

VERTICAL ARTICULATED
ROBOT
SPECIFICATIONS

TVL500/TSL3100

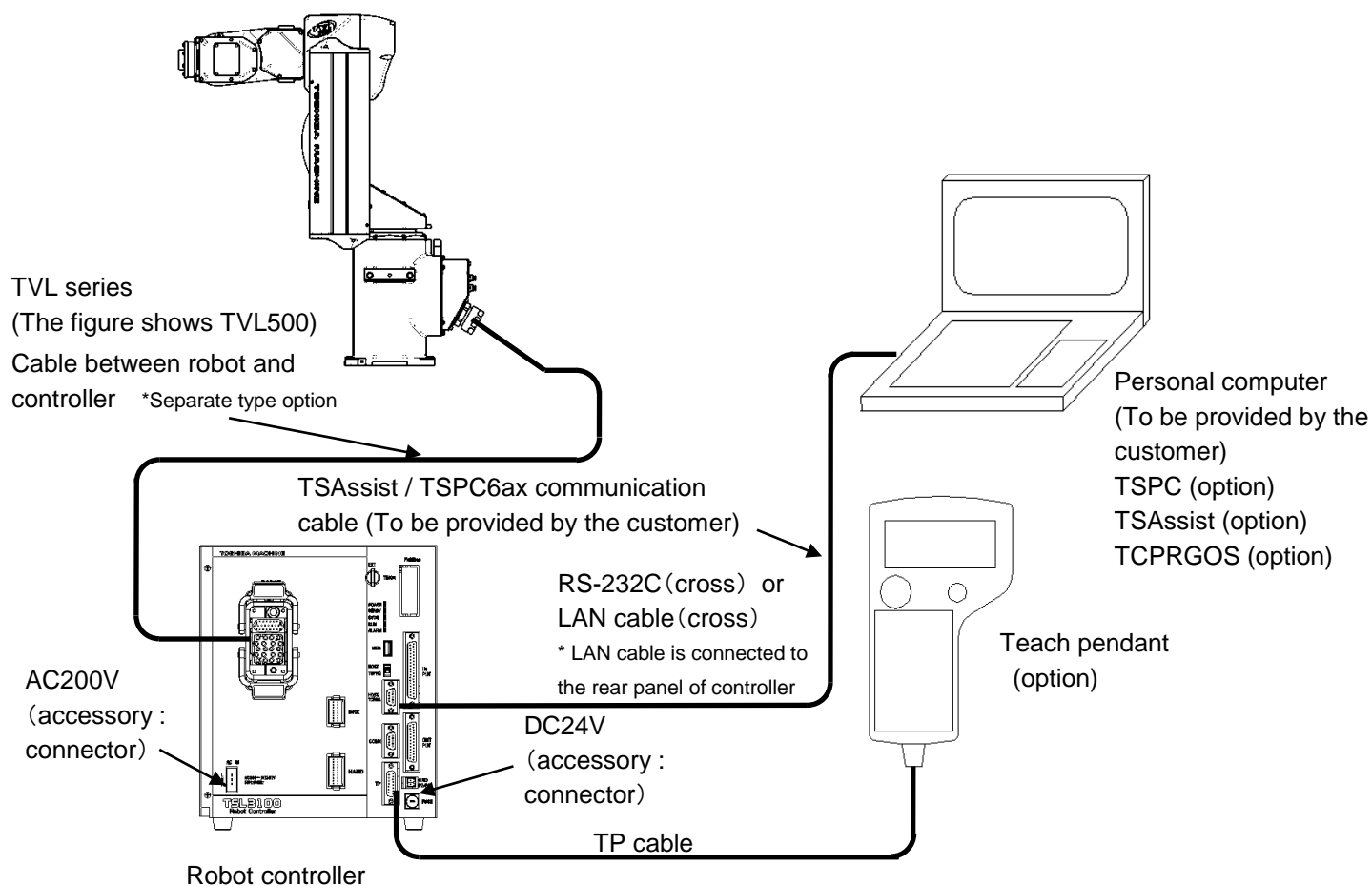
TVL700/TSL3100

APRIL 2014

TOSHIBA MACHINE CO., LTD.

NUMAZU, JAPAN

1. Structure of Robot Equipment



Structural drawing of robot equipment

[Standard Equipment and Accessories]

No.	Name of Equipment	Type	Q'ty	Remarks
1	Robot Body	TVL500/TVL700	1	
2	Cable between robot and controller	(Standard 3.5 m)	1	Separate type option
3	Robot controller	TSL3100	1	
4	I/O P24V supply connector	SL-4000-CP-2PGY	1	Standard accessory
5	Remote I/O connector	SL-4000-CP-5PGY	1	Standard accessory
6	External input connector	M067817	1	Standard accessory
7	External output connector	XM3A-2521	1	Standard accessory
8	External output connector shell	XM2S-2511	1	Standard accessory
9	Dummy plug for teach pendant	M067819	1	Standard accessory
10	System disk (DVD)		1	Standard accessory
11	Master mode selector key	AT-4079	1	Standard accessory
12	Power connector	03JFAT-SAYGF-I	1	Standard accessory
13	Fuse (3A) (spare)	51NM030H	1	Standard accessory
14	Arm clamp		1	Standard accessory
15	Nameplate character specification	English		
16	Polarity of controller	Type-N: Standard		Minus (-) common

[Robot Mechanical Option]

NO.		Type	Q'ty	Remarks	Applicability Note 2)
1	HAND IO Panel install in 2nd Arm (2)	2ND			○
2	HAND IO Panel install in 3rd Arm (2)	3RD			○
3	Built-in three-way solenoid valve	MN			○
4	Ceiling mount	T			○
5	Ceiling mount + HAND IO Panel install in 2nd Arm (2)	T2ND			○
6	Ceiling mount + HAND IO Panel install in 3rd Arm (2)	T3RD			○
7	Ceiling mount + Built-in three-way solenoid valve	TMN			○
8	Dust and water proof	IP			○
9	Dust and water proof + HAND IO Panel install in 2nd Arm (2)	IP2ND			○
10	Dust and water proof + HAND IO Panel install in 3rd Arm (2)	IP3RD			○
11	Dust and water proof + Built-in three-way solenoid valve	IPMN			○
12	Dust and water proof + Ceiling mount	IPT			○
13	Dust and water proof + Ceiling mount + HAND IO Panel install in 2nd Arm (2)	IPT2ND			○
14	Dust and water proof + Ceiling mount + HAND IO Panel install in 3rd Arm (2)	IPT3RD			○
15	Dust and water proof + Ceiling mount + Built-in three-way solenoid valve	IPTMN			○
16	Clean room	CR			○
17	Clean room + HAND IO Panel install in 2nd Arm (2)	CR2ND			○
18	Clean room + HAND IO Panel install in 3rd Arm (2)	CR3RD			○
19	Clean room + Built-in three-way solenoid valve	CRMN			○
20	Clean room + Ceiling mount	CRT			○
21	Clean room + Ceiling mount + HAND IO Panel install in 2nd Arm (2)	CRT2ND			○
22	Clean room + Ceiling mount + HAND IO Panel install in 3rd Arm (2)	CRT3RD			○
23	Clean room + Ceiling mount + Built-in three-way solenoid valve	CRTMN			○
24	Length change of cable between robot and controller	L05/L08/L10			○
25	Length change of cable between robot and controller (Movable)	L00R/L05R/ L08R/L10R			○
26	Separable cable between robot and controller				×
27	CE marking	E			○
28	KC's marking	K			○
29	Hand IO cable (straight)			1m/2m	○

Note 1) For robot model notation with optional specifications, refer to [Optional Specifications and Robot Model] on page 4

Note 2) Symbols in the "Applicability" column on the above table indicate the following meanings:

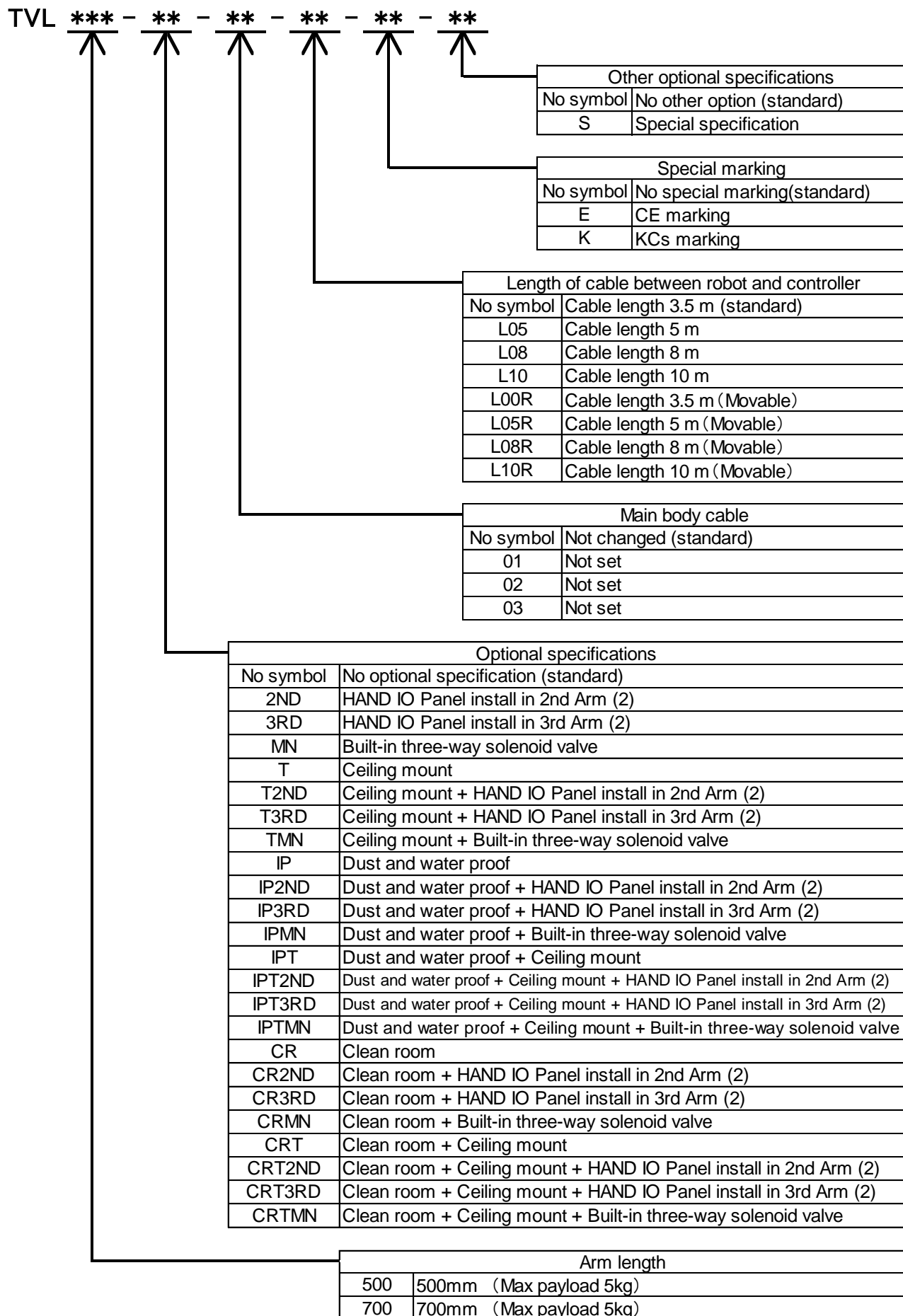
○: Applicable

×: Will be applicable gradually

For details of an item "Will be applicable gradually", please consult us.

[Optional Specifications and Robot Model]

Robot model notation with optional specifications is shown below.



Example 1) "TVL500"

Standard specification of VERTICAL ARTICULATED Robot TVL series with arm length 500 mm (maximum payload quantity 5 kg) specification, robot to controller 3.5 m specification.

Example 2) "TVL500-CRT-L00R-E-S"

VERTICAL ARTICULATED Robot TVL series with arm length 500 mm (maximum payload quantity 50 kg), cleanroom and ceiling mount specification, the length of movable cable between robot and controller of 3.5m, the CE marking, and the special specifications (for a certain customer).

Note) Currently some of the options are unavailable. For the availability of options, refer to [Robot Mechanical Option] on page 3.

[Controller Option]

No.	Name of Equipment	Type	Q'ty	Remarks
1	Teach pendant 1 (Standard cable 5 m)	TP1000-6ax		
2	Teach pendant 2 (Standard cable 5 m)	TP3000		
3	Extended cable for Teach pendant 1			10 m/15 m
4	Extended cable for Teach pendant 2			Separate
5	Common I/O Output: Type-P			Plus (+) common
7	External input signal cable	INPUT		Cable length: 6 m
8	External output signal cable	OUTPUT		Cable length: 6 m
9	Additional axis			Max 2 axis
10	Brackets to hold the controller	TSL31-T		2 pcs. per set *1
11	Addition of extension I/Os (Type-N, Type-P)	TR48DIOCN TR48DIOC		
12	Program development software	TSAssist		With instruction manual
13	Program development software	Virfit Agent		With instruction manual
14	Program development software	TSPC6ax		With instruction manual
15	Program development software	TCPRGOS		With instruction manual
16	Fieldbus function	PROFIBUS		*2
17		DeviceNet		
18		CC-Link		
19		Ethernet/IP		
20		EtherCAT		
21		PROFINET		

*1: Brackets are bundled up when the shipping. Customers please assemble that on your own.

*2: For fieldbus slave modules, any of the 6 types, Profibus, DeviceNet and CC-Link, Ethernet/IP, EtherCAT, PROFINET, can be selected. It is necessary to select which fieldbus to use when an order is made.

[Documents]

No.	Name of Equipment	Type	Q'ty	Remarks
1	Specifications manual		1	This manual
2	Complete instruction manual (DVD)		1	Japanese version
3	Complete instruction manual (DVD)		1	English version
4				
5				

Complete instruction manual (total of 9 documents)

Operation manual, Robot language manual, Interfacemanual, Transportation and installation manual, Maintenance manual, Communication manual, Safety manual, User parameter manual, and Alarm manual:

Cleanroom specifications

Cleanroom specifications Manual is also added.

Dust and Water-proof specifications

Dust and Water-proof specifications Manual is also added.

2. Robot Specifications

2. 1 Robot TVL500/TVL700 Standard Specifications

No	Item		Specifications		Remarks
1	Structure		Vertical multi-articulation		
2	Model		TVL500	TVL700	
3	No. of controlled axes		6 axes		
4	Arm length	Full length	500(mm)	700(mm)	
		Arm 1	260(mm)	400(mm)	
		Arm 2	240(mm)	300(mm)	
	Reach		602(mm)	801(mm)	
5	Working envelope	Axis 1	±170(deg)		
		Axis 2	-64~±165(deg)	-90~±165(deg)	
		Axis 3	0~±150(deg)	0~±165(deg)	
		Axis 4	±190(deg)		
		Axis 5	±120(deg)		
		Axis 6	±360(deg)		
6	Maximum speed	Axis 1	435(deg/sec)	295(deg/sec)	*1
		Axis 2	348(deg/sec)	270(deg/sec)	
		Axis 3	348(deg/sec)	295(deg/sec)	
		Axis 4	422(deg/sec)		
		Axis 5	422(deg/sec)		
		Axis 6	696(deg/sec)		
		Composite	7.98(m/sec)	7.71(m/sec)	
7	Payload mass	Rated	1 (kg)		*1
		Maximum	3 (kg) (Downward:5kg)	4 (kg) (Downward:5kg)	
8	Standard cycle time (when transferring 1 kg)		0.3(sec) level	0.4(sec) level	*2
9	Allowable moment of Inertia at end	Axis 4,5	0.15 (kg•m ²)		*1
		Axis 6	0.20 (kg•m ²)		
10	Positioning repeatability	X-Y-Z	±0.02(mm)	±0.03(mm)	*3
11	Drive system		AC servo motor for all axes		
12	Robot body	Mass	28(kg)	31(kg)	*4
		Color	White/Blue		
13	Dust and water proof type		1. Structure that protects against dust ingress 2. Structure that is not adversely affected by water jets from any direction		IP65 equivalent *5)
14	Cleanliness		1,000 or less dust particles of 0.1 μm or over in diameter, which exist in 1 cft (28,317 cm ³) of a sample area. Equivalent to clean class 3 defined by ISO		*5)
15	Power supply capacity				
16	Protection degree (Standard)		IP40		
17	Wiring and Air piping at HAND IO panel (standard)		INPUT 4, OUTPUT 4 / φ4×4		*6)

*1: Speed and acceleration are limited depending on motion patterns, payload mass, and offset value.

*2: Continuous operation of standard cycle motion pattern is not possible beyond the effective load ratio.
Carrying 1kg, Horizontal 300 mm, vertical 25 mm, round-trip, coarse positioning.

*3: One way positioning repeatability when the environment temperature is constant at 20 degrees Celsius. Absolute position accuracy is not ensured.

*4: Painting color may vary depending on the production lot. It does not affect the quality of the product.

*5: In the dust and water proof model and clean room model, packing is inserted between various covers and the housing. In order to maintain each specification, the packing is protruded from the covers, but this does not affect the product quality.

*6: In the dust and water proof model, clean room model and Built-in 3 way solenoid valve model, numbers of wiring and air piping for EOAT (end of arm tooling) is different from standard specification. Please refer to "[7. 5. 2 Dust and Water proof specification / cleanroom specification](#)" and "[7. 5. 4 Built-in 3 way solenoid valve Specification](#)" for detail.



CAUTION

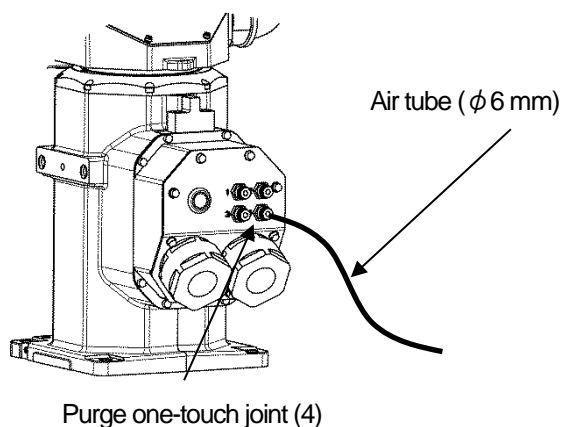
- Vibration may occur depending on the position of the robot or specific speeds. If vibration occurs, decrease the acceleration or change the speed.

2. 2 About Air Purge (dust and water proof specification)

A specified amount of air is supplied from the purge one-touch joint on the connector cover (base rear section) for enabling compliance with the dust and water proof specifications (IP65).

A pressure-reducing valve (prepared by the customer) is set at the pressure from 0.3 MPa to a maximum of 0.58 MPa, and is connected to an air tube.

The air supply is adjusted to around 30 L/min using a speed controller or other device (prepared by the customer). The air supply source and purge air tube ($\phi 6$ mm) should be prepared by the customer.



- Air specifications
- Maximum operating pressure: 0.58 MPa (6 kgf/cm²)
- Tube size: 6 mm (outer diameter)
- Fluid: Clean, dry air not including compressor oil or other substances
Air filtration 10 μ m or less
- Internal pressure air supply: Approx. 30 L/min



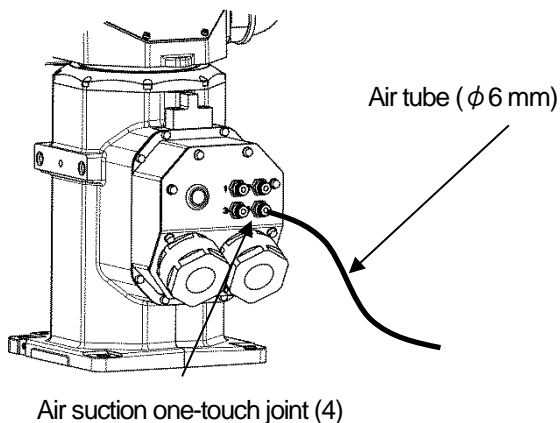
CAUTION

- The ingress of dust can occur if no air purge is applied.
- The controller is not protected against dust and drip.
- Be sure to always use clean, dry air. If dry air is not used, condensation occurs inside the robot, and the moisture accumulates, resulting in electrical leakage or a malfunction.
- Do not apply a pressure exceeding the maximum specified pressure. This can damage the seals and other components of the joints and reduce dust and water proof model performance.

2. 3 About Air Suction (clean room specification)

Clean room specification robot has an internal air suction one-touch joint on the connector cover (base rear section)

By providing air suction at a specified rate from the one-touch joint for suction located on the connector cover (base rear section), protection equivalent to an ISO cleanliness class of 3 is possible. The suction device and suction air tubes ($\phi 6$ mm) must be provided by the customer.



Suction Rate	30 N/min
Equivalent to ISO cleanliness class of 3	<ul style="list-style-type: none"> • 1000 or fewer particles per 1 m³ of air with a size of 0.1 μm or larger

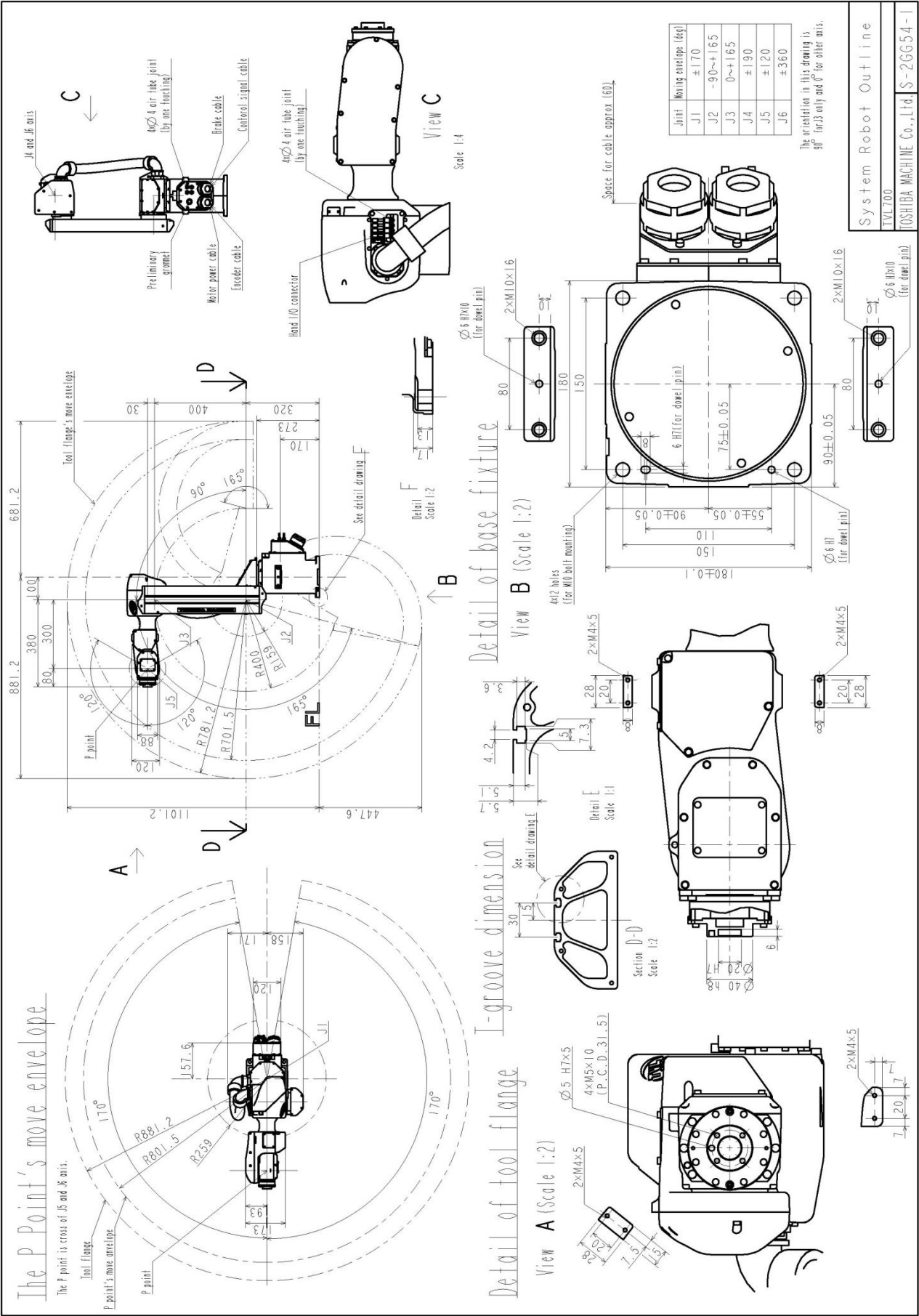


CAUTION

- The clean room must be an environment with a down flow rate of 0.4m/s or higher.
- Failure to perform suction will result in dust.
- The cleanliness level does not apply to the controller.



2. 5 External View of TVL700

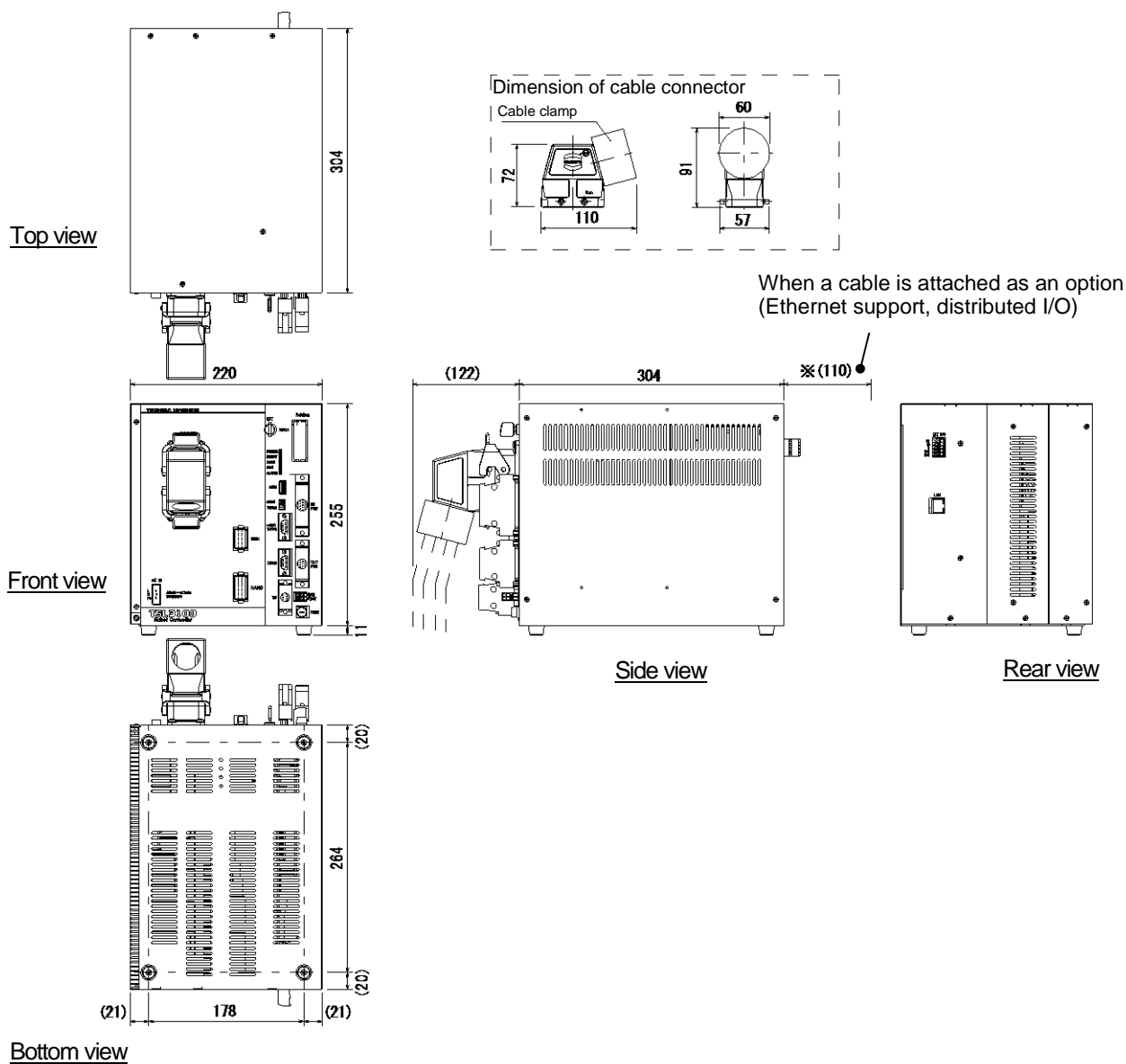


3. Controller Specifications

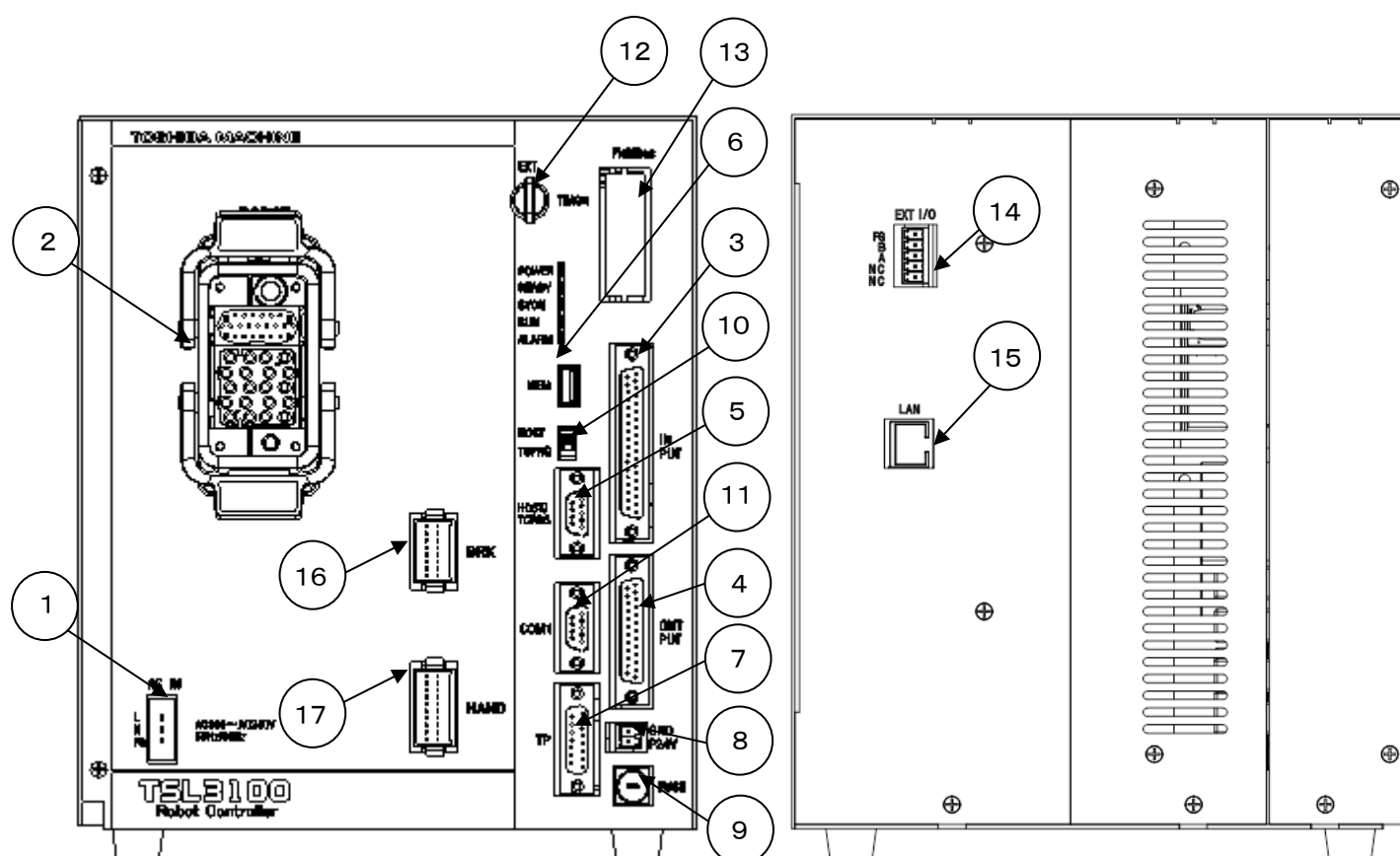
3. 1 Controller TSL3100 Standard Specifications

No	Item		Specification	Remarks
1	No. of controlled axes		No. of simultaneously controlled axes: 6 axes	
2	Motion mode		PTP (point-to-point), CP (continuous path; straight line, circular), short-cut	
3	Servo system		Digital servo	
4	Storage capacity		Total: Approx. 6,400 points + 12,800 steps 1 program: Approx. 2,000 points + 3,000 steps	500K bytes
5	No. of registrable programs		Max. 256 (User file: 247, system file: 9)	
6	Auxiliary memory		USB memory	
7	Storage		Battery backup RAM	
8	Position detection		By absolute encoder	
9	Teaching Method	Teaching points	Remote: To be guided through the teach pendant.	
			Coordinate: Coordinates X, Y, Z, A, B, C, U, V and T are entered through the teach pendant.	
		Program input	Input through the teach pendant.	
10	External input/output signals		8 inputs and 8 outputs	
11	Hand control signal		8 inputs and 8 outputs (In controller front panel) 4 inputs and 4 outputs (In robot HAND I/O panel)	
12	External control signal	Input	Program selection, start, stop, program reset, etc. 13signals in total	
		Output	Servo ON, operation ready, fault, cycle stop, etc. 9 signals in total	
13	Serial communication port		RS232C (1 port): Exclusive for HOST and TCPRG RS232C (1 port): General for COM1 RS-485 (1 port): Exclusive for distribution I/O RS422 (1 port): Exclusive for teach pendant. EtherNet (1 port)	Selection switch changes between HOST and TCPRG
14	Speed setting		Override/speed limit /program command: 1 to 100% each	
15	Acceleration setting		Program command:1 to 100%	
16	Teaching unit		Teach pendant	
17	Coordinate system		World, work, tool, base (Base, work and tool coordinate systems can be set separately.)	
18	Motion limit		Soft limit	
19	Self-diagnostic function		Detection of various errors, etc.	
20	Interruptive function		Start of interruptive program by input signal, timer, etc.	
21	Operation mode		TEACH mode, external auto (I/O), external auto (HOST)	
22	Operation method	Internal operation mode	Continuous, cycle, step, motion step	
		External operation mode	Cycle, continuous	
23	Controller	Outer dimensions	220(W)×266(H)×304(D)	including rubber feet
		Mass	9.0 (kg)	Including option
		Painting color	Black/White	
24	Power supply		Single-phase, 190 to 240V AC, 50/60 Hz	
25	Computer software (TSPC/TSAssist)		Program creation/teaching, remote control, etc.	
26	Program language		SCOL	

3.2 External View of Controller TSL3100 (1)



3. 2 External View of Controller TSL3100 (2)



External interface

1	AC IN	Power supply
2	ROBOT	Robot motor drive cable, robot encoder cable
3	INPUT	External control input signal and universal input signal (8 points)
4	OUTPUT	External control output signal and universal input signal (8 points)
5	HOST/TCPRG	Serial communication port for user/port for sequence program editing
6	MEM	Auxiliary memory port
7	TP	Exclusive serial port for teach pendant
8	External P24V	INPUT/OUTPUT signal external power supply
9	FUSE	INPUT/OUTPUT signal fuse (3A)
10	Connection Change	Switch to select HOST/TCPRG connection
11	COM1	Universal serial communication port
12	Mode Change	Switch to select operating mode and TEACHING/EXT mode
13	Fieldbus	Port for optional fieldbus
14	EXT I/O	Port for distribution I/O cable connection
15	LAN	Port for ethernet
16	BRK	Motor brake control cable
17	HAND	Robot hand control cable

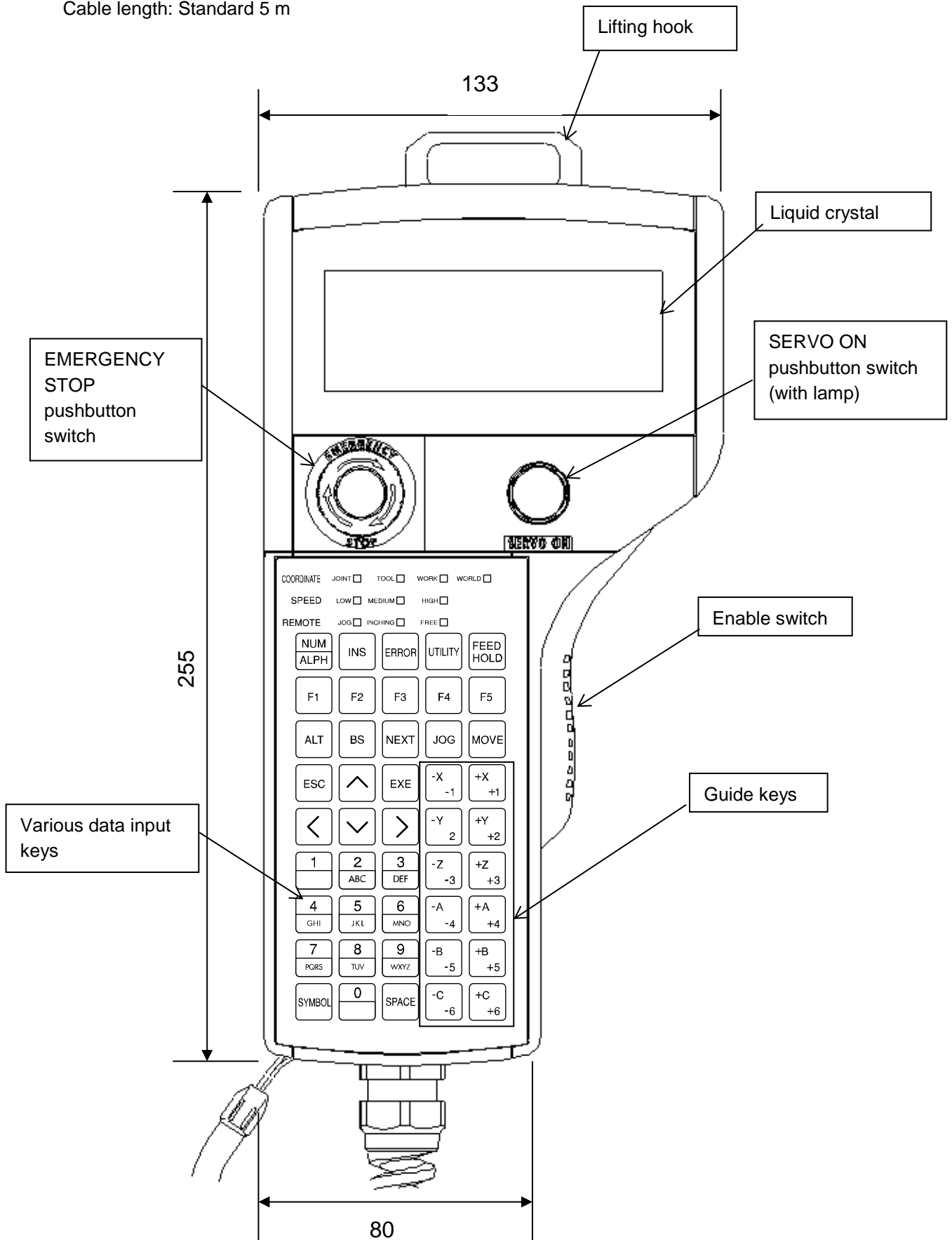
3. 3 Outline Drawing of Teach Pendant 1

Teach Pendant (Model TP1000-6ax)

Body thickness: 48 mm (including EMERGENCY STOP button: 56 mm)

Weight: 600 g (not including cable)

Cable length: Standard 5 m



*This teach pendant can be used together with the TSL3100E and TS3100 (6 axis system).

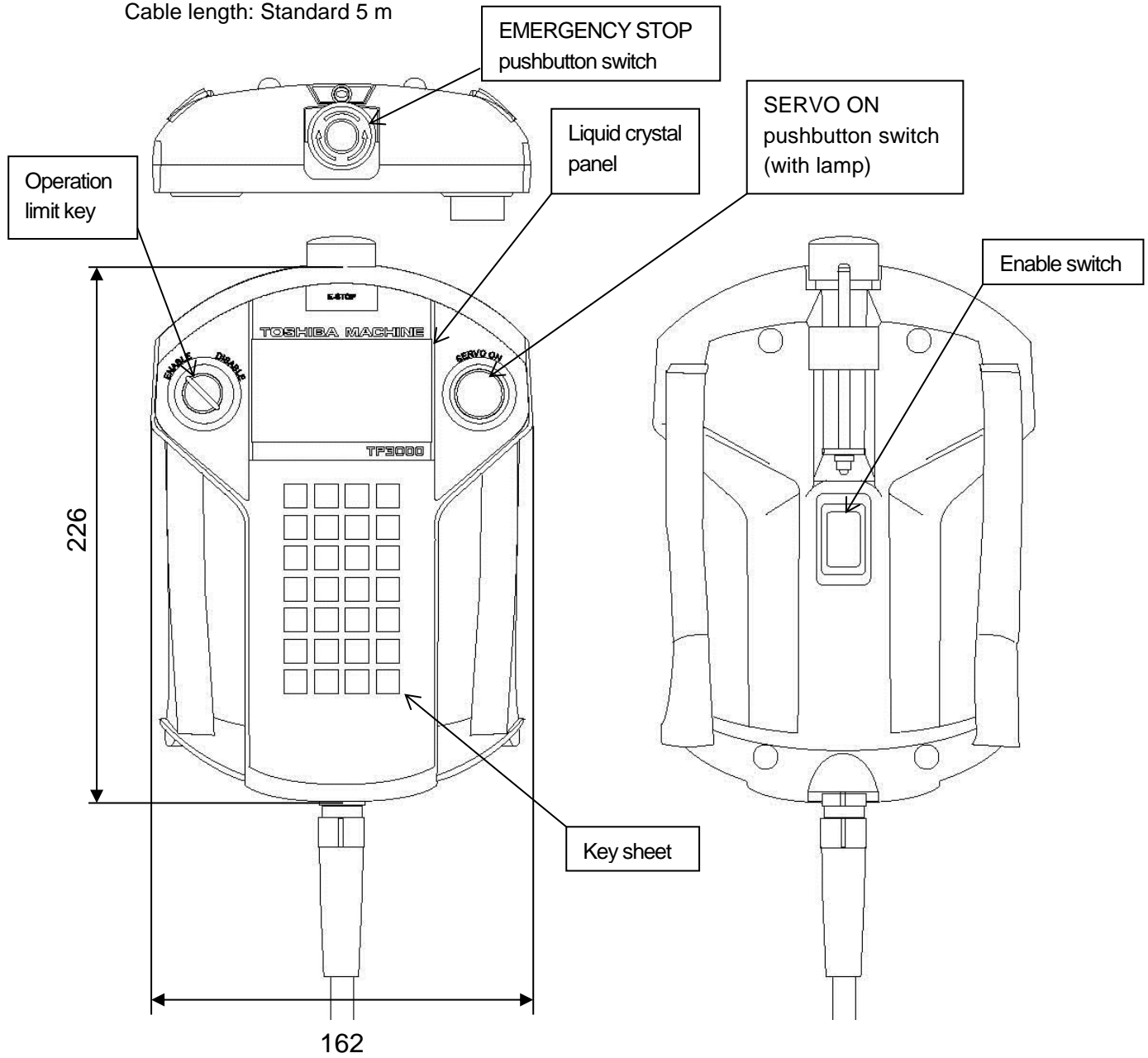
3. 4 Outline Drawing of Teach Pendant 2

Teach Pendant (Model TP3000)

Body thickness: 55 mm (including SERVO ON pushbutton switch)

Weight: 520 g (not including cable)

Cable length: Standard 5 m



1) Software

Item	Data	Remarks
Model	TP3000	
Push-button switch	1 (SERVO ON)	
Key switch	There (2Position) ENABLE/DISABLE	
Screen size	3.4"	
Screen color	Organic EL color	
Keyboard	28 (Variable)	
Data transfer interface	USB 2.0	Maintenance
Data storage media	MicroSD Card	Maintenance
Communication speed	9600~38400 bps	
Safety switch	3-position	
Emergency stop switch	1	
Backlight	There	
Protection class	IP65	IP65 non-cable connectors (D-SUB)
Cable length	Standard: 5m	
Size mm (Thickness / width / length)	226/162/55	
Mass (g)	520g	Except cable

2) Hardware

Item	Data	Remarks
Model	KeTop T20 techno	
Interface	RS422A	
Supply voltage / current	24V/250mA	
Operating temperature range	0~45°	
Impact resistance	Up to 1.5m drop height	
OS	MS Windows Embedded CE 6.0	

4. Permissible Load Specifications

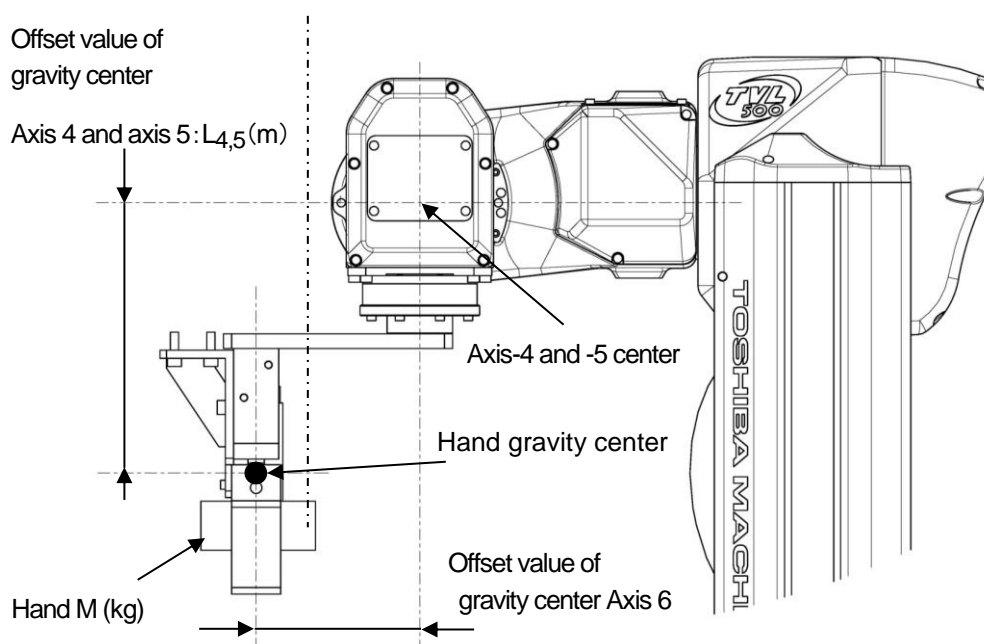
4. 1 Permissible Load Conditions

The robot load conditions are defined by the hand mass, moment of inertia and offset value of hand gravity center from tool flange center.

The permissible load conditions for TVL series are listed below table.

Conditions	Permissible values	
Model	TVL500	TVL700
Mass *1	rated 1kg (Up to 3 kg)	rated 1kg (Up to 5 kg)
Load inertia *2	Axis 4 and axis 5: $0.15 \text{ kg} \cdot \text{m}^2$ Axis 6: $0.2 \text{ kg} \cdot \text{m}^2$	
Offset value of load gravity center *3 (Axis 6)	Up to 100 mm (Load $\leq 3\text{kg}$)	Up to 100 mm (Load $\leq 3\text{kg}$)

- *1 The Maximum speed and acceleration are restricted depending on load conditions by the payload command. Please refer to "4. 2. 1 TVL500 " and "4. 2. 2 TVL700 "for the restriction rate by the payload command.
- *2 Please observe that the inertia of the end effector around the 4th, 5th, and 6th axes of the robot does not exceed each permissible load inertia.
- *3 The center of gravity offset value from the 6th axis should be within 100 mm. If the offset value is large, positioning repeatability may deteriorates or cause vibration. Regarding the 4th and 5th axes, there is no restriction on the offset value of the center of gravity. For the 4th and 5th axes, please observe the permissible load inertia.



In the case of the above figure, the load inertia is calculated as follows.

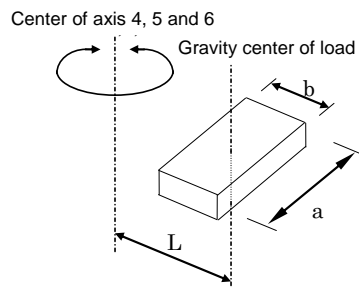
$$\text{Around the 4}^{\text{th}}, 5^{\text{th}} \text{ axis : } J_{4,5}(\text{kg} \cdot \text{m}^2) = M(\text{kg}) \times L_{4,5}^2(\text{m}^2)$$

$$\text{Around the 6}^{\text{th}} \text{ axis : } J_6(\text{kg} \cdot \text{m}^2) = M(\text{kg}) \times L_6^2(\text{m}^2)$$

○ Example of calculate the permissible load inertia

Shown below is a model simplifying the robot and load, and an arithmetic expression of the moment of inertia of the load.

a) Cuboid



L : Distance from axis 4, 5 and 6 center to gravity center of load (m)

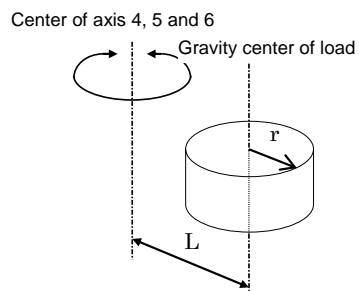
a : Width of load (m)

b : Length of load (m)

M : Mass of load (kg)

$$\text{Moment of inertia (kg}\cdot\text{m}^2) = \frac{M}{12}(a^2 + b^2) + ML^2$$

b) Cylinder



L : Distance from axis 4, 5 and 6 center to gravity center of load (m)

r : Radius of load (m)

M : Mass of load (kg)

$$\text{Moment of inertia (kg}\cdot\text{m}^2) = \frac{M}{2} r^2 + ML^2$$

4. 2 Load conditions and program setting

This robot can automatically change the maximum speed, acceleration/deceleration and servo gain by using the PAYLOAD command in the program according to the load conditions.

Be sure to use the PAYLOAD command.

The PAYLOAD command format is written as shown below if the hand mass is M kg and the gravity center offset is G mm.

PAYLOAD={M, Gx, Gy, Gz}

M : Load mass (kg)

Gx : Offset value of gravity center in X direction (unit: mm)

Gy : Offset value of gravity center in Y direction (unit: mm)

Gz : Offset value of gravity center in Z direction (unit: mm)

The PAYLOAD command has the following functions.

The maximum speed and acceleration/deceleration of each robot axis are automatically changed according to the set load conditions.

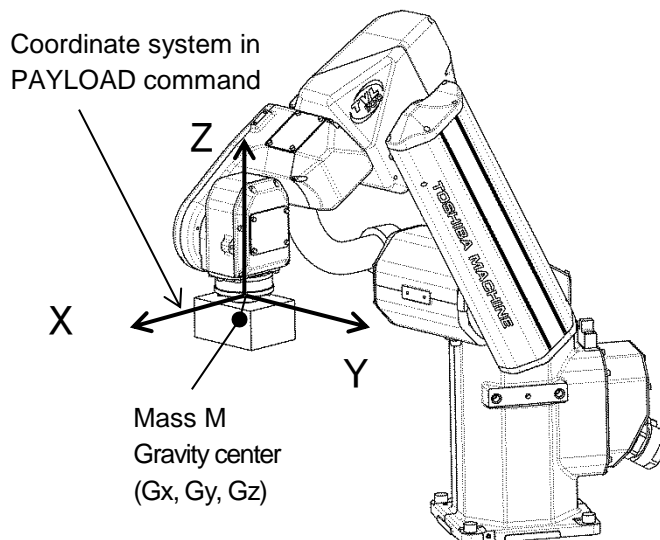
The servo gain of each robot axis is automatically changed according to the set load conditions.

When the PAYLOAD command is executed, the value of (L) is calculated and the maximum speed and acceleration for each axis are restricted

Example)

$$\text{Axis 1 to axis 5} \quad L = \sqrt{G_x^2 + G_y^2 + G_z^2}$$

$$\text{Axis 6} \quad L = \sqrt{G_x^2 + G_y^2}$$



CAUTION

- Be sure to use the PAYLOAD command.
- Unless the PAYLOAD command is used, the robot will vibrate or overshoot, resulting in malfunction or shortening of the life of the mechanisms. In the worst case, the mechanism will be damaged.
- Even when the PAYLOAD command is used, adjust the speed by using the SPEED or DECEL command while confirming the behavior of workpieces to be handled.
- Micro vibration may occur depending on the posture of the robot. If micro vibration occurs, decrease the speed and decelerate the robot.

**CAUTION**

- The load moment of inertia should be with the tolerances given in section "[4. 1 Permissible Load Conditions](#)".
- Even if there is no offset of load gravity center, when the moment of inertia is large, the robot may vibrate. When this happens, figure out the virtual gravity center offset (G mm) from the following equation, using the moment of inertia (J kg·m²) and mass (M kg).

$$G = \sqrt{\frac{J \times 10^6}{M}}$$

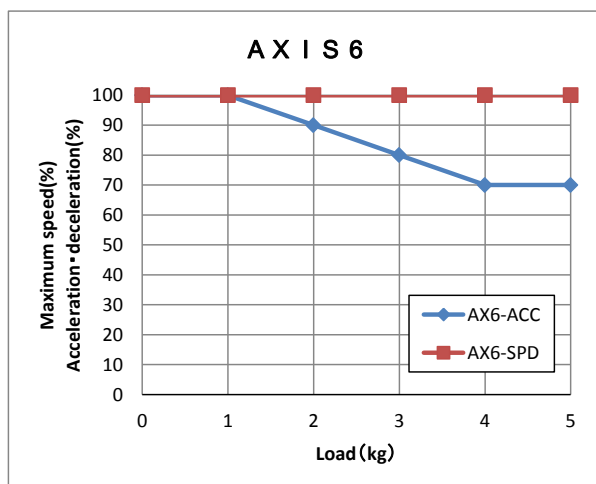
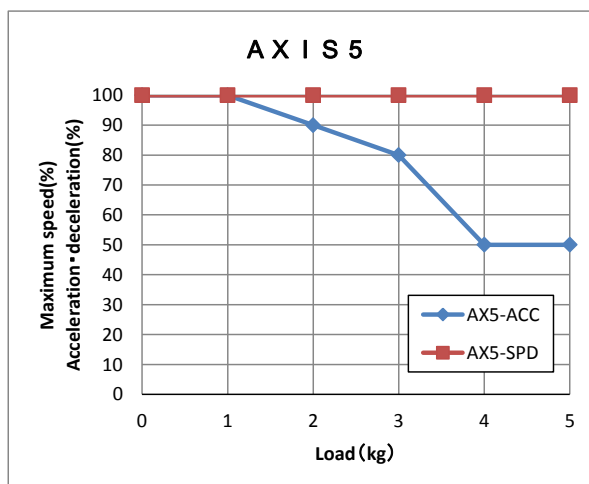
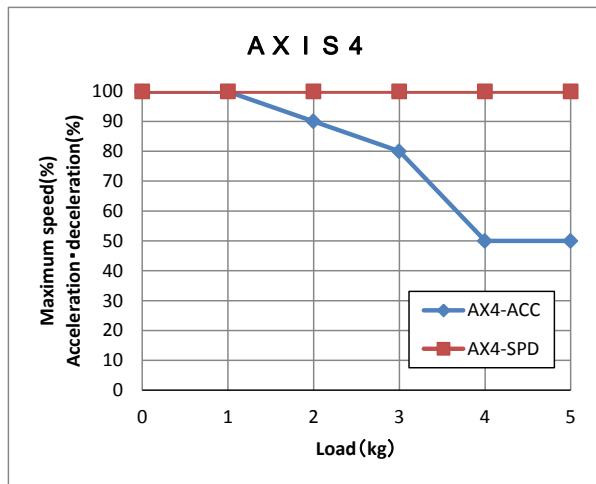
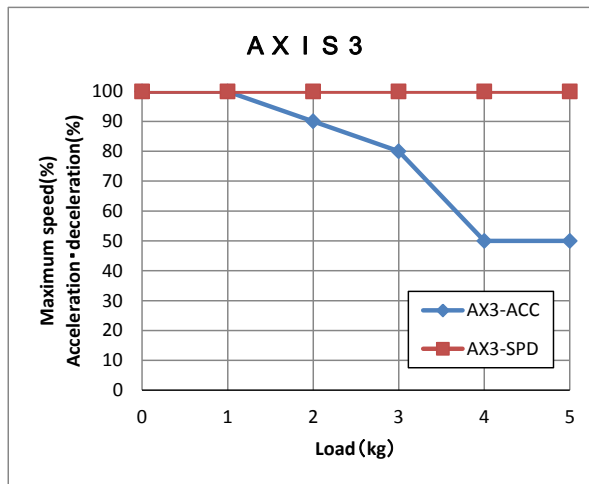
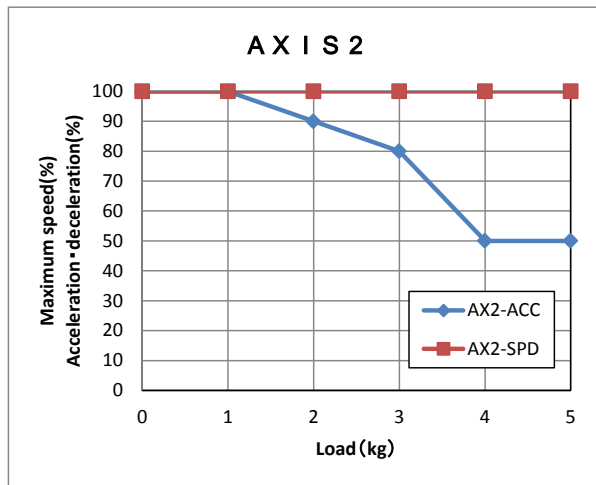
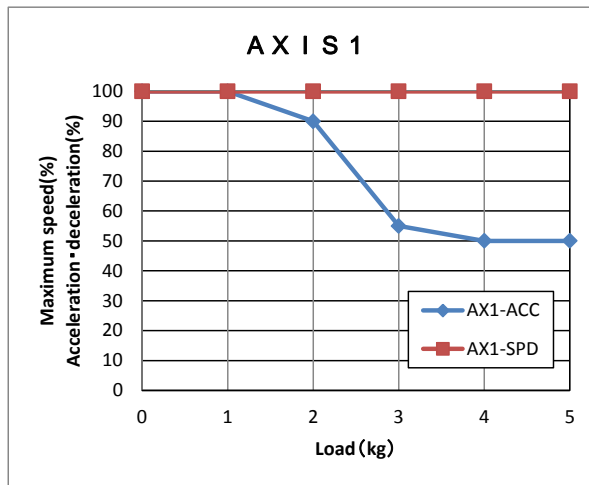
Then, designate the following command.

PAYLOAD={M, G, 0, 0}

4. 2. 1 TVL500

a) If there is no offset

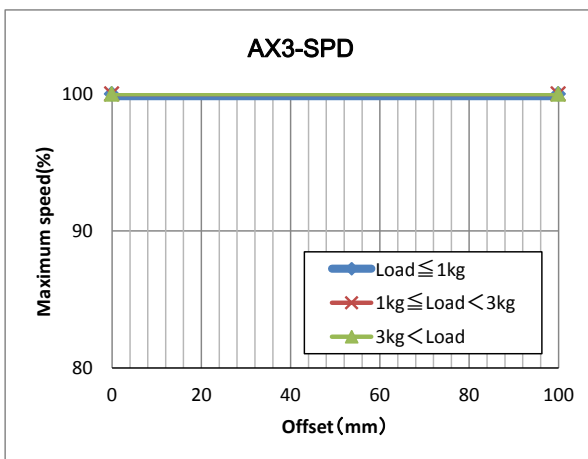
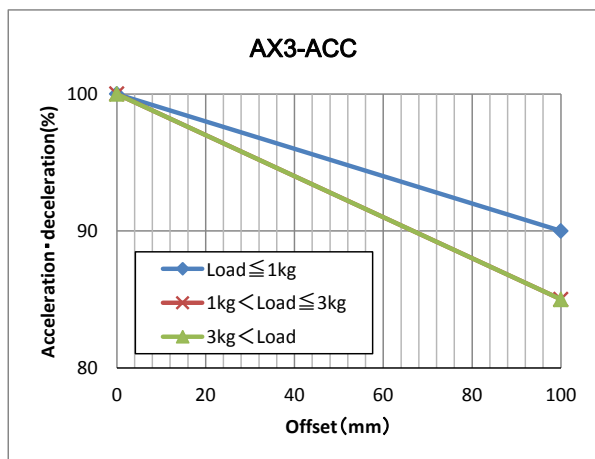
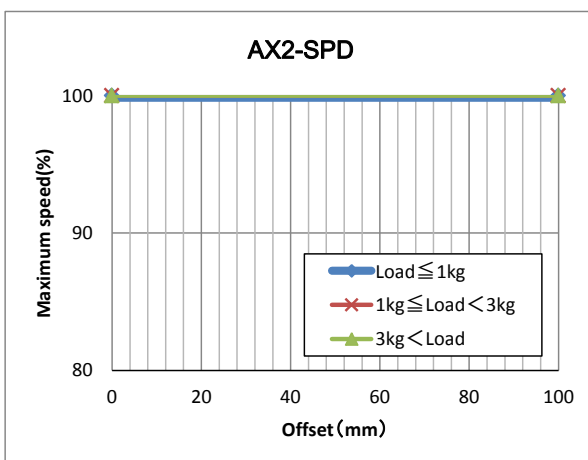
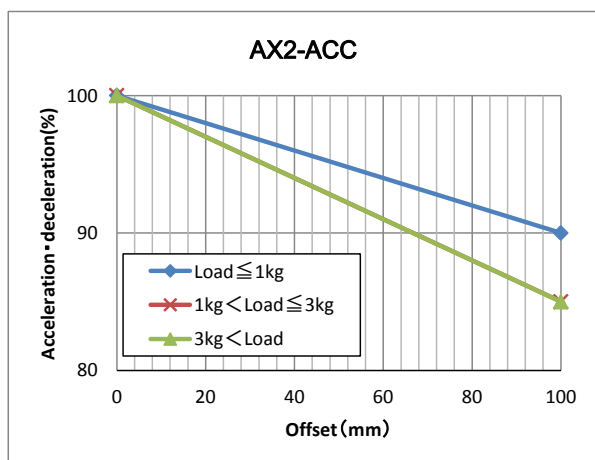
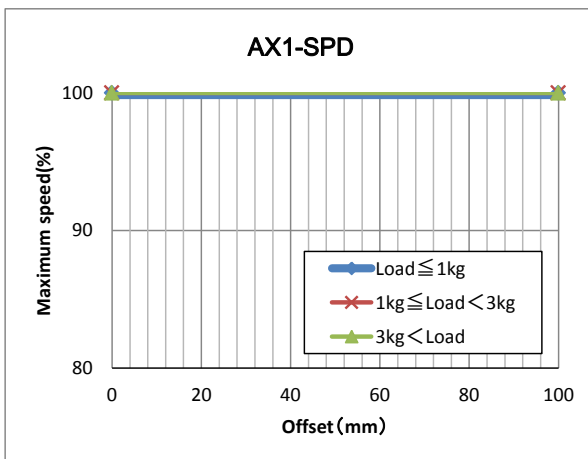
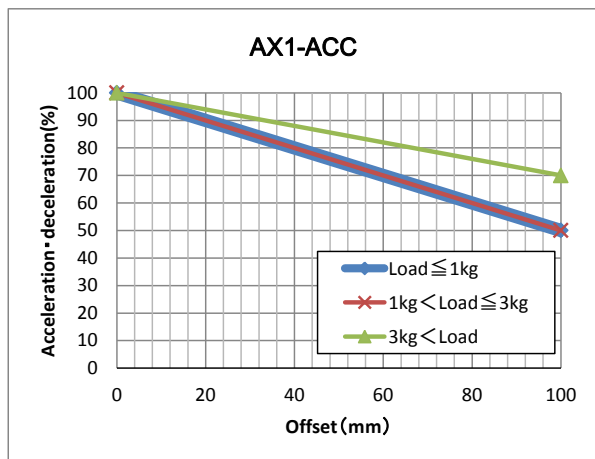
If there is no offset of load, the acceleration is limited by the load mass. The mass of load must be 3kg (Downward:5kg) or less. The figures below show the permissible load conditions where there is no offset.

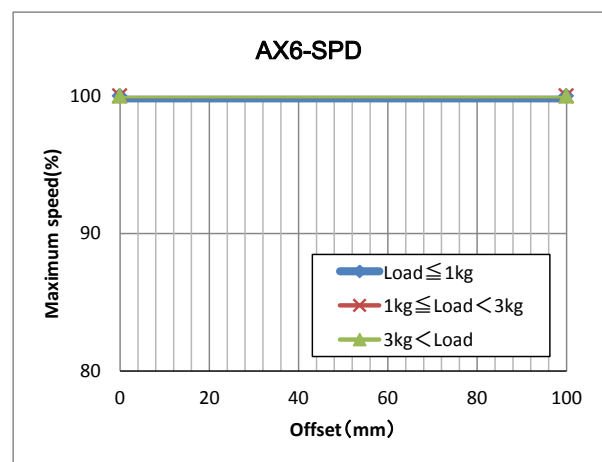
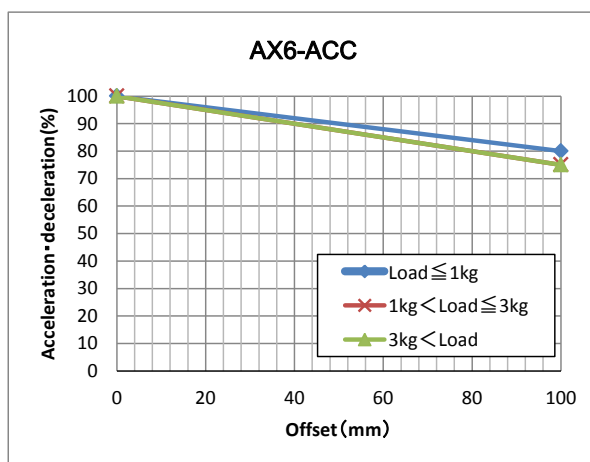
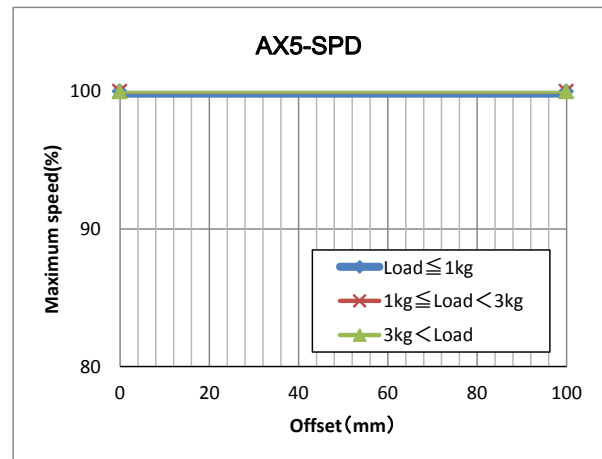
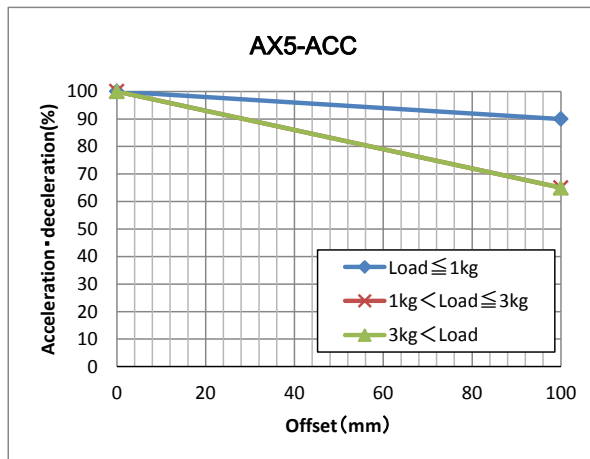
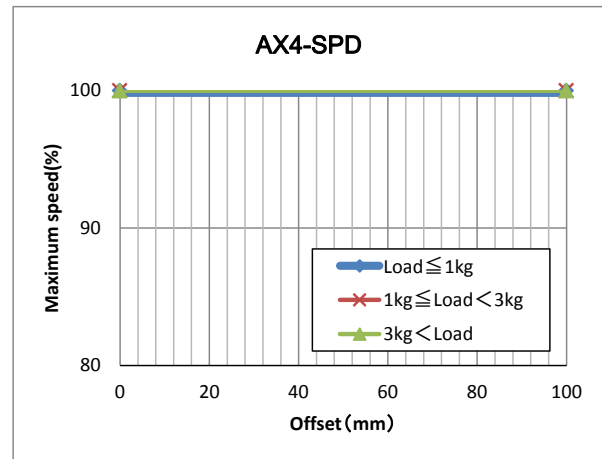
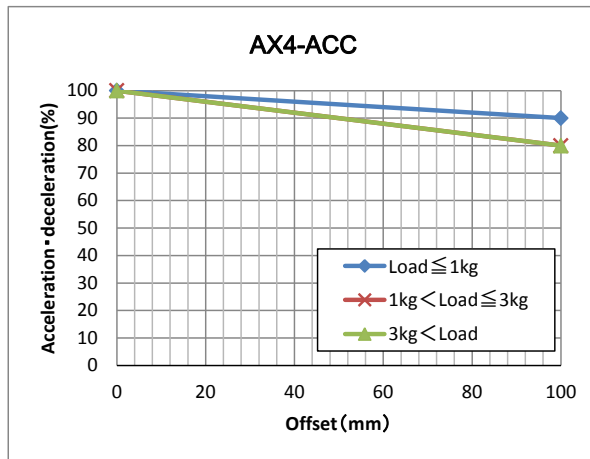


b) If there is an offset

If there is an offset of load, the acceleration set by the load mass in a) is further limited by the offset value.

The offset value of load must be 100 mm or less at 3kg (Downward: 5kg) or less. The figures below show the decrease rate of acceleration associated with the offset value.

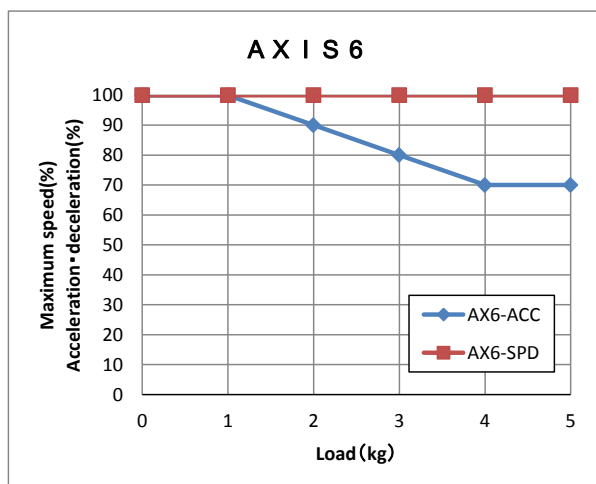
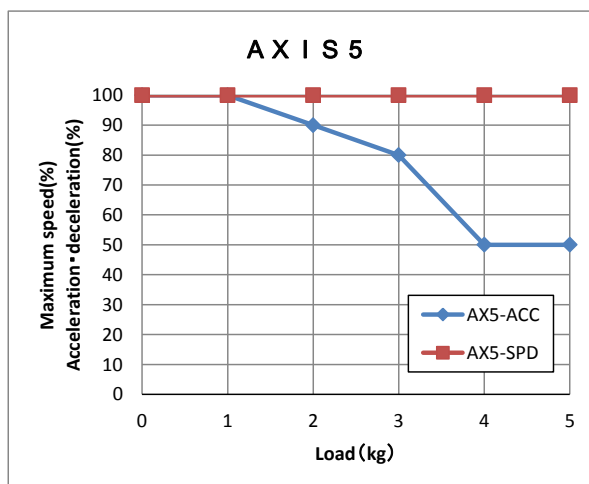
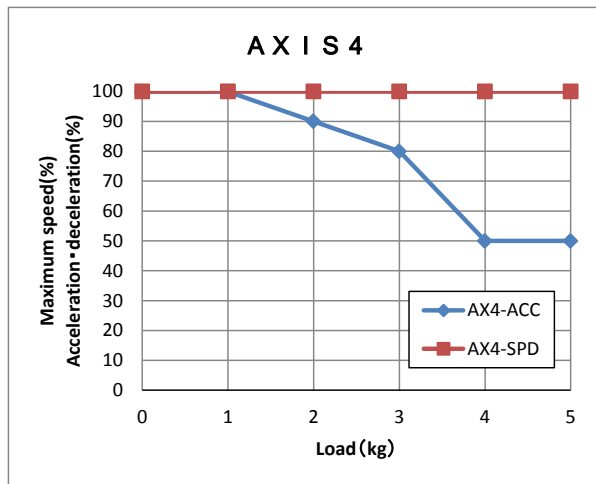
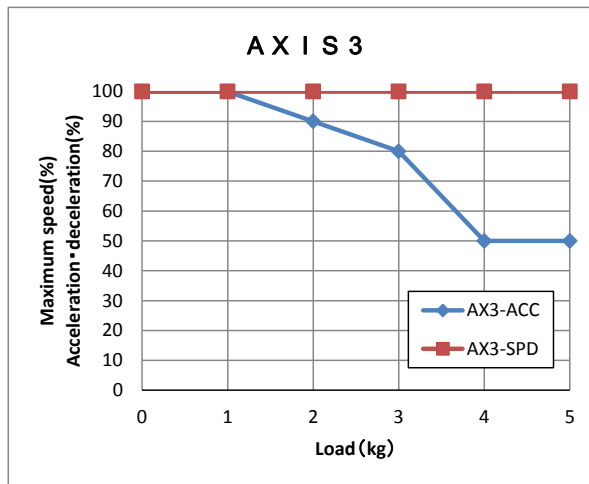
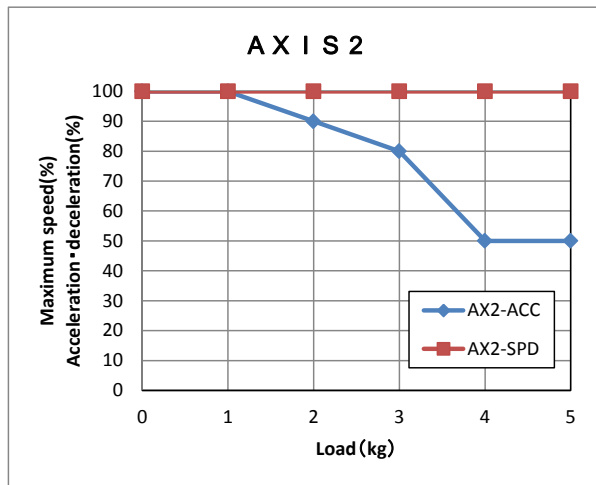
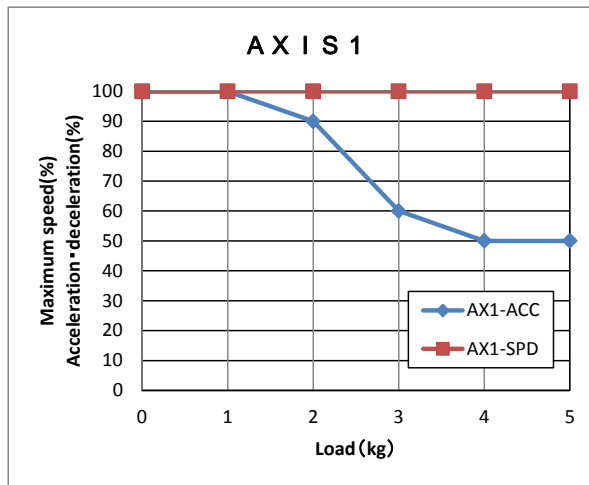




4. 2. 2 TVL700

a) If there is no offset

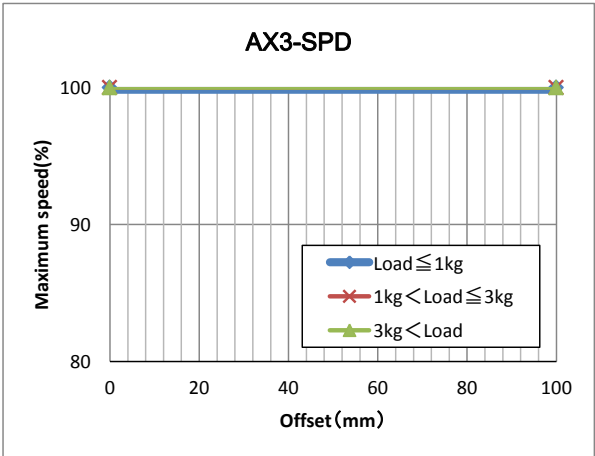
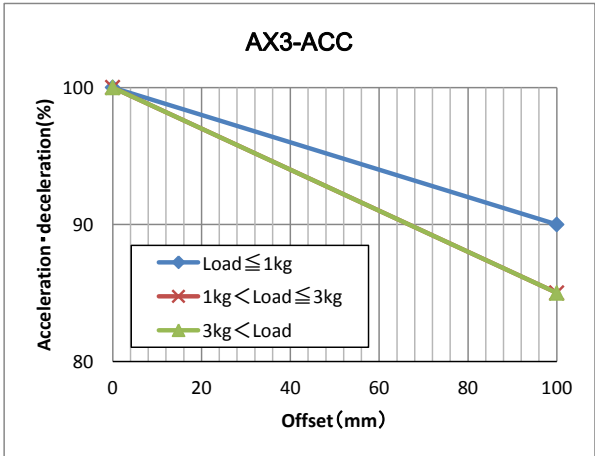
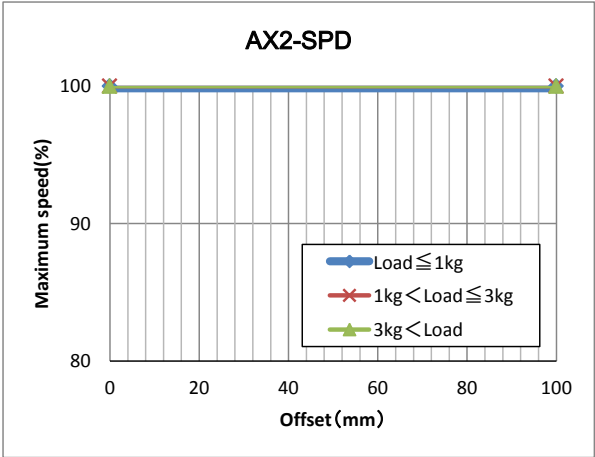
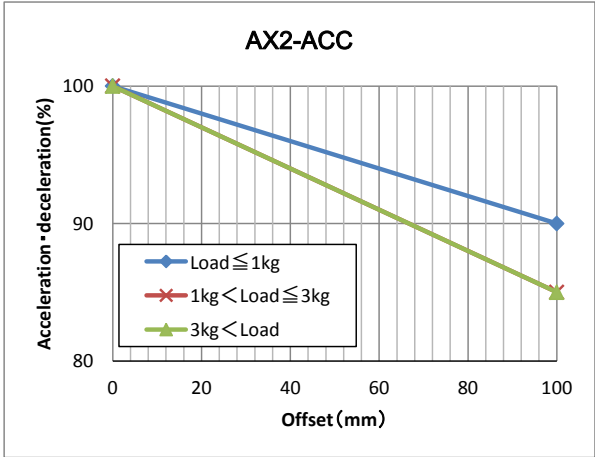
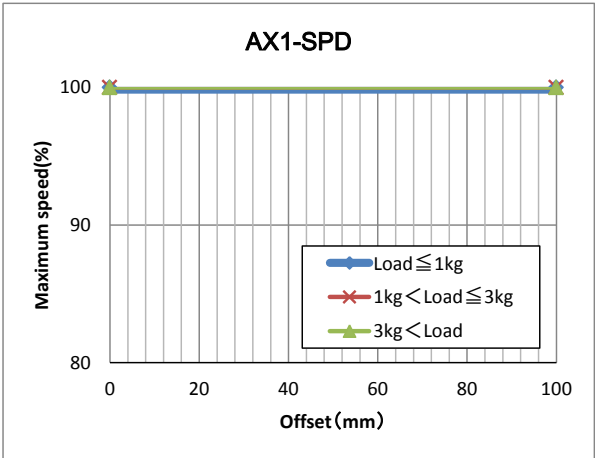
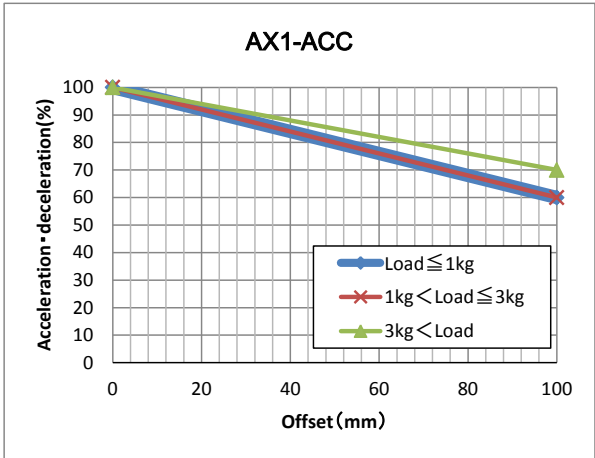
If there is no offset of load, the acceleration is limited by the load mass. The mass of load must be 4kg (Downward:5kg) or less. The figures below show the permissible load conditions where there is no offset.

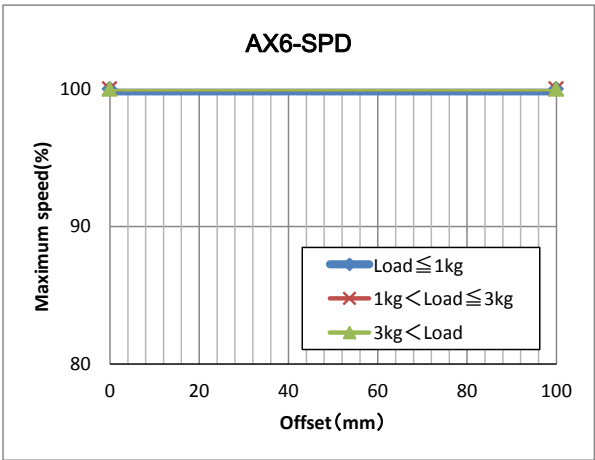
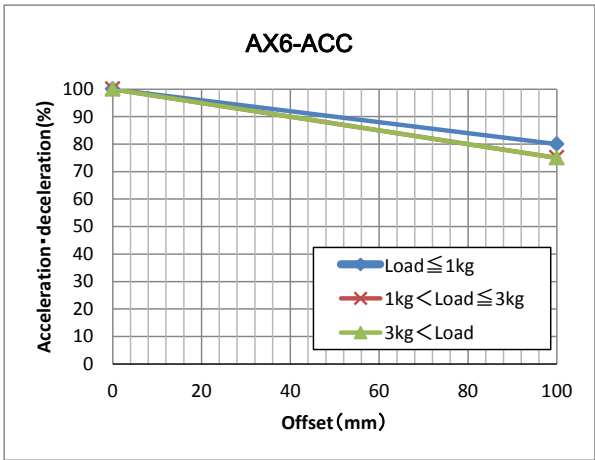
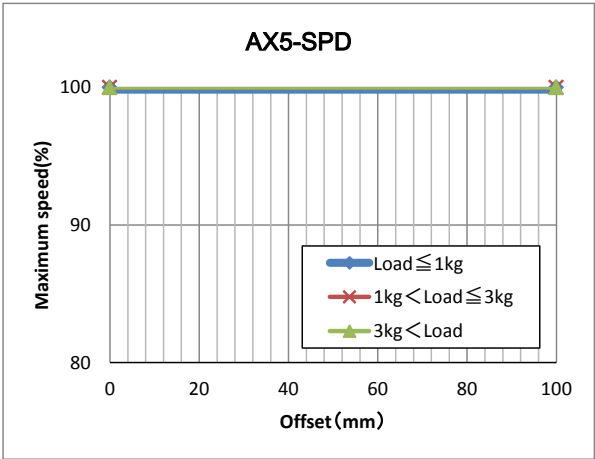
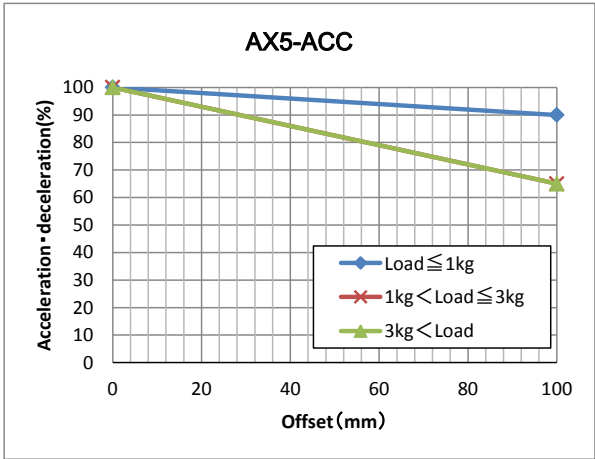
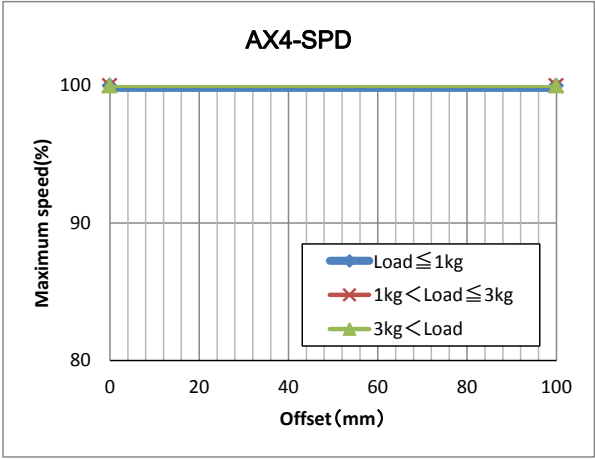
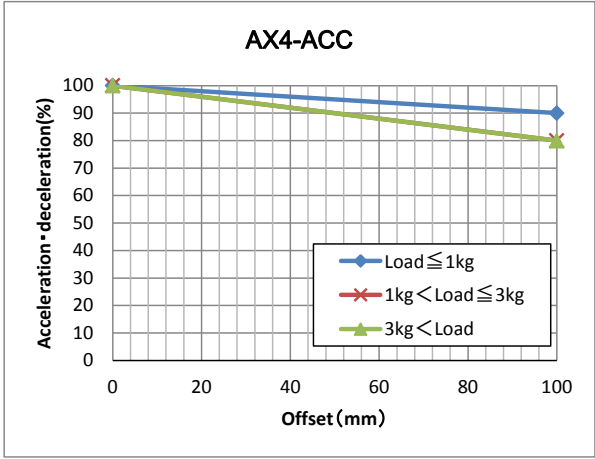


b) If there is an offset

If there is an offset of load, the acceleration set by the load mass in a) is further limited by the offset value.

The offset value of load must be 100 mm or less at 3kg (Downward: 5kg) or less. The figures below show the decrease rate of acceleration associated with the offset value.





5. General Specifications

a) Applicable standards

In principle, material, design and test of the equipment stipulated in these specifications shall be pursuant to the JIS, JEC and JEM standards.

b) Environmental conditions

Ambient temperature

operating temperature: 0 to 35°C *1

Temperature under transport and storage: -20 to 55°C

Humidity: 20 to 80 % (non-condensing)

Height above sea level: 1,000 m or less

Vibration: 0.98 m/s² or less

Dust: No conductive contaminant shall be contained.

Gas: No corrosive or flammable gas shall be contained.

Magnetic field: A magnetic source shall not exist nearby.

Surrounding environment: No iron powder, oil, or organic solvent shall be contained. *2

*1: If the robot is used in a place where the temperature rises to 35°C or more, pay special attention to the ambient temperature when the robot is operating. Consider the cooling of the robot body as needed. Please ask us for the cooling of the robot.

*2: In the case of dust and water proof model (option), it can be used in an environment equivalent to IP65. However, since the controller does not perform special dustproofing and waterproofing, please store it in a dustproof and waterproof case according to the usage environment.

c) In-house test

We carry out severe in-house inspection on all finished products.

d) Power supply, etc.

Power supply: Single phase, 190 to 240V AC, 50/60 Hz \pm 1 Hz

Instantaneous power failure: Within 2 cycles

Grounding: D-class grounding (ground resistance of 100 Ω or less)

e) Installation, piping and wiring

If the work of installation, piping and wiring is required, it shall be decided at a separate meeting.

f) Site adjustment and teaching

If the site adjustment and teaching are required, they shall be decided at a separate meeting.

If they are to be executed by Toshiba Machine, we will dispatch an experienced engineer or engineers.

Then, the customer shall provide test work pieces, parts, material, power, etc., required for the operation and adjustment of the robot system by an operator, and secure an all-out cooperative relationship with the equipment furnished by Toshiba Machine.

g) Acceptance

When visual appearance and quantities of the equipment delivered to the customer as described in these specifications have been tested, the equipment shall be regarded as having been accepted finally by the customer.

h) Warranty

1. Warranty period

Toshiba Machine agrees to repair or replace as necessary all defective material or workmanship up to the period shown below, whichever comes first.

Eighteen (18) months from the date of dispatch from our plant.

Twelve (12) months from the date of machine installation at customer's job site.

2,400 running hours from the date of initial machine operation.

2. Contents of warranty

- Only the product delivered to the customer is subject to Toshiba Machine's Guarantee. Such Guarantee covers the specifications and functions as defined in the product specifications manual, catalog, instruction manual, etc. Toshiba Machine will not be liable for any secondary or incidental damage that occurs as a result of a failure in this product.
- Toshiba Machine repairs the product free of charge only when it has malfunctioned after handling or use according to the instruction manual attached to the product within the specified warranty period.

3. Exemption from responsibility

Toshiba Machine's Guarantee shall not cover the following cases.

- Incorrect use not described in the instruction manual, and trouble or damage caused by negligent use.
- Inconvenience caused by aged deterioration or long-term usage (natural fading of coating or painting, deterioration of consumable parts *2 etc.).
- Inconvenience caused by sensuous phenomena (noise generation, etc. which will not affect the function).
- Remodeling or disassembly which Toshiba Machine does not permit.
- Trouble and damage caused by insufficient maintenance/inspection or improper repair.
- Trouble and damage caused by disaster, fire or other external factor.
- Internal data such as program and point which were created by the customer.

*2 Consumable parts: Backup battery for encoder battery, harness for the robot

4. Precautions

- Unless the robot was used pursuant to its specifications, Toshiba Machine will not guarantee the basic performance of the robot.
- If the customer did not observe the warnings and cautions described in this manual, Toshiba Machine will not assume the responsibility for any consequential accident resulting in injury or death, damage or trouble.
- Please note that the warnings, cautions and other descriptions stipulated in this manual are only those which can be assumed by Toshiba Machine as of now.

i) Others

When matters that are not mentioned in this specifications or change of specification are required, it shall be determined in consultation.

6. Robot Language SCOL

Type	Command	Purpose
Movement control commands	BREAK CLOSE1, CLOSE2 CLOSEI1 CLOSEI2 DELAY MOVE MOVES MOVEC MOVEA MOVEI OPEN1, OPEN2 OPENI1, OPENI2 PAUSE READY RESUME	Suspends movement immediately. Closes hand after completion of movement. Closes hand. Closes hand. Pauses for specified time. Synchronous movement. Linear interpolation movement. Circular interpolation movement. Absolute single axis movement. Relative single axis movement. Opens hand after completion of movement. Opens hand. Suspends a movement. Moves to machine coordinate origin. Restarts an interrupted movement.
Program control commands	FOR ~ TO ~ STEP ~ GOTO GOTO () IGNORE IF ~ THEN ~ ELSE ~ NEXT ON ~ DO ~ PROGRAM RCYCLE RETURN STOP WAIT	Repeats an operation. Branches unconditionally. Branches in accordance with the value of an expression. Cancels monitoring. Judges conditions. Repeats an operation. Registers conditions monitor. Marks beginning of program. Label for cycle reset. Returns to main program. Stops the program. Waits for establishment of conditions.
Program control commands	END KILL MAXTASK REMARK SWITCH TASK TID	End of program. Task standstill. Maximum number of tasks. Comments. Task change-over. Task start. Task ID.
I/O control commands	BCDIN BCDOUT CR DIN DOUT HEXIN HEXOUT PULOUT RESET PRINT INPUT	Inputs a BCD signal. Outputs a BCD signal. Outputs a CR code. Reads an input signal. Outputs a signal. Reads signals in hexadecimal notation. Outputs signals in hexadecimal notation. Outputs a pulse signal. Resets the controller. Outputs communication data. Inputs communication data.

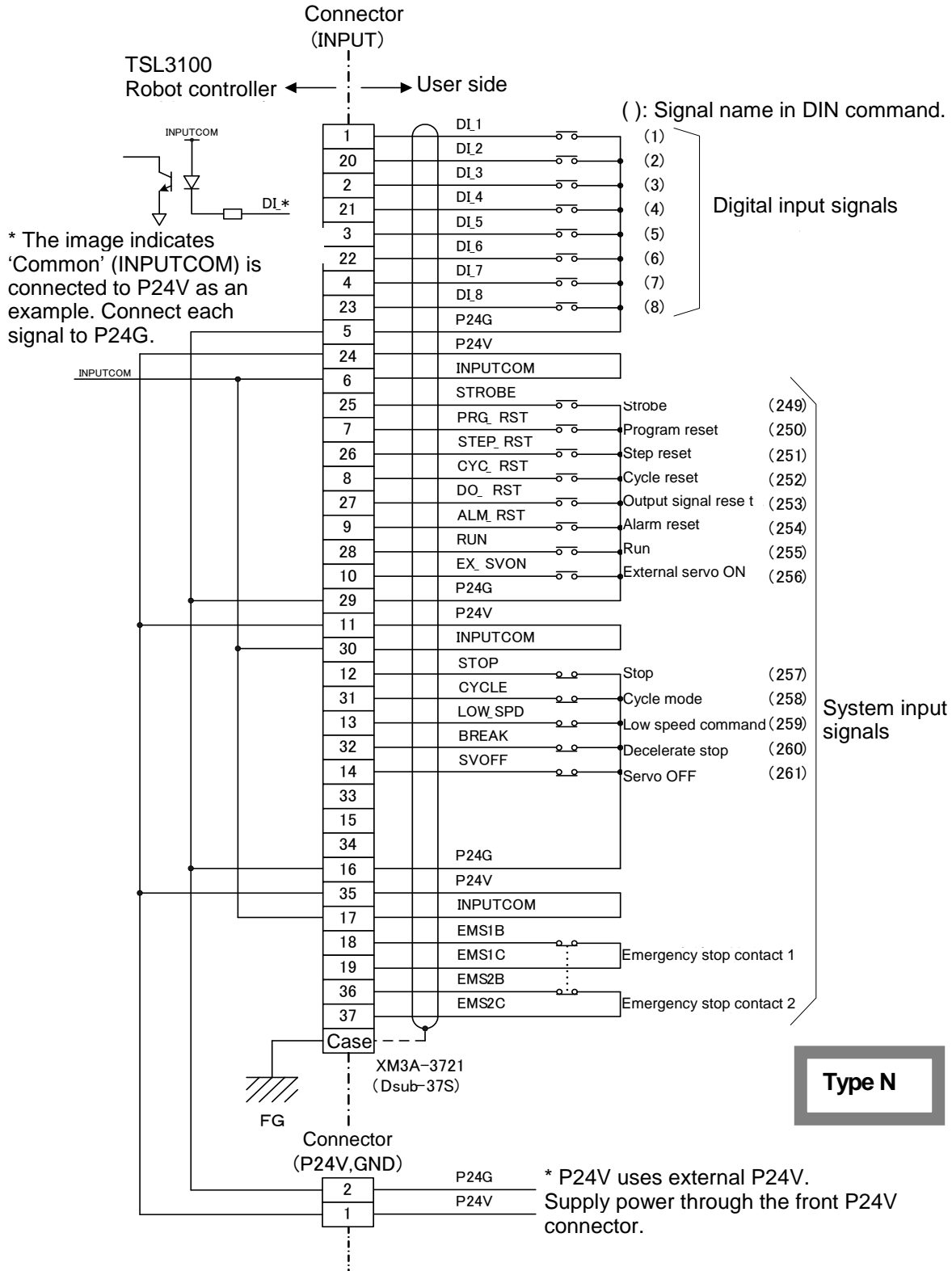
Type	Command	Purpose
Movement condition commands	ACCEL ACCUR ACTACL CONFIG DECEL DISABLE ENABLE NOWAIT PASS PAYLOAD SMOOTH (option) SPEED MOVESYNC SWITCH WITH	Specifies acceleration (during acceleration). Specifies positioning accuracy. Active acceleration/deceleration control Specifies configuration. Specifies acceleration (during deceleration). System switches off. System switches on. Does not wait for the completion of positioning for previous movement. Short-cut movement parameter. Sets load data. Smooth movement. Specifies speed. Specifies movement command synchronization/unsynchronization mode. Prohibits or allows task change-over. Specifies operating conditions.
Calculator commands	COS SIN TAN ABS ACOS AND ASIN ATAN ATAN2 DEST EXP HERE INT LN LOG10 MOD NOT OR POINT REAL SGN SQRT TRANS	Cosine. Sine. Tangent. Absolute value. Arccosine. Logical product. Arcsine. Arctangent. Arctangent. Destination position. Exponent to power e. Present position. Changes number to an integer. Natural logarithm. Common logarithm. Remainder. Negation. Logical sum. Creates positional type data. Changes number to a real number. Extracts and returns the sign. Square root. Creates coordinate type data.
Movement reference commands	BASE MODE MOTION MOTIONT REMAIN REMAINT TIMER TOOL WORK	Base coordinate system. System operating mode. Amount of movement which has been executed. Time expended for a motion. Amount of movement remaining to be executed. Time remaining for a motion. Timer. Tool coordinate system. Work coordinate system.

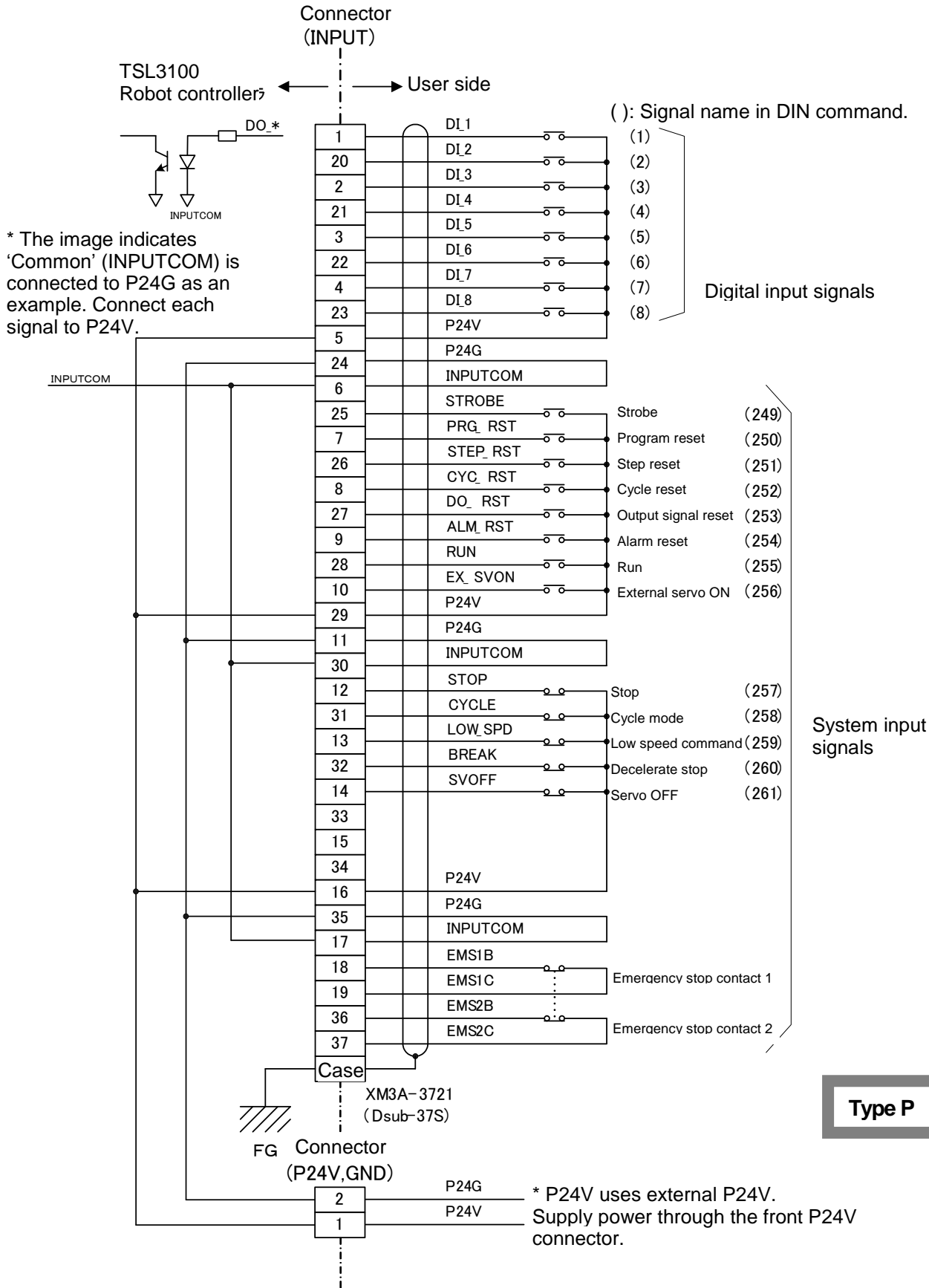
Type	Command	Purpose
Data definition commands	DATA DIM ~ AS GLOBAL RESTORE SAVEEND	Starts data definition. Array variable definition. Global variable definition. Saves an initial value of the global variable to a file. Saves data at power OFF.
Palletize command	INITPLT MOVEPLT	Initializes a pallet. Moves to pallet specified position.
System constants	COARSE ABOVE BELOW COM0, TP COM1 CONT CYCLE DBLE4 DBLE6 FINE FLIP FREE LEFTY NFLIP PAI RIGHTY SEGMENT SNGL4 SNGL6	Coarse positioning accuracy. Upper elbow non-flip configuration Upper elbow flip configuration Communication channel (teach pendant). Communication channel 1. Continuous operation mode. Cycle operation mode. 4-axis configuration (180° ≤ 4axis angle absolute position < 360°) 6-axis configuration (180° ≤ 6axis angle absolute position < 360°) Fine positioning accuracy. Wrist flip configuration Undefined configuration. Left hand configuration. Wrist non-flip configuration Pi. Right hand configuration. Segment operation mode. 4-axis configuration (absolute position of 4-axis angle < 180°) 6-axis configuration (absolute position of 6-axis angle < 180°)
Simplified PLC	PLCDATAR 1 ~ 8 PLCDATAW 1 ~ 8	Simplified PLC interface. Simplified PLC interface.
Mathematical symbols	^ - *, / +, - = == < >, > < < > < =, = < > =, = > ,	Exponentiation. Negative sign. Multiplication and division. Addition and subtraction. Substitution. Equal. Not equal. Less than. Greater than. Less than or equal. Greater than or equal. Comments.

7. External Interface

7.1 External Input Signals

Non-voltage contact specifications		Transistor specifications	
Contact rating	24V DC, 10 mA or more	Collector to emitter resistance	30V or more
Circuit current	Approximately 7 mA	Collector to emitter voltage	10 mA or more
Minimum current	24V DC, 1 mA	Collector to emitter	Leakage current 100 μ A or less
Contact impedance	100 Ω or less		





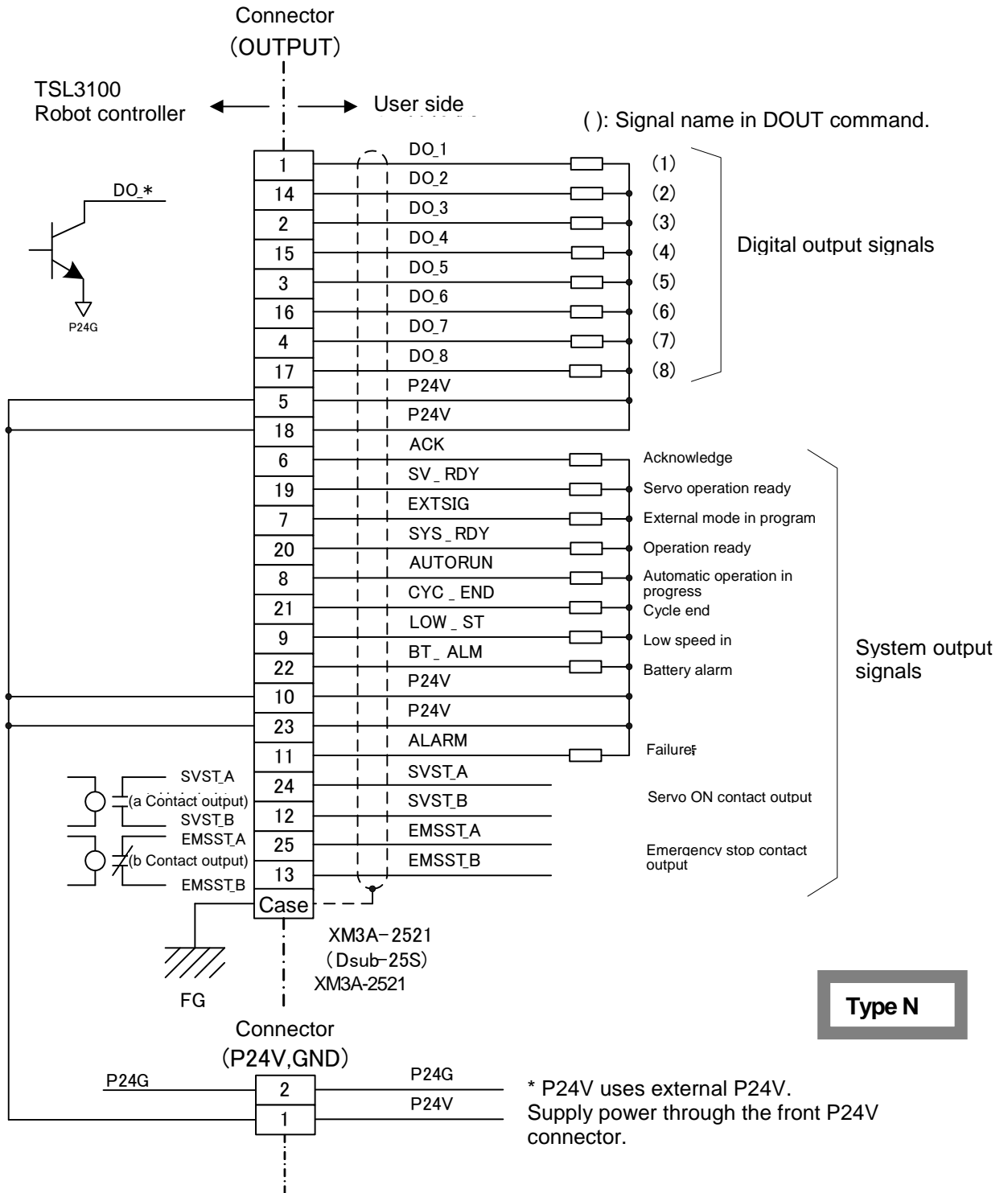
7. 2 External Output Signals

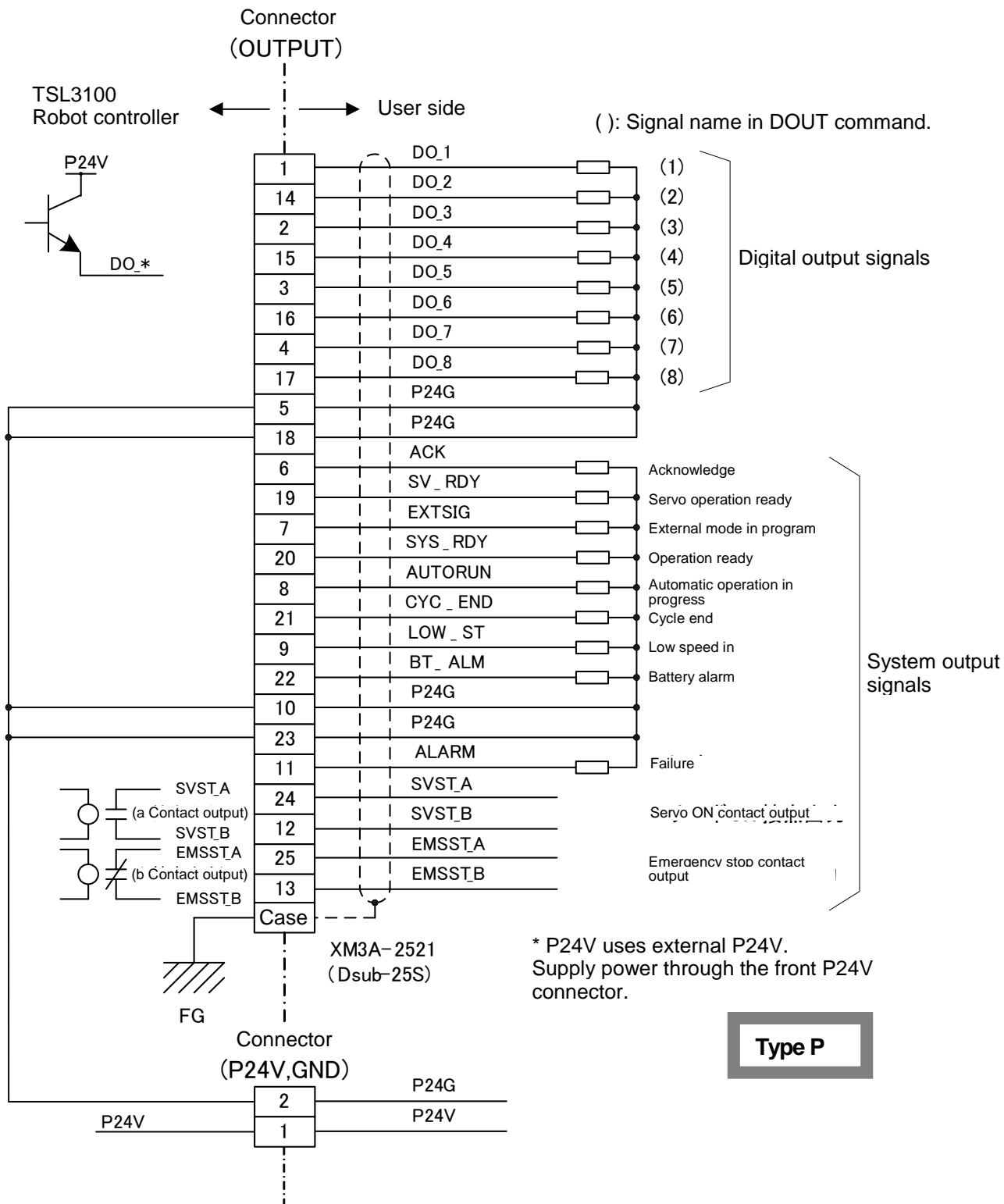
Transistor specifications

Rated voltage: 24V DC, rated current: 100 mA MAX

Relay contact specifications

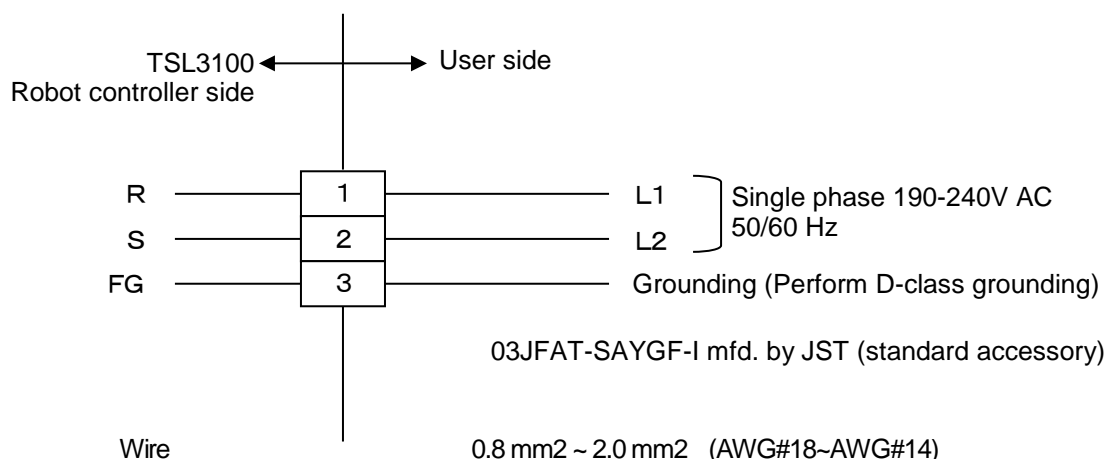
Maximum rating: 125V AC 0.5A MAX, 60V DC 1.0A MAX





7. 3 Power Supply

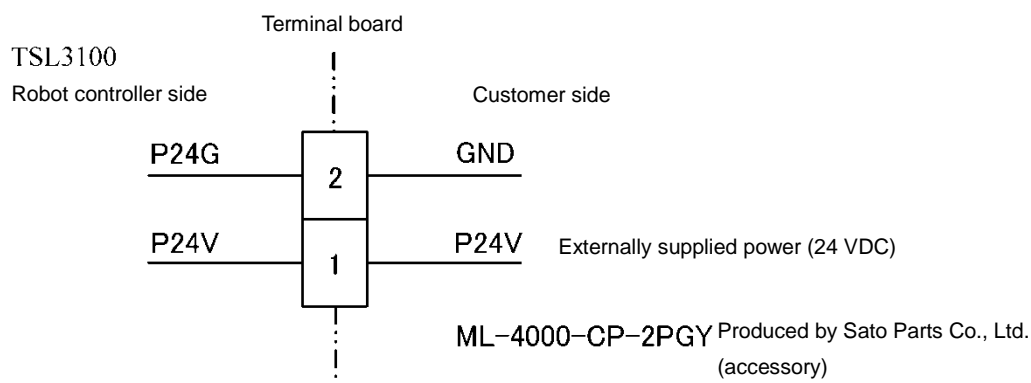
7. 3. 1 Power Supply



7. 3. 2 External Power Supply

Shown below are the input/output signals that use the externally supplied power (24 VDC). Be sure to supply external power (24 VDC).

- External input/output
- External operation input/output
- Extended input/output
- Hand input/output

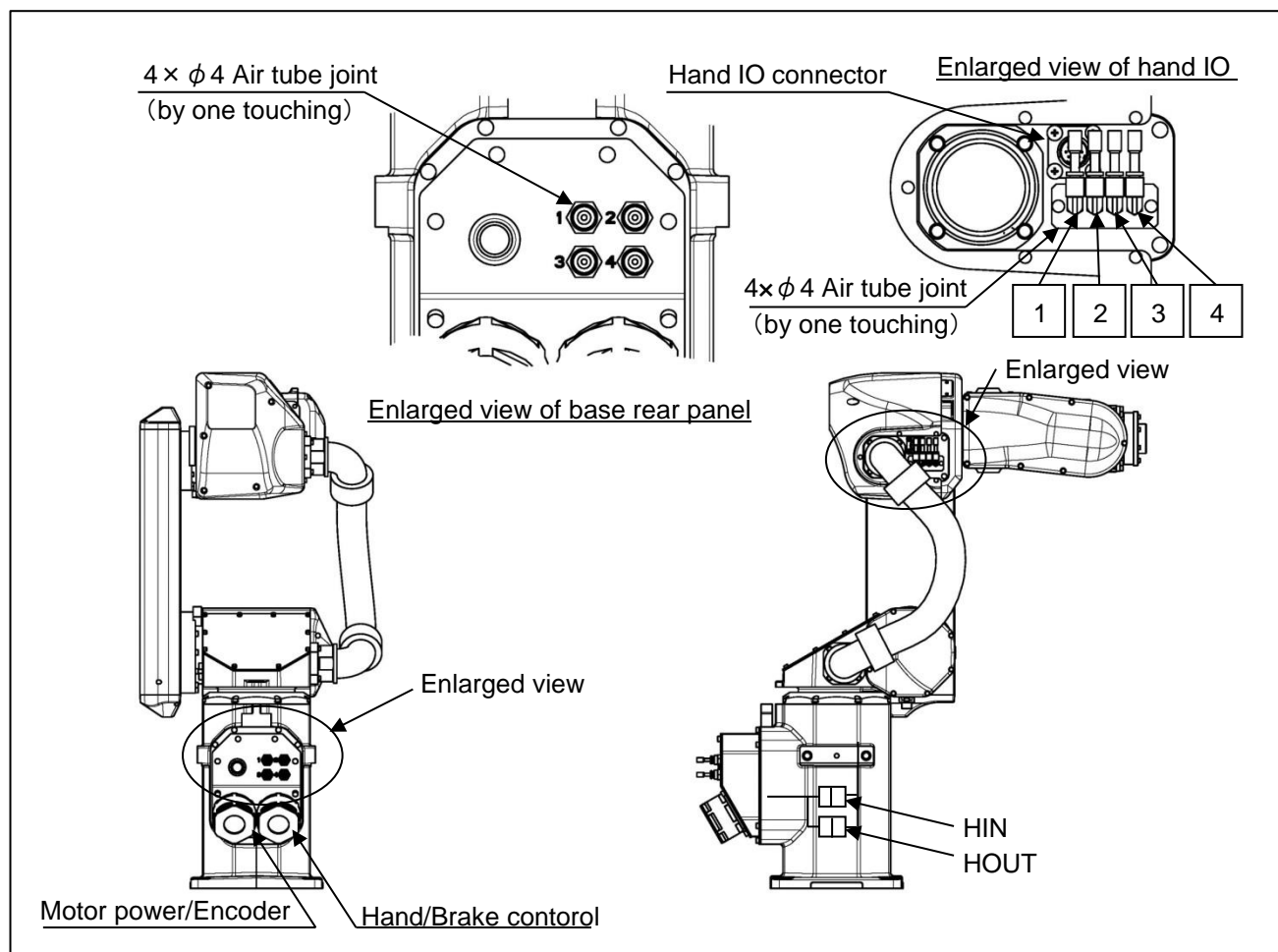


The wires for the connector are AWG24 to AWG16.

Use an appropriate power supply according to your environment (voltage source capacity).

The TSL3100 robot controller is equipped with a 3A (maximum) fuse, and therefore the total current used for hand I/O must be 3A or less. Operation beyond the rated capacity may cause problems such as blowout of a fuse. Make sure to operate within the rated capacity.

7. 4 Wiring and Piping for Hand Control (Standard)

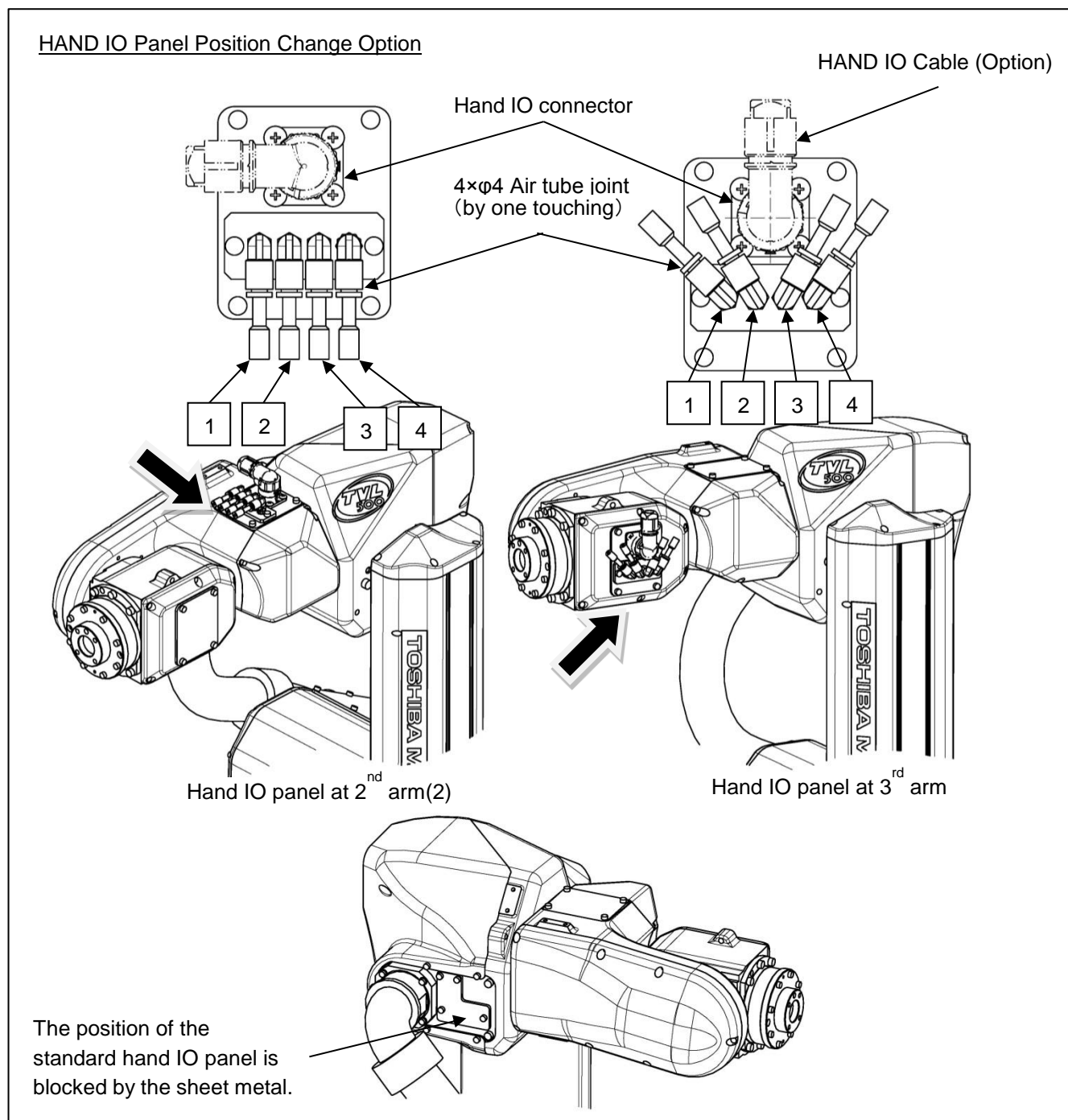


For the hand piping, a total of four (4) lines ($\phi 4 \times 4$) are provided. Connections are made on the base rear side and side of the 2nd arm (1).

For the hand wiring, four (4) input signals for the sensor, etc., four (4) control signals (Solenoid options : 8 signal) for the solenoid valve, etc., and 24V AC signal (total 2A or less) are provided. Connection on the hand side is performed by using connectors on the side of the 2nd arm (1). To control from the separate PLC, etc., separate connectors HIN and HOUT in the base and pull out the robot side connectors from the grommet on the back of the base then connect the cable running from the PLC, etc

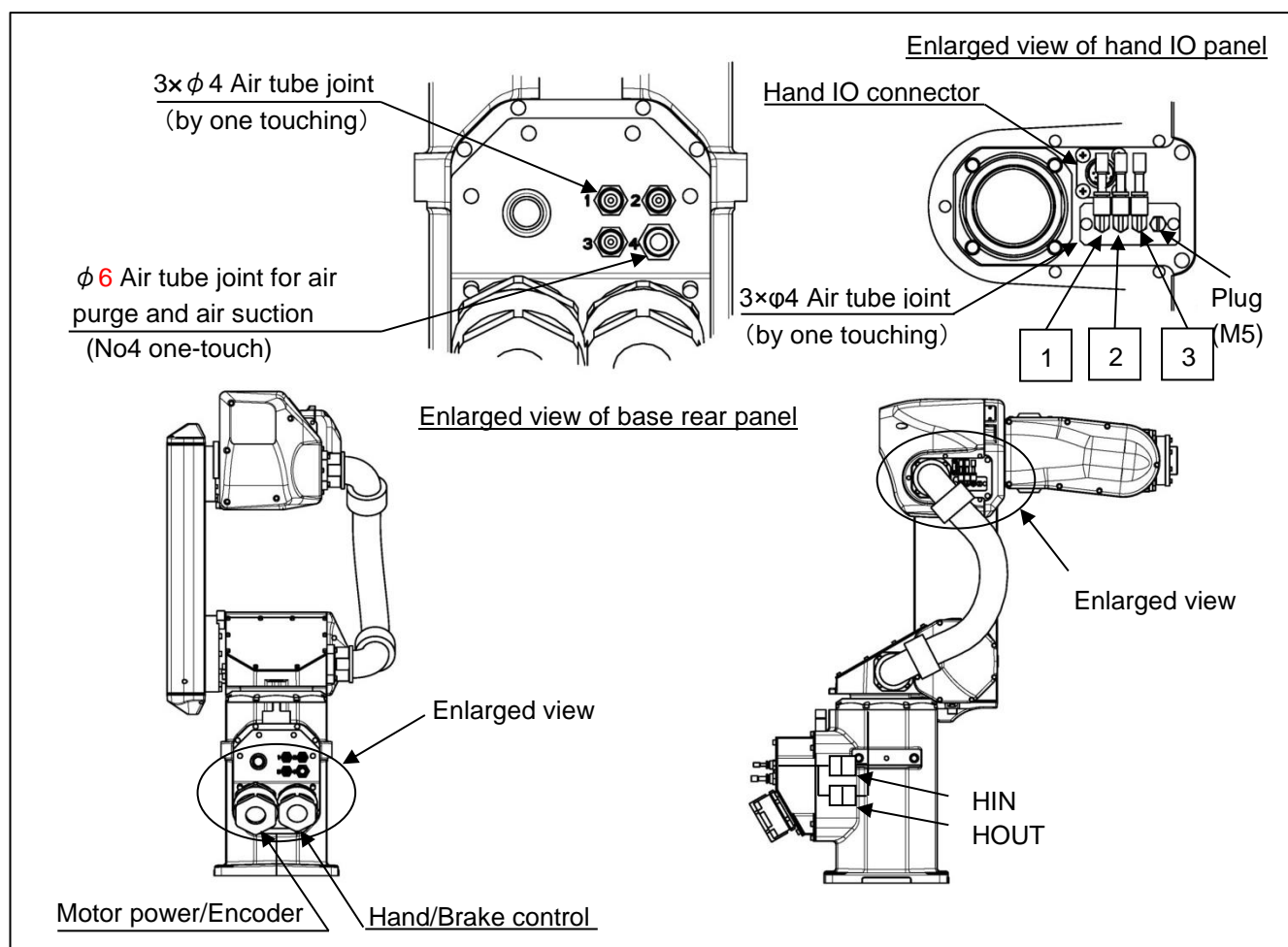
7. 5 Wiring and Piping for Hand Control (Option)

7. 5. 1 HAND IO Panel Position Change Specification



TVL series HAND IO PANEL position can be changed to the second arm (2) or the third arm as shown above. Since wiring and piping is possible from the closer position to the end effector, the wiring and piping will be cleanly. The direction of the connector when attaching the hand IO cable (option) is as shown in the above figure.

7. 5. 2 Dust and Water proof specification / cleanroom specification

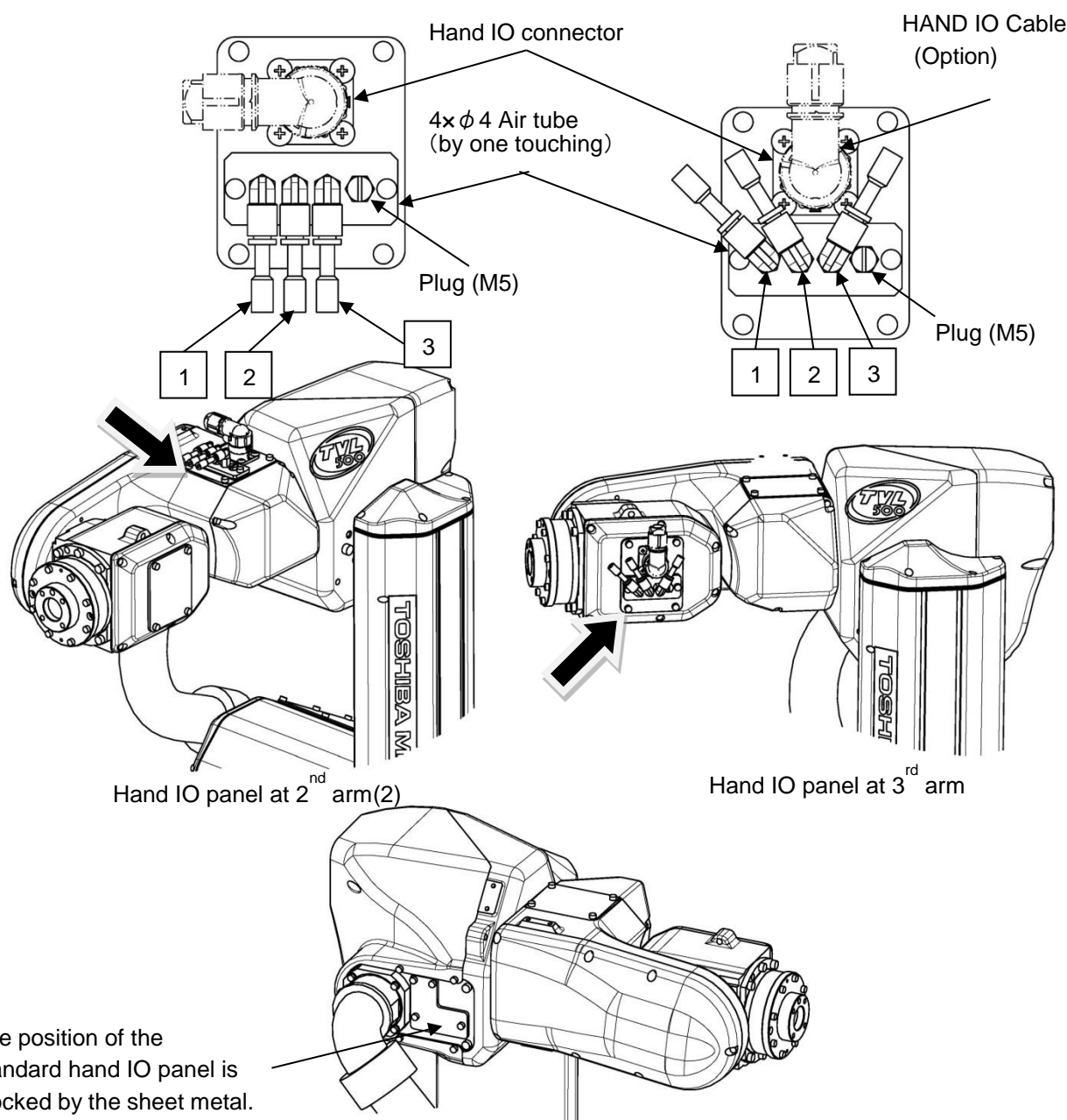


In the case of dust and water proof specification and clean room specification, a total of three (3) lines (ϕ 4 x 3) are provided for the pipe fitting. Connections are made on the base rear side and side of the 2nd arm (1).

For the hand wiring, four (4) input signals for the sensor, etc., four (4) control signals (Solenoid options: 8 signal) for the solenoid valve, etc., and 24V DC signal (total 2A or less) are provided. Connection on the hand side is performed by using connectors on the side of the 2nd arm (1). To control from the separate PLC, etc., separate connectors HIN and HOUT in the base and pull out the robot side connectors from the grommet on the back of the base then connect the cable running from the PLC, etc

※ The ϕ 6 air tube (No.4) located on base rear panel is used for internal air purge when the dust and water proof specification (option). And when the clean room specification (option), it is used for internal air suction. Therefore, the ϕ 6 air tube (No.4) on the Hand IO panel is plugged and a total of three(3) lines are available for the pipe fitting. This is the same as HAND IO OPTION.

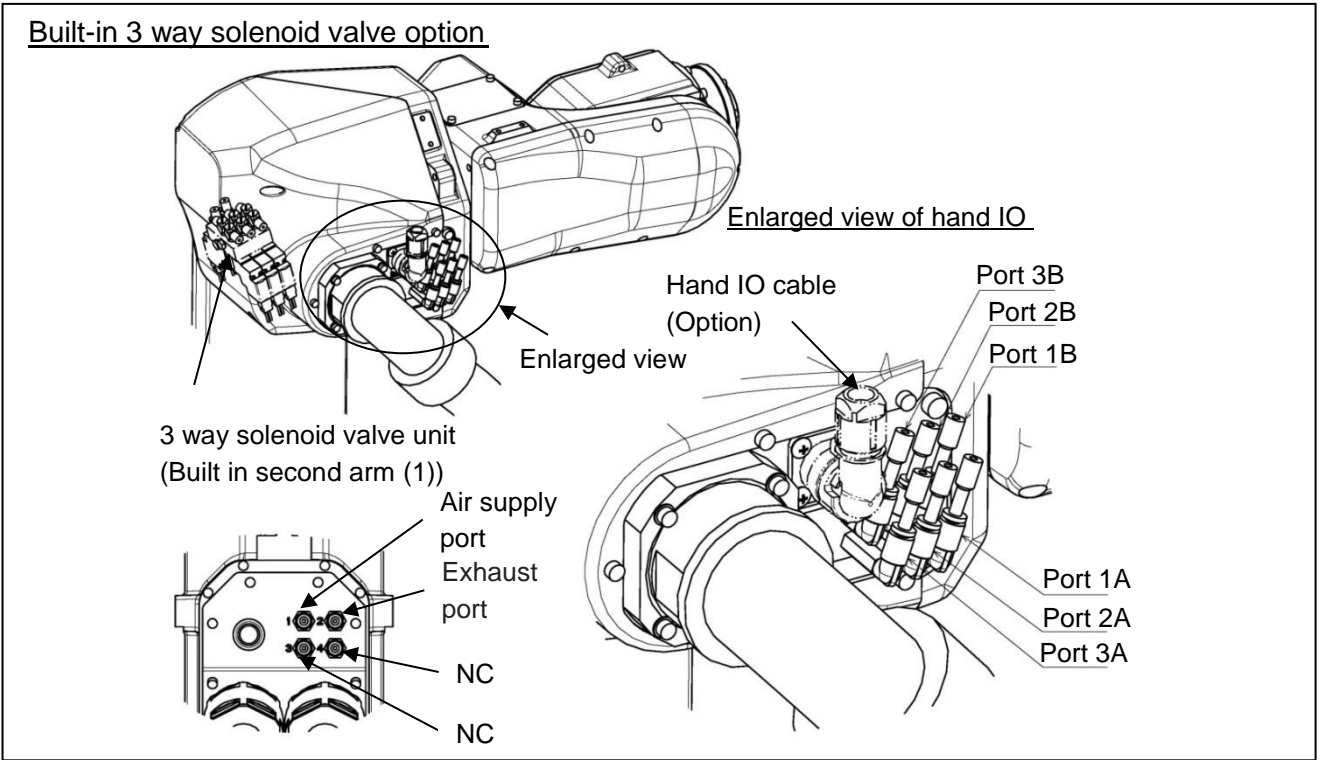
7. 5. 3 Dust and Water proof / cleanroom specification + HAND IO Panel Position Change Specification

HAND IO Panel Position Change Option(Dust and Water proof / Cleanroom)

TVL series HAND IO PANEL position can be changed to the second arm (2) or the third arm as shown above. Since wiring and piping is possible from the closer position to the end effector, the wiring and piping will be cleanly. The direction of the connector when attaching the hand IO cable (option) is as shown in the above figure.

- ※ The φ6 air tube (No.4) located on base rear panel is used for internal air purge when the dust and water proof specification (option). And when the clean room specification (option), it is used for internal air suction. Therefore, the φ6 air tube (No.4) on the Hand IO panel is plugged and a total of three(3) lines are available for the pipe fitting. This is the same as HAND IO OPTION.

7. 5. 4 Built-in 3 way solenoid valve Specification



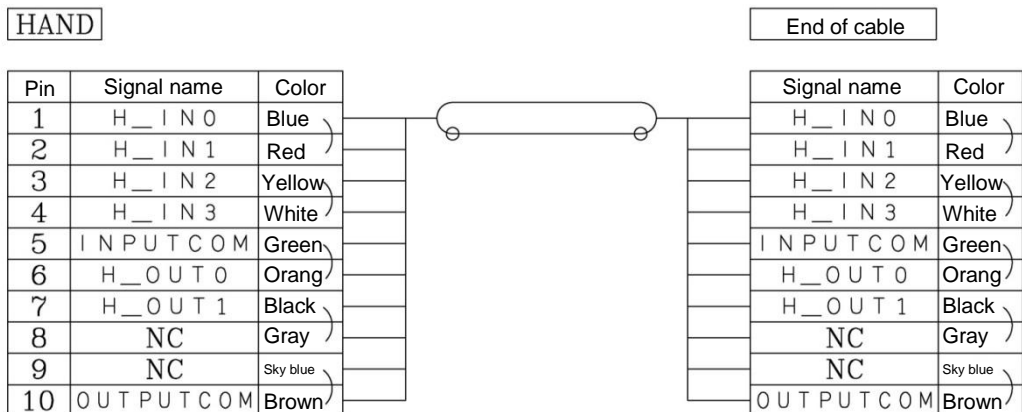
Built-in three way solenoid valve option is an optional specification that three sets of solenoid valves are built in the second arm of the robot.

By supplying air from the No.1 port of connector panel rear of the robot base and operating the signal for hand control, it is possible to control 6 air line.

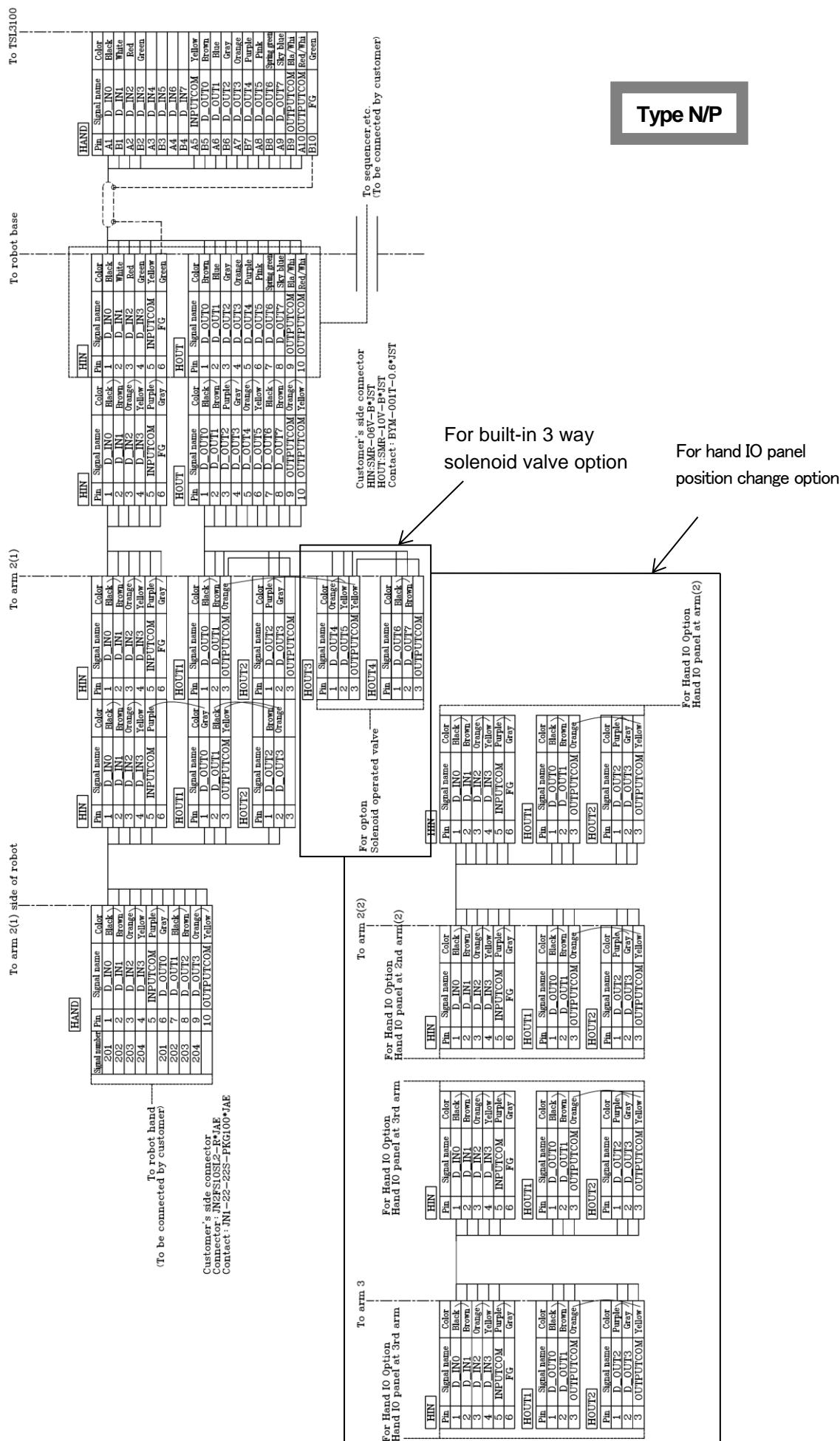
One-touch fittings of the connector panel are plugged when the factory shipped. Remove the plugs No. 1 and No. 2, supply air to No. 1, No. 2 is the exhaust port. Since the signal for hand control (signal numbers 203 to 208) is used to control the solenoid valve, the output signal that can be used with the hand IO connector is 2 signals. Below is the pin assignment diagram of the HAND IO cable for the built-in three-way solenoid valve specifications.

Solenoid valve type:	SYJ3233-5MR
	2 position double solenoid
Manufacturer:	SMC Corporation
Operating pressure range:	0.1 to 0.7 MPa
Response time:	15 ms or less (at 0.5 MPa)

Hand IO cable pin assignment when the built-in 3 way solenoid valve specification

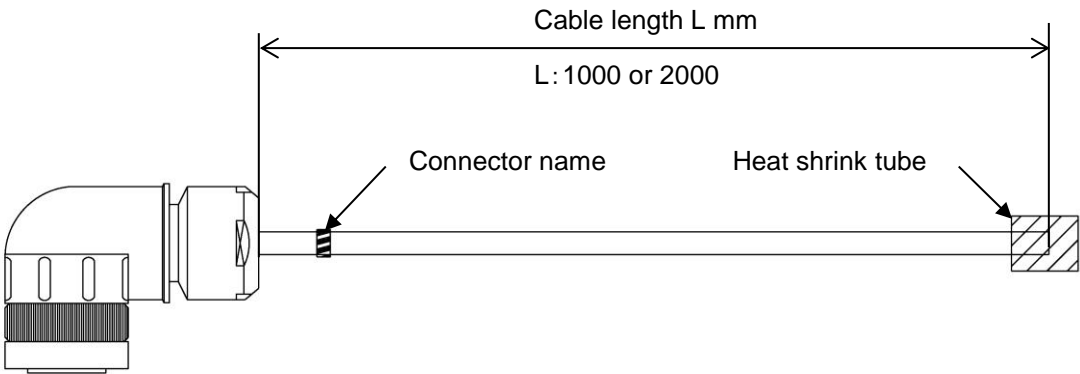


7. 6 Wiring for Hand Control

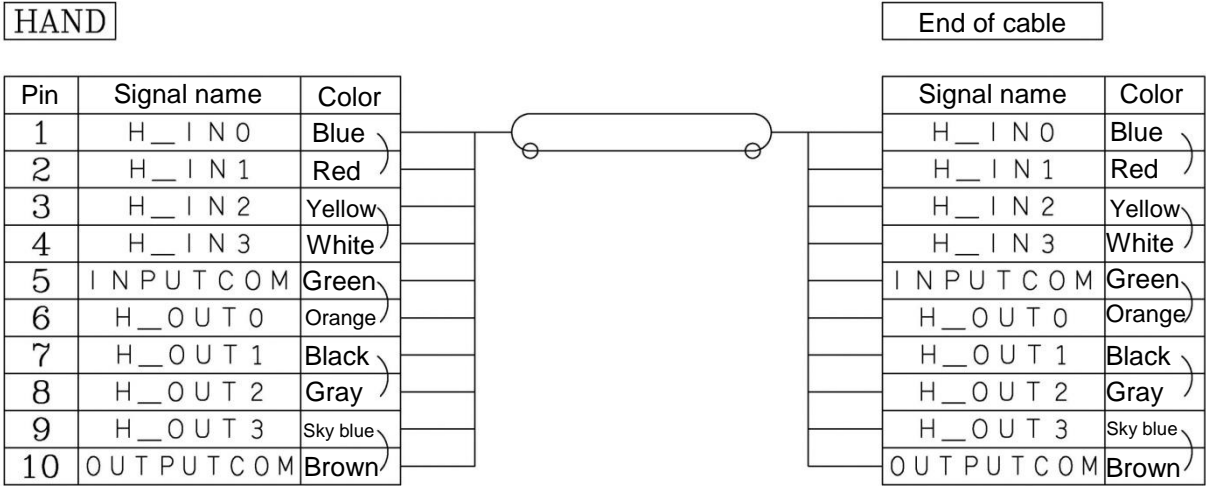


7. 7 HAND IO Cable (option) Wiring

The wiring diagram of the hand IO cable (option) and the parts list are shown below.



External view drawing of hand I/O cable



Hand I/O cable (option) wiring diagram

Hand I/O cable parts list

No	Product name	Type	Manufacture	Use qt.
1	Cable	RMFEV-SB(CL3) 0.2SQ-5P	DYDEN Corp	1
2	Cannon connector	JN2FS10SL2-R	JAE Hakko	1

8. Safety Precautions

8.1 General Items

- 1) Transport, installation, wiring, operation, inspection and maintenance should be performed by qualified personnel well versed in the equipment. Otherwise, an electric shock, injury or fire may be caused.
- 2) Install safety fences so that anyone cannot approach the dangerous area. This dangerous area is the area around the robot's operating range where a person may face a dangerous condition if he or she has entered.
- 3) When you have to enter the dangerous area, the robot should be emergency-stopped beforehand. Install an emergency stop circuit after you have fully read and understood the controller instruction manual.
- 4) Provide a necessary space in the dangerous area to perform the work safely.
- 5) Install the controller at a place outside the dangerous area, where an operator can watch all of the robot movements.
- 6) NEVER use the equipment at a place where it is exposed to water splashes, in a corrosive atmosphere, in an atmosphere containing inflammable gas or metal chips, or near combustibles. Otherwise, a fire or equipment failure may be caused.
- 7) DO NOT place the robot near a combustible material. If it ignites due to a fault, etc., a fire will break out.
- 8) DO NOT operate the robot if any part is damaged or missing. Otherwise, an electric shock, fire or fault will be caused.
- 9) NEVER replace or modify parts other than those described in the instruction manual. Otherwise, the robot performance will deteriorate, or a fault or accident will be caused.
- 10) Completely connect the grounding cable. Otherwise, an electric shock or fire will be caused if a fault or fault current occurs. Also, it could cause miss-operation by noise.
- 11) DO NOT incinerate, disassemble or charge the battery. Otherwise, it will rupture.
- 12) DO NOT change the data of the system configuration file. Otherwise, the robot will operate abnormally, resulting in a damage or accident.

8.2 Storage

- 1) When storing the robot, use the supplied fixtures to secure the arm and base, and then firmly secure the mounting sections. The robot can be unstable and fall down if it is not secured.
- 2) DO NOT store the robot at a place where it is exposed to direct rain or water splashes, or at a place containing any toxic gas or liquid.
- 3) Store the robot at a place where it is not directly exposed to sunlight and both the temperature and humidity are kept as specified.
- 4) DO NOT store a robot which has not been used for a long period of time after being unpacked. If the robot has been stored over a long period of time, be sure to consult with us before operation.
- 5) To prevent rust and dust, put it into a plastic bag and place a desiccant in the bag.
- 6) Before starting operation, perform break-in operations sufficiently.
- 7) If the equipment is stored in the long term, the service life of the backup battery will be reduced. To restart the operation, it is recommended to replace the battery.

8.3 Transportation and Installation

- 1) When installing the robot, secure it to the base completely. If it is installed incompletely, a fault or injury may be caused.
- 2) At the time of robot operation, sudden acceleration or deceleration is caused. When the robot is to be installed on a stand, therefore, it should be sufficiently rigid. If the robot is installed on a less rigid stand, vibration will be caused during robot operation, resulting in a fault.
- 3) Install the robot at a well leveled place. Otherwise, the robot performance will deteriorate, or a fault will be caused.
- 4) For the controller, keep a specified ample space for ventilation. Otherwise, the controller will overheat and go wrong.
- 5) Take all necessary measures not to impose an impact on the robot during transportation. Otherwise, a fault or injury will be caused.
- 6) Be sure to secure the robot with attached clamps before transportation. Otherwise, the robot performance will deteriorate, or a fault will be caused.

- 7) Do not transport the robot with the arm raised. Otherwise, an excessive force will be exerted on the robot mechanism, resulting in damage of the robot.
- 8) When lifting the robot, lift it up slowly as the robot will tilt slightly. If it is lifted up suddenly, it will cause a very hazardous situation.

8.4 Wiring

- 1) Electric work should be done by a qualified electric engineer. Otherwise, a fire or electric shock will be caused.
- 2) Wire the robot after installation. Otherwise, an electric shock or injury will be caused.
- 3) Always use the master power voltage and power capacity designated by Toshiba Machine. Otherwise, the equipment will be damaged or a fire will break out.
- 4) Always use the designated power cables. If a cable other than the designated one is used, a fire or fault will be caused.

8.5 Operation

- 1) DO NOT enter the dangerous area of the robot during operation. Otherwise, you will be seriously injured.
- 2) DO NOT leave any obstacles in the job space. If the equipment went wrong, a worker may be injured, or other serious accident may be caused.
- 3) Anyone other than the workers MUST NOT approach the equipment. Should he or she negligently touch a dangerous part of the equipment, he or she will get injured or involved in a serious accident.
- 4) NEVER perform an inappropriate operation which is not described in the instruction manual. Otherwise, the equipment will start by mistake, resulting in a personal injury or serious accident.
- 5) If you feel even a little that you are exposed to danger or the equipment works abnormally, press the EMERGENCY stop pushbutton switch to stop the equipment. If the equipment is used as it is, you will be injured or involved in a serious accident.
- 6) During operation, be sure to close the equipment cover. Should the cover be opened during operation, you will be struck by an electric shock or get injured.
- 7) Only a well-trained and qualified person is allowed to perform the operation. Should the equipment be operated improperly, it will start by mistake, causing a personal injury or serious accident.

- 8) If the equipment has malfunctioned, turn the power off, identify and remove the cause of the abnormality, maintain the peripheral equipment and completely restore the malfunctioned equipment. Then start the equipment at a low speed. If the equipment starts, with the abnormality remaining, you will be involved in a serious accident.
- 9) In principle, the teaching operation should be performed outside the dangerous area of the robot. If it should be performed inevitably within the dangerous area, strictly observe the following matters.
 - [1] The teaching operation should always be performed by two (2) persons. One person performs the job and the other person watches outside the dangerous area. Also, both persons should try to prevent miss-operation with each other.
 - [2] The operator should do the job in an attitude ready to press the EMERGENCY stop pushbutton switch at any time. Also, he or she should perform the job at a position from which he or she can evacuate immediately at the time of an emergency after confirming the robot's operating range and shields in the surroundings.
 - [3] The supervisor should keep watch on the job at a position where he or she can see the entire robot system and operate the EMERGENCY stop pushbutton switch at the time of an emergency. Also, he or she should keep anyone from entering the dangerous area. If the worker or other person does not follow the instructions of the supervisor, he or she will be involved in a serious accident.
- 10) If an abnormality has generated or the POWER LED lamp on the control panel remains off after the main power switch of the equipment was turned on, turn off the main power immediately and confirm the wiring. Otherwise, you will be struck by an electric shock or a fire will break out.
- 11) Unless the robot operates toward a designated direction at manual guide, turn off the servo power. Otherwise, the robot will be damaged or you will be involved in an accident.
- 12) Pushbutton operations of the control panel and teach pendant should be confirmed visually. Otherwise, you will be involved in an accident due to miss-operation.
- 13) After the power is turned on or before the start of an automatic operation, be sure to reset a relevant program beforehand. If the continuous mode is selected for the program execution environment, the robot will collide with the peripheral equipment, resulting in damage to or an accident with both pieces of equipment.

14) Before operating the equipment, perform the following inspection.

- [1] Make sure that the visual appearance of the robot, controller, peripheral equipment and cables are in good condition.
 - [2] Make sure that no obstacle stands in or near the operating range of the robot and peripheral equipment.
 - [3] Make sure that the emergency stop and other safety devices operate properly.
 - [4] Make sure that no abnormal noise or vibration is involved in the robot operation.
- If the above prior inspection is skipped, the equipment will be damaged or you will be involved in an accident.

15) The speed of test operation is initially set at 20% of the maximum robot speed.

16) The speed of automatic operation is initially set at 100% of the maximum robot speed.

8.6 Maintenance and Inspection

- 1) Anyone other than a qualified engineer should not perform inspection.
- 2) Be sure to turn off the main power of the controller before starting inspection or maintenance.
- 3) Perform maintenance and inspection regularly. Otherwise, the equipment will go wrong or you will be involved in an accident.

8.7 Waste Disposal

- 1) This equipment should be disposed of as industrial waste. When disposing of the battery, follow the user's provided regulations.

TOSHIBA MACHINE Co., Ltd.
