have equivalent performance level, and connect its dual channels to the two individual channels of Emergency Stop Port to keep the systematic safety performance as PLd Cat. 3. The electrical design of the external emergency switch port is Normally Closed. In other words, when one of the channels is open, an emergency stop will be triggered.

When the user activates Emergency Stop, the TM Robot will decrease its speed to zero and then cut the power of robot. The brakes activate 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. If required, the operation steps to reset the emergency stop state are as follows:

1. Rotate the Emergency Switch to the pop-up state. At this time, the robot arm will be re-powered. The Indication Light Ring will light up again with blue light, indicating it enters the Safe Start up Mode.
2. Press the Stop Button on the Robot Stick for about three seconds, the robot will perform the calibration action of the start-up process and return to the original operating mode.

WARNING:
The power of the robot arm will be cut and the joint brake will be activated, if the Emergency Stop is triggered. The Indication Light Ring of robot's end module will not show light and the three lights from the robot stick will be constantly blinking. In this case, although each of the joint will be automatically locked through the breaking device on joints, the robot body will still drop slightly, before it completely stops. Pay attention to the existing risk that the end part of the robot may pinch human body or collide with other objects.

WARNING:
In case of Emergency Stop, power of the robot arm will be cut including to the end effector of the robot. If the system was integrated with power I/O enabled end effector, at the emergency stop condition may cause the payload to be dropped while performing the gripping/vacuuming function.
This shall be taken into consideration when the user integrates the system and perform appropriate design in compliance with risk assessment. To prevent the unexpected dropping of work pieces, user can choose an end-effector with self-maintaining function, using pneumatic logic configuration of reverse logic, using the power supply/IO of control box, or connecting extra power supply. The user should be responsible for a correct integration.

2.3.2 SF2 Encoder Standstill

This safety function is automatically activated after every Cat. 2 Stop. Encoders of each joint are monitored continuously to check if there is any unintended motion, until the user acknowledges and manually recover the robot from Cat. 2 Stop status. If there is any unintended motion, this safety function will trigger a Cat. 0 Stop, cutting the power supply directly to the robot.

2.3.3 SF3 External Safeguard and SF9 External Triggered Collaborative Mode

These two safety functions are to provide the user with Safeguard Port of the robot control box connecting with external safety protection devices, to achieve the safety application of halting the robot or triggering the collaborative mode. For the related connection and usage, refer to the "Hardware Installation Manual" of the corresponding hardware version. The resume of SF3 External Safeguard can be set as manual or auto. Refer to the relevant contents in the "Software Manual" of corresponding software version. The resume of SF9 External Triggered Collaborative Mode is auto, which means the robot will be back to the original project speed autonomously.

2.3.4 SF4~SF8 Defined Safety Function

The functional descriptions of SF4 to SF8 safety functions and the physical meanings are shown below:

Safety Function	Name	Description
SF4	Joint Torque Monitoring	Each joint’s torque limit condition can be set. When the robot exceeds its set value, it will trigger a Category 2 stop.
SF5	Joint Position Limit	Each joint’s motion angle limit can be set. When the robot exceeds its set value, it will trigger a Category 2 stop.
SF6	Joint Speed Limit	Each joint’s motion speed range can be set. When the robot exceeds its set value, it will trigger a Category 2 stop.
SF7	TCP Speed Limit	The tool center point speed limit can be set. When the robot exceeds its set value, it will trigger a Category 2 stop.
SF8	TCP Force Limit	The tool center point force limit can be set. When the robot exceeds its set value, it will trigger a Category 2 stop. The tool center point force is the external force received at the tool center point estimated through the model by the robot system. It is not the protection value of applied external force at the tool center point by the robot system.

Refer to the relevant contents in the "Software Manual" of the corresponding software version for the setting of each item. Users can use any method listed below to manually resume the robot from SF4 to SF8:

1. pressing the STOP button on robot stick
2. any operation on the icons in the left sidebar of the TMflow (except Shutdown)
3. pressing FREE button in the end module of TM Robot
4. Complete mode changing on robot stick.

DANGER:
Pay attention that the "TCP Force” (Tool Center Point Force) is the external force received at the tool center point estimated through the model by the robot system, not the protection value of the external force at the tool center point on the robot system. When the robot system estimates the external force received at the tool center point, the robot will perform a category 2 stop, start deceleration until completely stopped. Therefore, clearly understand the amount of the external force applied before the robot is completely stopped in this condition will exceed this setting value. The exceeded degree will increase as the robot speed increases, so the stopping criteria of TCP Force should only be used in case of slow motion. This setting cannot be mistakenly used as the only basis for risk assessment of human-robot collision forces.

CAUTION:
When the motion of TM Robot is passing the area near singular space, due to the nature of singularity, the TCP force may be over-estimated and triggers TCP Force Stop Criteria. Users can set the robot's motion properly, e.g. do not set the motion too close to the singular space, to avoid this situation.

3. Safety Related Operation

This section describes a number of safety-related robot functions and designs in addition to the safety functions. The user must follow the instructions to operate.

3.1 Joint Movement without Drive Power

The conditions of robot without driving force include the following three kinds: emergency stop, start up from the packing pose, and loss of power. The first two can enter Safe Start up Mode when the emergency switch resets, and the latter is the situation when the robot product loses external power entirely. The following describes how to operate it:

3.1.1 During an Emergency Stop Procedure

The brake of each joint axis will automatically lock the joint, to avoid unlimited sagging of the robot's joints due to gravity. If you need to move the robot to resolve the condition, follow the steps listed below:

1. reset the emergency switch. The power to the arm end will be restored at this time
2. wait for 10 seconds to enter the Safe Start Up Mode, and the display of light blue light at Indication Light Ring of the arm end can be seen. Motor power will still be disabled at this time.
3. The FREE button at the robot end can be continuously pressed to release the joint axis brake, and move each joint axis to perform the operation of moving the robot's joints.
4. After the situation is resolved, press the stop button on the Robot Stick for about three seconds, the robot will perform the calibration startup process and return to the original operating mode.

3.1.2 Extending the Robot from the Packing Pose

Refer to the relevant contents in the "Software Manual" of the corresponding software version for the operation of extending the robot from the Packing Pose. The reset method is the same as described in the emergency stop.

DANGER:
When performing the operation of forcing the release of brakes without motor power, pay attention to this situation: when the FREE button is pressed and the brake is released, the robot's body will sag again due to gravity. When the FREE button is pressed to release the brake, grasp the end of robot and expect the phenomenon of this gravity sagging, and take the initiative to lift up the end of robot to prevent additional harm that already happened such as pinch injuries. If it is found at this moment that the robot itself cannot sustain the sagging of the robot body due to unstable grip or physical factors, release the FREE button immediately, and the brake of each robot joint will be locked again to prevent more harm to the human body or damage to the machine.

3.1.3 When the Robot Product Loses Power

In this situation, if it is necessary to move the arm joint module to resolve the situation, the brake of each joint module needs to be removed manually. Following the steps as below:

1. Remove the joint module protective cover screw and the joint module protective cover
2. Press the brake solenoid valve to release the brake

Refer to the illustration of the operating instructions for releasing the brakes as specified in the "Hardware Installation Manual" of each robot product model.

3.2 Operation Mode and Mode Switching

TM Robot has two operation modes: Manual Mode and Auto Mode. The modes can be visually distinguished by the color of the mode indicator of Robot Stick, and Indication Light Ring on robot’s end module . The robot is in Auto Mode when starting up.

3.2.1 Auto Mode

When the robot is in Auto Mode, the Indication Light Ring on the end module displays blue light and the Mode Indicator on Robot Stick is at Auto position. When the robot is in Auto Mode, user can press the Robot Stick Play/Pause button to play/pause the robot project in turn. The robot speed plays according to the project speed. In Auto Mode, the FREE button on the end module does not actuate, and cannot perform Hand Guiding operation.

3.2.2 Manual Mode

When the robot is in Manual Mode, Indication Light Ring on the end module displays green light and the Mode Indicator on Robot Stick is in the Manual position. In Manual Mode, it can be divided into Manual Control Mode and Manual Trial Run Mode. The Indication Light Ring on the End Module displays constant green during Manual Control Mode, and blinking green during Manual Trial Run Mode.

3.2.2.1 Manual Control Mode

In Manual Mode, when the robot is in a non-operational state, it is a Manual Control Mode. Within this mode, users can jog the robot with controller UI in TMflow. When the robot is in the Manual Control Mode, all robot motion will be limited to 250 mm/sec or less. If the robot speed exceeds 250 mm/sec, it will enter an error stop state. In addition, Hand Guiding Mode can only be activated from Manual Control Mode. The FREE button on the End Module can be pressed to move the robot by Hand Guiding.

3.2.2.2 Manual Trial Run Mode

When the user is in the project editing page of TMflow, pressing the Play/Pause button on the Robot Stick enters Manual Trial Run Mode. The 250mm/sec speed limit does not apply while editing projects in Manual Trial Run Mode but the project speed will be reduced to 10% during each trial run. The Add/Subtract buttons on the Robot Stick can be used for adjust the project run speed in Manual Trial Run Mode for higher project speed. Each button press increases or decreases project run speed by 5%. This is used to adjust the project speed.

3.2.3 Switching Between Operation Modes

To switch the operation mode of the robot, use the Mode Switch Button on the robot Stick to switch between Auto / Manual Modes. When the robot operates in Auto Mode, the system cannot switch itself from Auto Mode to Manual Mode. The Stop Button on the Robot Stick must be pressed first to stop the robot operation in order to switch to Manual Mode. The switching method is to press the Mode Switch Button on the Robot Stick.

By switching from Manual Mode (including Manual Control and Manual Trial Run Mode) to Auto Mode, you must to keep holding the Mode Switching Button for a few seconds. Meanwhile, when the two positions of Mode Indicator on the Robot Stick start blinking, press the Plus/Minus Button in the sequence of "Plus-Minus-Plus-Plus-Minus" to switch from Manual to Auto Mode. When the robot is in Manual Trial Run Mode, and when switched to Auto Mode as the former mentioned operation, the Project Speed at this time will be set to the default speed. That is, without being modified again by another trial run, the Project Speed in Auto Mode is then recorded.

3.3 Hold to Run

When the TM Robot is in Manual Control Mode it can several jogging function, including:

- joint angle movement
- robot base end movement
- tool base end movement
- self-defined base end movement
- move to visual initial position
- visual servo action
- step run
- move to point
- hand guiding
- other functions

In these functions, the safety of TM Robot is enhanced by Hold to Run design. Hold to Run in TM Robot's system is divided into two categories. When performing higher risk control operation, various functions shall be operated by the Hold to Run design using the physical buttons on the Robot Stick.

The first category is to jog the robot by continuously pressing the Plus / Minus Button of the Robot Stick. The second category is to jog the robot to move by continuously pressing the software button on the TMflow. Once the physical button or software button is released half way, the robot will stop operation immediately, and will continue operation when pressed again. Some of the functions have two categories of Hold to Run functions. The user can choose one of above functions to implement.

If user chooses to use the buttons on TMflow connected with the robot through TCP/IP or Wi-Fi, the TM Robot will automatically stop your control of the robot and stop the robot operation when the connection is broken. Note that, depending on the quality of connection, there may be a maximum detection delay of disconnection of 0.7 seconds. It may cause the robot to continue to move along the original Hold to Run command after you release the software button.

If user chooses physical button to perform Hold to Run function, the detection time of releasing the button is 30ms by the system. Therefore, in the case of control operations of higher risk, the Robot Stick should be used to operate each Hold to Run function.

3.4 Singular Point / Singular Space

The motion of articulated robot manipulator is often limited by the kinematic design, and cannot perform Cartesian motion control under any posture. The pose or space that will cause the robot unable to perform Cartesian control is a singular point or singular space. When this product encounters a singular point / singular space, it will stop the motion.

The singular space for TM Robot product configuration is divided into three types:

Internal Singular Space.

- Extensible Singular Space.
- Wrist Singular Space.

Internal Singular Space:

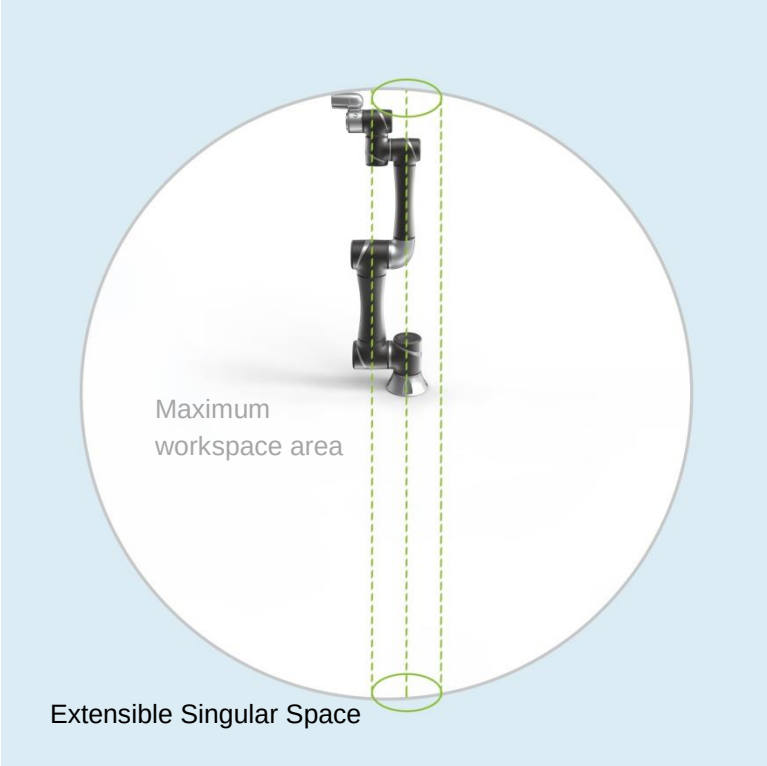
The distance from the intersection of the rotational axes of the fifth joint and the sixth joint to the extended line of the rotational axis of the first joint is defined as R_{offset}. The cylindrical space that formed by R_{offset} as radius and centered on the extended line of the rotational axis of the first joint is the Internal Singular Space. As soon as the robotic arm approaches the Internal Singular Space, the arm will stop and issue a warning. The R_{offset} value of each product series is shown in the following table:

Main model	R_{offset}
TM5 Series	122.3 mm
TM12/14 Series	156.3 mm

The definition of R_{offset}.

Extensible Singular Space:

When the third joint is almost at its zero degree, which means the robot is almost at the maximum working radius. The space exceeded this radius is the Extensible Singular Space. In this space, the robot will stop and report a warning due to exceeding the motion range of the robot..



The maximum working range can be achieved when the third joint is almost at zero degrees

Wrist Singular Space:

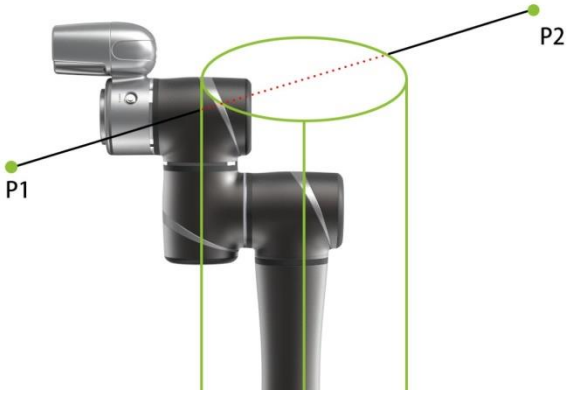
When the rotational axes of the fourth and the sixth joint are in parallel, the robot will enter Wrist Singular Space. At this time, the motion of arm will cause a large-angle displacement of the fourth joint, but it will be stopped due to stop criteria of motion speed. Once the robot enters the Wrist Singular Space, it will stop and report an error.

When the fourth and sixth joint are nearly parallel, is the robot is about to entering the Wrist Singular Space.

The Solution when Encountering Singular Space:

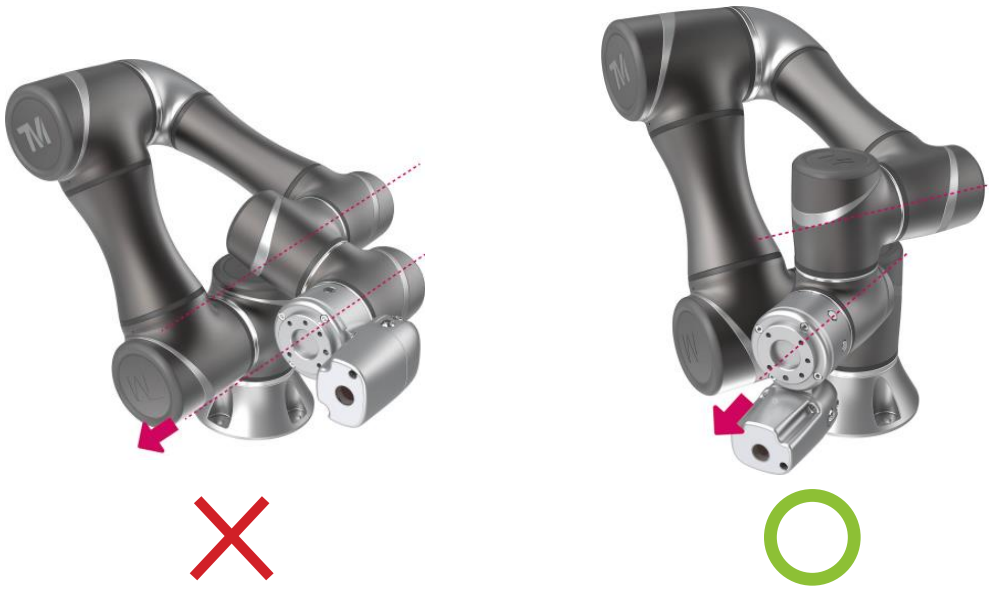
When the robot reports singularity, confirm the posture of the robot. If the tool end path crosses the internal cylinder as shown in the figure below, check the first point description. If the rotational axes of fourth and sixth joints of the robot are in parallel, check the second point description below.

1. When the arm reports a warning due to the Internal Singular Space, press the FREE button to release it from the posture. Re-consider the point position or change the motion type to PTP between the points to avoid the arm path between the points crossing the Internal Singular Space, as shown in the figure below.



When the path crossing the Internal Singular Space, singularity will be triggered> Adjust the path and confirm the it will not cross the Internal Singular Space

2. When the robot reports a warning because entering the Wrist Singular Space, press the FREE button to release it. When the rotational axes of the fourth and the sixth joint are in parallel, if users still try to perform Cartesian motion, the Wrist Singular Space will be encountered. At this time, the method in the following figure can be referred, to avoid the rotational axes of the fourth and the sixth joint being parallel.



This example demonstrates how to avoid the rotational axes of the fourth and sixth joint being parallel, when the user need to move the robot according to tool Z-axis.

4. Compliance of Safety Regulations

This section describes the compliance and certification of this product to international safety regulations.

This product complies with to the following international safety regulations:

ISO 10218-1:2011

ISO/TS 15066

ISO 13849-1:2015

Certification: Third-party certification (refer to the certificate in Annex A)

The details of safety regulations compliance are explained below

4.1 Compliance of ISO 10218-1 and ISO/TS15066

This product fully complies with the combined scope of ISO 10218-1:2011 and ISO/TS-15066.

ISO 10218-1:2011 “Robots and Robotic Devices - Safety Requirements for Industrial Robots - Part 1: Robots", is the latest version of the international standard that regulates the safety of industrial robot products. It mainly aimed at the traditional industrial robot products. However, in responding to the development of new type industrial robots in the market - collaborative industrial robots, and the possibility of using system integration method to achieve the human-robot collaborative application with traditional industrial robots, , there are a few related human-robot collaborative principle regulations specified in its section “5.10: Collaborative Operation Requirements”. The section lists four scenarios that allow human-robot coexistence, for any item in compliance, the human-robot collaborative scenario of the item can be applied. It can be referenced from the table that this product is applicable to human-robot collaboration scenarios:

	ISO10218-1:2011 Section	Item	Outline	Description	Applicability of this Product
1	5.10.2	Safety-rated monitored stop	The robot must be stopped when personnel entering the collaborative space	This item is available for traditional industrial robots fences and interlock switches. This function must meet the safety level specified in Safety Regulation of Section 5.4.	The control box of this product has an Emergency Stop Port and Safeguard Ports. Their safety level complies with the requirement specified in Section 5.4.
2	5.10.3	Hand guiding	The robot has hand guiding function	Collaborative type robot normally is equipped with this function.	This product has a hand guiding function, suitable for this applicable to this scenario.

3	5.10.4	Speed and separation monitoring	The robot can monitor the distance from people and decelerate accordingly	If the traditional robot is equipped with a safety laser scanner that can measure distance, this item can be used to perform a human-robot collaborative application. However, if it does not equipped with the power / force monitoring of item 4, when the personnel enters the robot's working range, the robot must also decelerate the speed to 0. This function must meet the safety level PL=d, Cat. 3 or SIL2 specified in Section 5.4.2.	If the safety related parameters are properly set, the robot does not need to stop when the personnel enters the swing range of the robot due to force limiting function. At the same time, safety devices can be connected to the Safeguard Ports: Collaborative Mode Port of this product, to decrease the speed of the robot to collaborative speed, achieving a more efficient human-robot collaboration application.
4	5.10.5	Power and force limiting by inherent design or control	The robot will stop when colliding with people. Inherent design means such as elastic mechanism, or through control: function composed of sensor-logic- output system.	Collaborative robot usually has this function, and this function must meet the safety level specified Safety Regulations of Section 5.4. In the same article, it is also mentioned that there will be a more detailed specification in ISO/TS 15066.	This product achieves control limit force stop function through the control method of sensor -logic-output system. Its safety level meets the provisions specified in Section 5.4.

ISO/TS 15066:2016 “Robots and Robotic Devices—Collaborative Robots”, introduced in the ISO 10218-1:2011, is the latest technical specification of international safety regulations extended for new-type industrial robots - collaborative robots. As indicated with its title TS (Technical specification), this document is not ISO safety regulation. It is the safety technical specification planned in responding to the ever-changing new technology and new market product. It is also a reserve technical specification for inclusion in the ISO safety regulations in the future. Since the risk of harm within a human-robot collaborative application is even greater than traditional application, its specifications are actually more stringent and precise.

The Corporation regards product safety as the highest design principle. Therefore, apart from ISO 10218-1 compliance, the design is also in accordance with the safety requirements of ISO/TS 15066. For instance, the Collaborative Mode is designed in conformity with the maximum impact force, pressure, and clamping force defined in ISO/TS 15066.

However, there are also some parts of the specifications changes the requirements of ISO 10218-1 specified for traditional industrial robots, in order to reduce the pressure during human-robot collaboration. This product also adopts some of the designs.

The relevant design and corresponding provisions in safety regulations of this part are listed in the following sections.

4.1.1 Requirement of Enabling Device

ISO 10218-1:2011 “Section 5.7: Operational Modes” requires that when operating Manual Reduced Speed Mode of industrial robots (corresponding to the Manual Control Mode of this product) and Manual High Speed Mode (corresponding to the Manual Trial Run Mode of this product), it is necessary to work with Enabling Device conformed to IEC 60204-1. The enable switch is a three-stage design that is held by the user's fingers, causing the robot to stop when fully opened and when fully gripped. Only when held in the middle position, the robot can be activated by additional related operations.

In ISO/TS 15066:2016 “5.4.5 Enabling device requirements” further describes: “…If a risk assessment determines that risk reduction traditionally achieved by the use of an enabling device would be alternatively achieved by inherently safe design measures or safety-rated limiting functions, then the pendant control for a collaborative robot system may be provided without an enabling device.”. The Pendant of this product is the Robot Stick, which is greatly different from the traditional robot Pendant design. It can be grasped in one hand and is easy to press the emergency switch on it. Because the robot is equipped with force limit function, in order to reduce the user's operating pressure, this product does not tie to a specific Enabling Device in Manual Trial Run Mode. In addition, although this product does not tie to a specific Enabling Device in Manual Trial Run Mode, controls in this mode are equipped with Hold to Run design through the physical press buttons on Robot Stick or software interface.

Based on the above design considerations and reference to the contents of the ISO/TS 15066, with the third party performs the risk assessment, this product conforms to the combined scopes of ISO 10218-1:2011 and ISO/TS 15066.

The user can connect the duel channel Enabling Device to Safeguard Pause Port in the Control Box, to achieve the same function, If the risk assessment requires.

4.1.2 Requirement of Hand Guiding Device

In ISO 10218-1:2011, 5.10.3 “Hand guiding section”, it states that the guiding device must be installed near the end-effector and must be equipped with the following two safety devices: an Emergency Switch and an Enabling Device conformed to the safety regulations. Compared to this, Section 5.5.3.2.2 “Guiding Device” in ISO/TS 15066:2016 further explains: “The robot system shall be equipped with a guiding device that incorporates an emergency stop (ISO 10218-1:2011, 5.5.2 and 5.8.4) and an enabling device (ISO 10218-1:2011, 5.8.3), unless the enabling device exclusion requirements of 5.4.5 are met.” The hand guiding function of this product prevents the user from accumulating operating pressure and is not equipped with a three-stage enabling switch. Instead, it uses continuously pressing of the FREE button located at the end module to enable the robot to operate the Hand Guiding Mode, and the robot itself has the safety functions of force limit / speed limit. Based on the above design considerations and reference to the content of ISO/TS 15066, with the third party to perform the risk assessment, this product conforms to the combined scopes of the ISO 10218-1:2011 and ISO/TS 15066.

4.2 Other Major Differences from Traditional Industrial Robots

In addition to the combined scopes of the ISO 10218-1:2011 and ISO/TS 15066:2016 with the third party certified compliance, all other items of this product comply with ISO 10218-1:2011, and are also completely certified by the third-party. The following sections describe other major differences from traditional industrial robots, which are still conformed to the requirements of safety regulations.

4.2.1 On the Compliance of Safety Level Requirement

According to section 5.4.2 “Performance requirement specification” in ISO 10218-1;2011, the safety function of the industrial robot must conform to PL=d (Performance Level, defined in ISO 13849-1), Cat. 3 (Category of Structure), or SIL2 level defined in the IEC standard. Compared to this, the safety function of this product conforms to ISO 13849-1, PL=d, however, its Structure Category is based on the design of each safety function that can be divided into two major categories- Cat. 3 and Cat. 2. In regard to this difference, the explanation is as follows:

At the same time, ISO 10218-1:2011 also has the relevant clauses in Section 5.4.3 “Other control system performance criteria” to supplement the requirements of Section 5.4.2:“The results of a comprehensive risk assessment performed on the robot and its intended application may determine that a safety-related control system performance other than that stated in 5.4.2 is warranted for the application.”. For the compliance of this clause, the product has performed a complete risk assessment and being certified by a third party with the approval by the certification organization. The PLr (Performance Level Requirement) is still level d, but the Structure Category of safety function can be set as Cat. 3 or Cat. 2, depending on the risk. This product is also certified that all safety functions achieve PL=d through Cat. 3 or Cat. 2 structure category. Among

them, the safety functions similar to the traditional industrial robots such as emergency switch / external emergency stop also adopted Cat. 3 structure category design, and the rest of the function of control stop adopted Cat. 2 structure category design. Therefore, this product fully conforms to the requirements of safety level specified in Section 5.4 in ISO 10218-1.

4.2.2 Compliance of Mode Locking Design

According to the section 5.7.1 in ISO 10218-1, the mode-switching device of the industrial robots must have the capability to be locked in one of the modes. In the typical design of traditional industrial robots, this requirement is usually achieved through setting the mechanical mode-locking device equipped with a physical key. This product is an innovative design with gripping and ergonomic considerations of robot stick, to reduce the user's operating pressure, the mode switching locking is achieved through the design of long pressing the mode switch button, then input the specific physical button pressing sequence which is different from that of the traditional robots. This is in line with the original spirit of safety regulations to avoid inadvertent / non-conscious operation condition to switch the operation mode by the user. In addition, within the same clause also has the following description: “The selector can be replaced by another selection means which restricts the use of certain functions of the robot (e.g. access codes)”. The design of this product has also passed the accreditation of the third party certification organization as the design in compliance with this clause. Therefore, the function related to mode lock is fully conformed to the requirements of section 5.7.1 in ISO 10218-1.

4.2.3 Access of Safety Setting

TM Robot's safety setting has been integrated with the user's permission system of the entire product. This design has also been approved by a third-party certification organization to comply with the safety regulations. Read the related section of the “Software Manual” of the product for related operations.

4.3 Compliance of Other Items in ISO 10218-1

There are several items likely to cause doubts when the users refer to the safety regulations. The compliance of these designs to ISO 10218-1: 2011 are further described in following sections.

4.3.1 About the Falling of Gripped Object During Emergency Stop

As described in section 5.2.2 “Power loss or change” of ISO 10218-1, the robot cannot cause hazards during power loss or change. The user often misunderstands that this is to regulate the robot cannot cause the falling of object gripped by the end when the emergency switch is pressed. This is not the details of definition. The end-effector is installed by the user to facilitate the application, and is not included in the scope of this product. The power source and control of end-effector is also determined by the user's integration method. This product conforms to regulations specified in section 5.2.2 of ISO 10218-1, the power supply of robot must be cut during emergency stop. Therefore, if the user uses the power in the End Module to power the end-effector, when Emergency Stop occurs, the power supply of the End Module, including digital IO, will become low. This may cause the work piece gripped by the end-effector to fall. As mentioned above, cutting the power of the end effector does not violate the safety regulations. About this, if the user determined the falling of object gripped by the end-effector shall be avoided during Emergency Stop when integrating the system, it still can be achieved when use this product with following methods:

- Use the 24V electrical output provided by the control box to supply the power to end effector instead of using the End Module of robot to supply power.
- Install independent power supply for the end effector.
- If the end effector is a pneumatic control design, the external design can be low potential actuation design.
- Select the end effector with self-maintaining function / mechanical design.

4.3.2 About Single Point of Control

As stated in the section 5.3.5 “Single Point of Control” in ISO 10218-1, the industrial robot cannot be controlled by other sources when being operated using a pendant box or other teaching device. This is intended to protect the user from the dangers caused by other people operating through other remote control device or ambiguous control device at the same time. Although the design of this product can be controlled by the keyboard, mouse and screen directly extended from the control box through wired or wireless control, every control device using TMflow to perform control has the design of a single control permission that only one single device can perform control at any given time. This complies with the regulations.

WARNING:
If the risk assessment indicates that the work cell should be designed as below: if there is an Emergency Stop to the robot, other work cell devices, such as PLCs or conveyors, should also be Emergency Stopped, user can achieve this through system integration of safety related components, such as safety controller.

5. Declaration of Incorporation

The following is based on the Declaration of Incorporation in application of 2006/42/EG, Annex II, No. 1 B

The robot product of the Corporation is a partly completed machinery. When it is put into automation applications, it needs to be integrated with other equipment, and appropriately installed with the safety related measures and design before it can be used. When the semi-finished products are to put on the market, the following requirements need to be achieved. It must be noted that since the TM Robot product is easy to use, the “system integrator” here refers to the end user who uses the product directly through simple installation.

A: Not related

B: Satisfied by machinery equipment provider

C: Must be responsible by the system integrator

Attention: in the following tables:

- Items marked as A: The scope of use of this product has been exceeded, and is not included into the consideration, or it is not directly related to this product.

- Items marked as B solely: The items that are to be satisfied by the machinery equipment provider, meaning the machinery provider has satisfied or has specified in each of the Software and Hardware / Safety Manual. In the latter case, the system integrator is still responsible for the full compliance with specification of machinery equipment provider. In addition, in the entire system, the satisfaction of machinery equipment belonging to the system but not belonging to this product is not included here, and the system integrator must be responsible for it.

- Items marked as C solely: The item cannot be satisfied by this product. The system integrator must implement additional measures.

- Items marked as both B and C:

    1. When the item can be satisfied in using this product itself, the machinery equipment provider of this product shall satisfy it.
    2. When the system integrator replaces the related functions of this product through system integration, the system integrator shall satisfy it. For example:
        - Replacing the emergency switch of the Robot Stick with an external emergency switch connected to the Emergency Switch Port
        - Replacing the Play/Stop Button of the Robot Stick with user-defined IO or the functions of equivalent functions.

When this type of design replaces the original function of this product, the system integrator shall be responsible for the equivalence of the replacement.

3. The machinery equipment provider satisfies this item in normal condition, but in extraordinary conditions, the satisfying of this item is the responsibility of the system integrator. For example:
   - The product does not have any concern of being cracked broken in normal operation without collision, but the situation that causes the robot to be cracked broken / tilted / even fallen in strong collision environment due to incorrect programming setup and safety setting during operation.

Number	Original Language Items	A	B	C
1.1	Essential Requirements			
1.1.1	Definitions		X	
1.1.2	Principles of safety integration		X	
1.1.3	Materials and products		X	
1.1.4	Lighting			X
1.1.5	Design of machinery to facilitate its handling		X	
1.1.6	Ergonomics		X	X
1.1.7	Operating positions			X
1.1.8	Seating			X
1.2	Control Systems			
1.2.1	Safety and reliability of control systems		X	X
1.2.2	Control devices		X	X
1.2.3	Starting		X	X
1.2.4	Stopping		X	X
1.2.4.1	Normal stop		X	X
1.2.4.2	Operational stop		X	X
1.2.4.3	Emergency stop		X	X
1.2.4.4	Assembly of machinery			X
1.2.5	Selection of control or operating modes		X	X
1.2.6	Failure of the power supply			X
1.3	Protection against mechanical hazards			
1.3.1	Risk of loss of stability			X
1.3.2	Risk of break-up during operation		X	X
1.3.3	Risks due to falling or ejected objects		X	X
1.3.4	Risks due to surfaces, edges or angles		X	
1.3.5	Risks related to combined machinery	X		
1.3.6	Risks related to variations in operating conditions			X
1.3.7	Risks related to moving parts		X	X
1.3.8	Choice of protection against risks arising from moving parts			X
1.3.8.1	Moving transmission parts			X
1.3.8.2	Moving parts involved in the process			X
1.3.9	Risks of uncontrolled movements			X
1.4	Required characteristics of guards and protective devices			
1.4.1	General requirements			X
1.4.2	Special requirements for guards			X

1.4.2.1	Fixed guards			X
1.4.2.2	Interlocking movable guards			X
1.4.2.3	Adjustable guards restricting access			X
1.4.3	Special requirements for protective devices			X
1.5	Risks due to other hazards			
1.5.1	Electricity supply			X
1.5.2	Static electricity			X
1.5.3	Energy supply other than electricity			X
1.5.4	Errors of fitting			X
1.5.5	Extreme temperatures	X		
1.5.6	Fire	X		
1.5.7	Explosion	X		
1.5.8	Noise		X	X
1.5.9	Vibrations			X
1.5.10	Radiation	X		
1.5.11	External radiation			X
1.5.12	Laser radiation	X		
1.5.13	Emissions of hazardous materials and substances		X	X
1.5.14	Risk of being trapped in a machine			X
1.5.15	Risk of slipping, tripping or falling			X
1.5.16	Lightning			X
1.6	Maintenance			
1.6.1	Machinery maintenance			X
1.6.2	Access to operating positions and servicing points			X
1.6.3	Isolation of energy sources			X
1.6.4	Operator intervention			X
1.6.5	Cleaning of internal parts	X		
1.7	Information			
1.7.1	Information and warnings on the machinery		X	
1.7.1.1	Information and information devices		X	X
1.7.1.2	Warning devices		X	X
1.7.2	Warning of residual risks		X	
1.7.3	Marking of machinery		X	
1.7.4	Instructions		X	
1.7.4.1	General principles for the drafting of instructions		X	
1.7.4.2	Contents of the instructions		X	
1.7.4.3	Sales collateral	X		

6. Terms and Conditions Agreement

6.1 Warranty Limitations of Liability

6.1.1 Warranties

- Exclusive Warranty

Omron's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Omron (or such other period expressed in writing by Omron). Omron disclaims all other warranties, express or implied.

- Limitations

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, ABOUT NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE PRODUCTS. BUYER ACKNOWLEDGES THAT IT ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE.

Omron further disclaims all warranties and responsibility of any type for claims or expenses based on infringement by the Products or otherwise of any intellectual property right.

- Buyer Remedy

Omron's sole obligation hereunder shall be, at Omron's election, to (i) replace (in the form originally shipped with Buyer responsible for labor charges for removal or replacement thereof) the on-complying Product, (ii) repair the non-complying Product, or (iii) repay or credit Buyer an amount equal to the purchase price of the non-complying Product; provided that in no event shall Omron be responsible for warranty, repair, indemnity or any other claims or expenses regarding the Products unless Omron's analysis confirms that the Products were properly handled, stored, installed and maintained and not subject to contamination, abuse, misuse or inappropriate modification. Return of any Products by Buyer must be approved in writing by Omron before shipment. Omron Companies shall not be liable for the suitability or unsuitability or the results from the use of Products in combination with any electrical or electronic components, circuits, system assemblies or any other materials or substances or environments. Any advice, recommendations or information given orally or in writing, are not to be construed as an amendment or addition to the above warranty.

See http://www.omron.com/global/ or contact your Omron representative for published information.

6.1.2 Limitation of Liability; Etc

OMRON COMPANIES SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR PRODUCTION OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED IN CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY.

Further, in no event shall liability of Omron Companies exceed the individual price of the Product on which liability is asserted.

6.2 Application Considerations

6.2.1 Suitability of Use

Omron Companies shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in the Buyer's application or use of the Product. At Buyer's request, Omron will provide applicable third party certification documents identifying ratings and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer's application, product or system. Buyer shall take application responsibility in all cases.
NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT(S) IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

6.2.2 Programmable Products

Omron Companies shall not be responsible for the user's programming of a programmable Product, or any consequence thereof.

6.3 Disclaimers

6.3.1 Performance Date

Data presented in Omron Company websites, catalogs and other materials is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of Omron's test conditions and the user must correlate it to actual application requirements. Actual performance is subject to the Omron's Warranty and Limitations of Liability.

6.3.2 Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron's representative at any time to confirm actual specifications of purchased Product.

6.3.3 Errors and Omissions

Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Appendix A. Certificate of Compliance and Declaration of Incorporation

CERTIFICATE OF COMPLIANCE

Certificate No. MDC 2005

SGS Reference:	**CST252884/1**
Date of Issue:	**04th May 2018** Issue No.: **1** **Expiry Date: 03th May 2023**
Client/Applicant:	**TECHMAN ROBOT Inc.** **4F, No. 188, Wenhua 2nd Rd. Guishan Dist., Taoyuan City,Taiwan**
Manufacturer:	**As above**
Scope of certification:	**Full technical file assessment according to Annex VII 2006/42/EC**
Description of Equipment	**Industrial Robot**
Type/Series:	**TM5-700, TM5M-700, TM5X-700, TM5MX-700,TM5-700 SEMI, TM5M-700 SEMI, TM5X-700 SEMI, TM5MX-700 SEMI, TM5-900, TM5M-900, TM5X-900, TM5MX-900, TM5-900 SEMI, TM5M-900 SEMI, TM5X-900 SEMI, TM5MX-900 SEMI, TM12, TM12M, TM12X, TM12MX, TM12 SEMI, TM12M SEMI, TM12X SEMI, TM12MX SEMI, TM14, TM14M, TM14X, TM14MX, TM14 SEMI, TM14M SEMI, TM14X SEMI, TM14MX SEMI**
Serial Number(s):	**N/A**
Trade Mark/Name:	**TECHMAN ROBOT**
Assessment Performed:	**Assessed for compliance with the requirements of Annex VII of the Machinery Directive 2006/42/EC, ISO 12100:2010, EN 60204-1:2006/AC:2010, EN ISO 13849-1:2015, EN ISO 10218-1:2011 and ISO/TS 15066 / 2016**
Conclusion:	**In the opinion of SGS United Kingdom Limited the submitted technical file referenced as CST252884/1 satisfies the requirements of the Machinery Directive 2006/42/EC**

Authorised Signature
Daniele Paoli
Machinery Manager

Page 1 of 1

The CE mark as shown below can be used, under the responsibility of the manufacturer, after completion of an EC Declaration of Conformity and compliance with all relevant EC Directives.

CE

SGS United Kingdom Limited
Unit 12A & 12b, Bowburn South Ind Est, Bowburn Durham, DH6 5AD Tel +44 (0)191 377 2000 Fax +44 (0)191 377 2020
Registered in England No. 1193985 Rossmore Business Park, Ellesmere Port, Cheshire CH65 3EN www.sgs.com
Member of SGS Group (SGS SA)

MD 38 Iss 03 - 02/09/2016

SGSPAPER
18540859

DECLARATION OF INCORPORATION

We **TECHMAN ROBOT Inc.**
4F, No. 188, Wenhua 2nd Rd. Guishan Dist., Taoyuan City, Taiwan

Declare that the

Product name: Industrial Robot

Series Model Number:
TM5-700; TM5M-700; TM5X-700; TM5MX-700; TM5-900; TM5M-900; TM5X-900; TM5MX-900;
TM5-700 SEMI; TM5M-700 SEMI; TM5X-700 SEMI; TM5MX-700 SEMI; TM5-900 SEMI;
TM5M-900 SEMI; TM5X-900 SEMI; TM5MX-900 SEMI;
TM12; TM12M; TM12X; TM12MX; TM14; TM14M; TM14X; TM14MX;
TM12 SEMI; TM12M SEMI; TM12X SEMI; TM12MX SEMI; TM14 SEMI; TM14M SEMI; TM14X SEMI; TM14MX SEMI;

Conform to the essential safety requirements of the relevant European Directive:

- Machinery Directive 2006/42/EC
- Electromagnetic Compatibility Directive 2014/30/EU
- Low Voltage Directive 2014/35/EU

The following essential requirements of EC Machinery Directive 2006/42/EC have been applied:

Clause 1.1.2, 1.1.3, 1.1.5, 1.1.6, 1.1.7, 1.2.1, 1.2.2, 1.2.3, 1.2.4.1, 1.2.4.2, 1.2.4.3, 1.2.4.4, 1.2.5, 1.2.6, 1.3.1, 1.3.2, 1.3.4, 1.3.6, 1.3.7, 1.3.8.1, 1.3.8.2, 1.3.9, 1.4.1, 1.4.2.1, 1.4.3, 1.5.1, 1.5.2, 1.5.3, 1.5.4, 1.5.13, 1.5.14, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.6.5, 1.7.1.1, 1.7.1.2, 1.7.2, 1.7.3, 1.7.4, 1.7.4.1, 1.7.4.2, 1.7.4.3

The person who compile technical file established within the EU:

Name: SGS UK

Address: SGS United Kingdom Rossmore Business Park, Ellesmere Port, Cheshire CH65 3EN

Mounting and connecting instructions defined in catalogues and technical construction files must be respected by the user.

They are based on the following standards：

- EN ISO 12100: 2010 / Safety of Machinery - General principles for design / Risk Assessment and Risk reduction.
- EN 60204-1:2006/AC:2010 / Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN ISO 13849-1:2015 / Safety of machinery - Safety-related parts of control systems Part 1: General principles for design
- EN ISO 10218-1:2011 / Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots
- ISO TS 15066-2016 / Robots and robotic devices — Collaborative robots
- EN 61000-6-2:2005 / Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
- EN 61000-6-4:2007/ A1:2011 / Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments.

The relevant technical documentation has been compiled in accordance with Annex VII, Part B of EC Machinery Directive 2006/42/EC. We undertake, in response to a reasoned request, to supply it to the market surveillance authorities within a reasonable period.

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of the Machinery Directive.

Authorized Signature : Haw Chen
Name : Haw Chen
Responsibility : CEO
Date : April 25, 2018
Place : Taiwan

Appendix B. TM Robot Stopping Time and Distance for all Series Product Models

The stopping time and stopping distance of the Cat.1 stop functions of this product in different speeds and different end payloads are shown below.

WARNING:
Any moving robot requires some distance to stop. When stopping a robot, make sure that there is no interference with other equipment. This requires more distance at high operating speeds or heavier payloads.

TM5-700 Series

Stop Time and Stop Distance Table								
Percentage of Maximum Payload (%)	Extension(%)	Speed(%)	First joint		Second joint		Third joint	
			Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)
33	33	33	364	9.00	600	9.29	442	8.97
		66	377	17.96	516	18.15	466	17.91
		100	381	26.55	657	27.13	486	26.92
	66	33	455	8.99	567	9.17	422	8.96
		66	531	17.95	594	18.08	457	17.94
		100	610	26.34	528	27.72	457	23.41
	100	33	367	8.98	534	9.30	432	9.00
		66	396	17.94	501	18.19	530	18.02
		100	427	26.76	526	27.80	541	28.81
66	33	33	378	9.01	531	9.23	475	8.99
		66	401	17.95	547	18.12	478	17.97
		100	575	26.75	551	26.99	570	26.91
	66	33	496	8.96	529	9.29	433	8.97
		66	545	17.96	506	18.14	526	17.98
		100	563	26.46	526	28.36	583	27.73
	100	33	517	8.94	568	9.38	636	9.08
		66	598	17.90	524	18.10	545	18.16
		100	614	26.58	575	28.53	527	28.75
100	33	33	565	8.96	585	9.26	567	9.12
		66	570	17.92	585	18.16	675	18.28
		100	579	26.33	356	30.98	666	27.40
	66	33	566	8.95	588	9.34	625	9.28
		66	576	17.92	578	18.26	656	18.26
		100	570	26.88	343	31.10	550	27.56
	100	33	597	8.94	576	9.34	681	9.34
		66	593	17.86	516	18.14	555	18.09
		100	596	26.00	544	26.45	528	28.80

TM5-900 Series

Stop Time and Stop Distance Table								
Percentage of Maximum Payload (%)	Extension(%)	Speed(%)	First joint		Second joint		Third joint	
			Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)
33	33	33	519	8.96	626	9.24	457	8.99
		66	512	17.95	555	18.03	475	17.93
		100	466	25.68	563	27.20	476	27.09
	66	33	374	8.97	598	9.32	444	8.96
		66	719	17.95	510	18.11	636	18.12
		100	664	26.33	521	27.34	650	27.41
	100	33	366	8.98	524	9.25	428	8.97
		66	412	17.93	518	18.23	510	18.04
		100	442	26.57	508	24.20	498	28.66
66	33	33	508	8.98	660	9.19	629	9.23
		66	589	17.97	666	18.20	536	18.09
		100	476	26.86	575	27.62	635	27.06
	66	33	635	8.93	633	9.27	518	9.00
		66	645	18.00	640	18.16	647	18.19
		100	668	26.73	569	28.14	676	27.73
	100	33	366	9.02	506	9.22	565	8.96
		66	479	17.96	522	18.16	514	16.93
		100	503	26.58	517	23.61	485	28.62
100	33	33	474	8.99	572	9.15	662	9.21
		66	571	18.02	573	18.22	640	18.18
		100	568	26.94	563	28.00	637	27.36
	66	33	508	9.00	691	9.31	627	9.18
		66	566	18.10	641	18.23	652	18.26
		100	583	26.72	534	28.45	680	27.56
	100	33	549	9.04	542	9.28	436	8.97
		66	645	18.16	551	18.11	520	18.13
		100	594	26.60	569	23.15	499	28.78

TM14 Series

Stop Time and Stop Distance Table								
Percentage of Maximum Payload (%)	Extension(%)	Speed(%)	First joint		Second joint		Third joint	
			Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)
33	33	33	416	6.01	554	6.18	511	8.83
		66	662	12.00	650	12.33	621	17.84
		100	482	18.24	635	18.58	510	26.32
	66	33	374	5.99	637	6.41	527	8.94
		66	643	11.99	641	12.34	689	17.66
		100	644	18.18	654	18.65	545	26.54
	100	33	482	6.04	530	6.27	453	8.42
		66	531	11.90	657	12.37	589	18.28
		100	624	18.17	626	17.64	575	28.86
66	33	33	680	6.00	623	6.36	598	9.17
		66	684	11.98	605	12.20	632	18.91
		100	690	18.13	595	18.54	631	27.19
	66	33	595	5.99	576	6.35	635	9.28
		66	597	11.96	557	12.42	600	18.33
		100	581	18.13	557	18.51	599	27.50
	100	33	548	5.98	530	6.38	432	8.52
		66	568	11.84	576	12.41	567	18.32
		100	568	18.25	589	17.75	531	28.77
100	33	33	591	5.99	574	6.34	529	9.10
		66	608	11.97	575	12.38	557	18.22
		100	582	18.15	585	18.89	556	27.27
	66	33	611	5.99	594	6.48	575	9.12
		66	615	11.99	616	12.26	671	18.30
		100	618	18.23	604	18.98	571	27.34
	100	33	570	6.06	568	6.29	575	8.95
		66	567	12.06	552	12.34	587	18.20
		100	568	18.39	591	17.61	544	28.87

TM12 Series

Stop Time and Stop Distance Table								
Percentage of Maximum Payload (%)	Extension(%)	Speed(%)	First joint		Second joint		Third joint	
			Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)	Stop Time (ms)	Stop Distance (˚)
33	33	33	365	6.02	634	6.27	674	9.35
		66	364	12.00	557	12.18	588	18.12
		100	473	18.20	559	18.48	615	27.26
	66	33	368	6.01	563	6.27	584	9.19
		66	634	12.01	531	12.24	653	18.30
		100	621	18.17	541	18.45	552	27.73
	100	33	541	5.98	597	5.22	544	8.94
		66	564	12.01	587	12.21	532	18.14
		100	591	18.17	592	17.80	569	28.90
66	33	33	662	6.02	644	6.16	632	9.20
		66	657	12.01	645	12.26	657	18.10
		100	659	18.16	666	18.67	695	27.08
	66	33	501	6.03	664	6.12	680	9.36
		66	661	12.00	601	12.33	676	18.30
		100	661	18.16	588	18.91	570	27.50
	100	33	539	6.02	545	6.38	513	9.10
		66	543	12.01	545	12.36	520	18.15
		100	530	18.40	565	17.88	591	28.82
100	33	33	584	5.99	540	6.19	606	9.17
		66	596	11.99	560	12.52	592	18.01
		100	603	18.14	535	18.88	572	27.07
	66	33	579	6.06	549	6.26	613	9.33
		66	581	12.09	564	12.52	606	18.12
		100	585	18.27	556	19.24	582	27.75
	100	33	580	6.06	558	5.36	608	9.34
		66	548	12.12	537	12.39	547	18.15
		100	564	18.41	518	18.14	611	27.50

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 ADEPT 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

Authorized Distributor:

Cat. No. I625-E-01 1018 (1018)

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