CKD

SCARA Robot

KSL3000 Interface Manual

INSTRUCTION MANUAL

SM-A20054-A

- Read this Instruction Manual before using the product.
- Read the safety notes carefully.
- Keep this Instruction Manual in a safe and convenient place for future reference.

CKD Corporation

Preface

This manual describes the type, function and handling method of external cables connecting the KSL3000 robot controller with external equipment.

This manual is intended for the system designers and manufacturing engineers.
The KSL3000 robot controller can work in concert with the external equipment through digital input and output signals that can be programmed by the SCOL language. Also, system input signals that can allows external operation of the controller, system output signals informing an operator of the controller status (PLC processing function) and serial input and output signals that can be connected with the host computer, etc., are provided so that the user can easily construct an FA system.

* Instruction manuals which are referred to from this manual

Installation & Transport Manual
Maintenance Manual
Safety Manual
Operation Manual
User Parameter Manual
Simple PLC Function Manual
Communication Manual

CAUTION

This manual does not contain any detailed descriptions on power and robot connection.
For the connection of the power and robot, see the Installation & Transport Manual.

Safety Precautions

This manual contains important information for the safe use of the equipment and the prevention of injury to the operator and others and the prevention of damage to property. Read and understand the meanings of the following indications and symbols first, and observe these precautions.

[Meanings of indications]

Indication	Meaning
 **DANGER**	Indicates the imminent danger that incorrect operation could cause death or serious injury.
 **WARNING**	Indicates the danger that incorrect operation could cause death or serious injury.
 **CAUTION**	Indicates the possibility that incorrect operation could cause injury*1 to the operator or damage to the property*2.

*1: Injury indicates injuries such as wounds, burns, and electric shock that do not require hospitalization or long-term outpatient treatment.

*2: Damage to property indicates extensive damage related to the destruction of assets or materials.

[Meanings of symbols]

Symbol	Meaning
	Indicates a prohibited action. The specific content of the prohibition is shown pictorially or in text form inside the symbol or nearby it.
	Indicates a required action. The specific content of the required action is shown pictorially or in text form inside the symbol or nearby it.
	Indicates a danger and precaution. The specific content of the precaution is shown pictorially or in text form inside the symbol or nearby it.

CAUTION

To install and operate the controller safely, read and understand the separate Instruction Manual "SM-20062-A KSL3000 for Safety" in advance.

[Maintenance]

Strictly observe the following in order to use the controller safely.

! **DANGER**	
 Prohibited	• Do not burn, disassemble, or recharge the battery. Otherwise it may blow out.
 Required	• Turn off the main power switch of the controller before maintenance and inspection. • When disposing of the battery, observe the customer-defined rules. • Ensure that the equipment is grounded by a grounding wire. Otherwise, electric shock or fire may result due to malfunction or electric leakage. Malfunction due to noise may also result.

! **CAUTION**	
 Prohibited	• Do not replace or modify parts that are not stated in the instruction manual. Performance degradation or malfunction may result.
 Mandatory	• Use replacement parts specified by CKD. • Regularly conduct maintenance and inspection. Otherwise, equipment failure or accident may result.

! CAUTION

To perform the maintenance and inspection of the robot with safety, read through and through the Maintenance Manual provided separately before actually starting the work.

Table of Contents

Section 1 Type of External Cable

1.1 Layout and Name of Connectors

The KSL3000 robot controller is connected with the robot and external equipment, using connectors and terminal blocks provided on the front and rear panels of the controller.

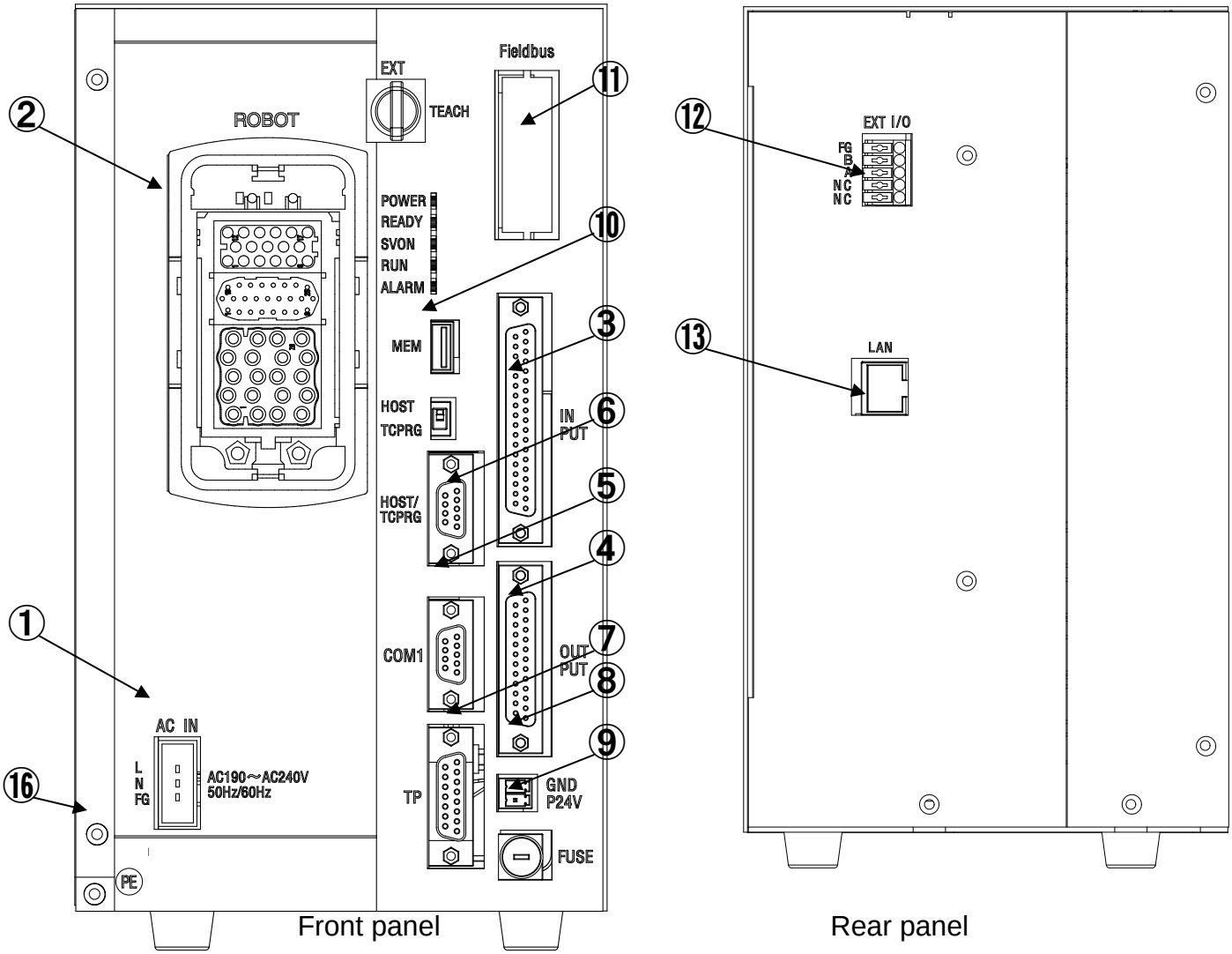


Fig. 1.1 Layout and name of connectors

1.2 Power Cable "AC IN"

Fig. 1.1–① (with connector)
The power cable is an interface feeding the main power (single phase, 190/240 V AC, 50/60 Hz) to the KSL3000 robot controller. Connector "AC IN" is used.
For details, see the Installation & Transport Manual provided separately.

1.3 Motor, Encoder, Hand I/O Cables "ROBOT"

Fig. 1.1–②
The motor drive cable connects the KSL3000 robot controller and robot. It feeds the 3-phase AC power to each axis feed motor of the robot and connects the parking brake signal for securing the motor shaft. The encoder cable controls the encoder signal for rotation angle detection of each robot axis, and the hand I/O cable controls the hand at the end of the robot.
Connector “ROBOT” is used.
For details, see the Installation & Transport Manual provided separately.

1.4 External I/O Signal Cable

1.4.1 External Input Signal Cable "INPUT"

Fig. 1.1–③ (with dummy connector)
The external input signal cable is an interface recognizing each signal which is input to the KSL3000 robot controller from the external equipment.
The external input signal comes in eight (8) digital input signals that can be programmed at the user's discretion, using the SCOL language or PLC function and thirteen (13) system input signals that allow operation of the controller from the external equipment. This signal, together with the external output signal in Para. 1.4.2, allows the robot controller to work in concert with the external equipment.
Also, three (3) system input signals of external servo ON, external servo OFF and external emergency stop are included in this cable. Connector "INPUT" is used.

1.4.2 External Output Signal Cable "OUTPUT"

Fig. 1.1–④ (with connector)
The external output signal cable is an interface which outputs each signal from the KSL3000 robot controller to the external equipment.
The external output signal comes in eight (8) digital output signals that can be programmed at the user's discretion, using the SCOL language or PLC function and system output signals that output the controller status to the external equipment.
This signal, together with the external input signal in Para. 1.4.1, allows the robot controller to work in concert with the external equipment.
Connector "OUTPUT" is used.

1.5 Serial I/O Signal Cable

1.5.1 Serial I/O Signal "COM1"

Fig. 1.1–⑤
Serial I/O signal cable COM1 is exclusively used for the RS232C and allows data communication with an image processing equipment or other FA equipment that can connect an RS232C interface. Connector "COM1" is used.

1.5.2 Serial I/O Signal “HOST”/TCPRG

Fig. 1.1–⑥
Serial I/O signal cable HOST/TCPRG is exclusively used for the RS232C and HOST allows transfer and saving of various parameters and updating of the system when connected with the host computer.

The KSL3000 robot controller uses exclusive sequence control tool "TCPRGOS" (option) to transfer, save and monitor sequence programs.
TCPRG is the connector to connect with this sequence control tool.
For the use of TCPRGOS, see the Simple PLC Function Manual (option) provided separately.

The connector "HOST/TCPRG" is used. The setting can be switched between "HOST" and "TCPRG" using the switch above the connector.

1.6 Teach Pendant Cable "TP"

Fig. 1.1–⑦ (with dummy plug)
This is an interface connecting the KSL3000 robot controller and teach pendant (TP). The teach pendant is an option. By connecting the TP cable, creation of motion programs, manual robot guidance, etc., are possible through the teach pendant. Connector "TP" is used. The TP cable is secured to the teach pendant and cannot be disconnected from the teach pendant. The standard cable length is 5 m.

1.7 FUSE Cable "FUSE"

Fig. 1.1–⑨
This is a fuse for detecting overcurrent (3A) of the digital signal input/output to the KSL3000 robot controller. It is used for protecting patterns. "FUSE" is located in the bottom section of the front panel.

1.8 I/O P24V Supply Cable

Fig. 1.1–⑧
This is a connector for external power supply connection for setting INPUT, OUTPUT, and the INPUT and OUTPUT for HAND to ON or OFF. P24V is supplied externally.

1.9 MEM Cable "MEM"

Fig. 1.1–⑩
A USB memory device can be used to transfer and save the parameters and back up the programs and other data. The connector "MEM" is used.

1.10 Fieldbus Cable "Fieldbus"

Fig. 1.1–⑪ (option)
This supports connection with fieldbus devices, which is available as an option function in the KSL3000 robot controller. PROFIBUS, DeviceNet, or CC-Link can be selected as the type of fieldbus for the slave module. "FieldBUS" is located in the top section of the front panel.

1.11 External I/O Cable "EXT I/O"

Fig. 1.1–⑫ (with connector)
This is an RS485 communication terminal connecting the KSL3000 robot controller with the optional remote I/O module function (TR48DIOCN-1/TR48DIOC-1 module, etc.). Terminal block "EXT I/O" is used.
For details of the TR48DIOCN-1/TR48DIOC-1, see the Extension I/O Function Manual (option).

1.12 LAN Cable "LAN"

Fig. 1.1–⑬
This supports connection by 10BASE-T, in the KSL3000 robot controller. If a hub is used, a straight cable is used. If the computer and controller are connected directly one-to-one, a cross cable is used. Also, TCP/IP protocol can be used to perform communication with computers or visual equipment on the Ethernet within the same local area for enabling the creation and editing of programs using the computer programmer TSPC and debugging start assistance and maintenance.

1.13 Extension I/O Signal Cable

1.13.1 Extension Input Signal Cable "INPUT (TR)"

Fig. 7.3–⑭ (option)
This is an interface which inputs an external signal from the external equipment to remote I/O module TR48DIOCN-1/TR48DIOC-1. Like the external input signal cable, the extension input signal cable is provided with twenty-eight (28) digital input signals that can be programmed at the user's discretion, using the SCOL language or PLC function. The extension input signal, together with the external output signal or extension output signal, allows the robot controller to work in concert with the external equipment. Connector "INPUT (TR)" is used.

Note: To discriminate from the INPUT cable connector of the KSL3000 robot controller, the extension input signal cable connector is referred to as "INPUT (TR)" in this manual.

1.13.2 Extension Output Signal Cable "OUTPUT (TR)"

Fig. 7.3–⑮ (option)
This is an interface which outputs an external signal from remote I/O module TR480DIOCN-1/TR48DIOC-1 to the external equipment. Like the external output signal cable, the extension output signal cable is provided with twenty (20) digital output signals that can be programmed at the user's discretion, using the SCOL language or PLC function. The extension output signal, together with the external input signal or extension input signal, allows the robot controller to work in concert with the external equipment. Connector "OUTPUT (TR)" is used.

Note: To discriminate from the OUTPUT cable connector of the KSL3000 robot controller, the extension output signal cable connector is referred to as "OUTPUT (TR)" in this manual.

1.14 PE Cable "PE"

Fig. 1.1-⑯ (with M4 screw)
The PE cable connects the PE ground terminal of the KSL3000 robot controller in order to prevent electric shock. Connect the PE using a 2.0 mm^2 cable whose length is 1 m or shorter with a green grounding wire or a green and yellow grounding wire. Do not attach any switch or overcurrent protection device to the PE cable.

Section 2 Power Cable

2.1 Connecting the Power Cable

To connect the KSL3000 power cable, use the attached connector (03JFAT-SAYGF-1 made by JST).

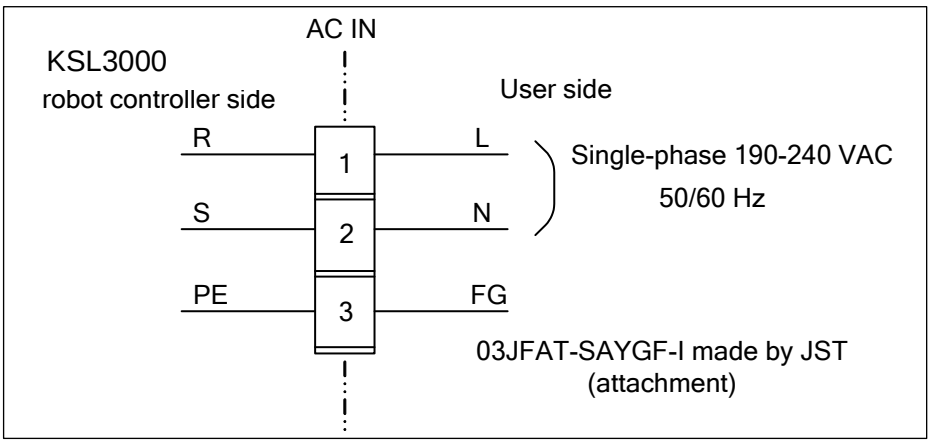


Fig. 2.1 Connection of power cable

The cable is not included in the accessories. The customer must use the supplied plug connector connected to the ACIN of the controller to fabricate the cable.

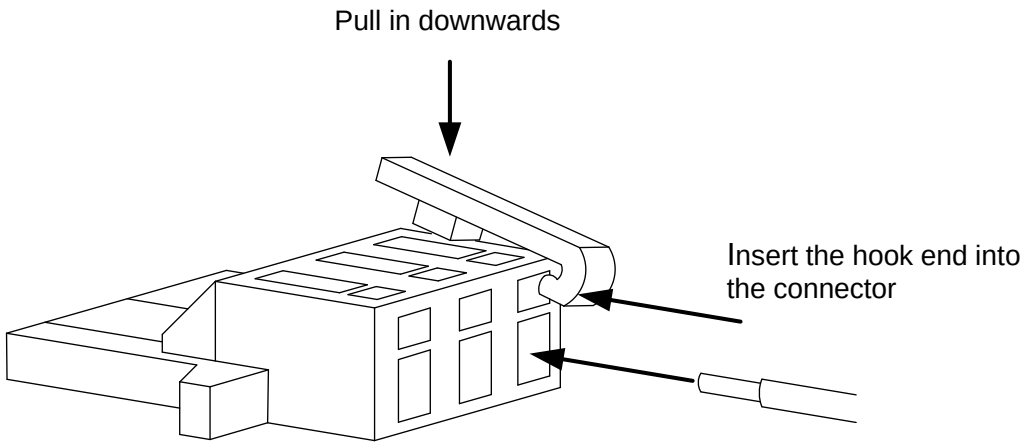
Table 2.1 Power Supply Specifications

Power supply	Single-phase 190-240 V AC 50/60 Hz ± 1 Hz
Power capacity	KHL-300, KHL-400: 0.7 kVA KHL-500 to KHL-700: 1.4 kVA KHE-400: 2.6 kVA
Instantaneous power failure	40 msec or less
Ground	Class D dedicated grounding

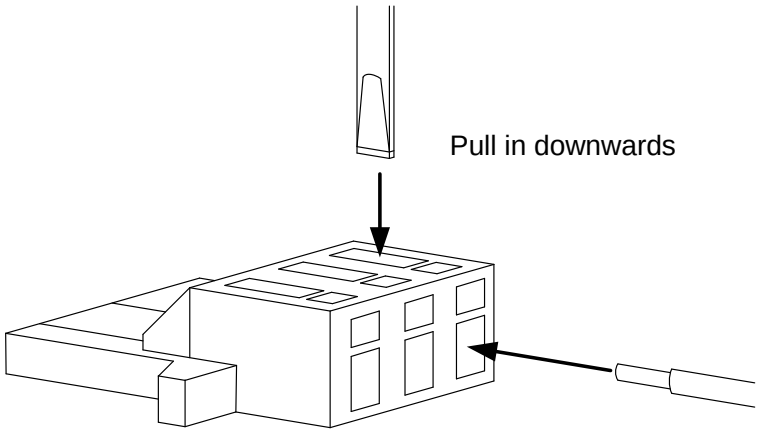
Be sure to ground the PE ground terminal to prevent electric shock.

2.2 Method of Connecting the Power Cable

Use the supplied cable connection jig (model: J-FAT-0T) to fabricate the cable. Engage the hook of the supplied cable connection jig to the connector, and push it in so that the power cable is no longer inserted. Peel off about 10 mm of the cable covering, firmly insert the cable inside, and then pull up the supplied cable connection jig. (After that, gently pull on the cable to check that it is firmly connected and does not drop out. However, be careful that you do not pull too hard on the cable because this can apply excessive force to the cable and damage it.)



A slotted-head screwdriver can also be used to fabricate the cable. Use the slotted-head screwdriver to push down into the connector slot so that the power cable is no longer inserted. Peel off about 10 mm of the cable covering, firmly insert the cable inside, and then pull up the slotted-head screwdriver. (After that, gently pull on the cable to check that it is firmly connected and does not drop out. However, be careful that you do not pull too hard on the cable because this can apply excessive force to the cable and damage it.)

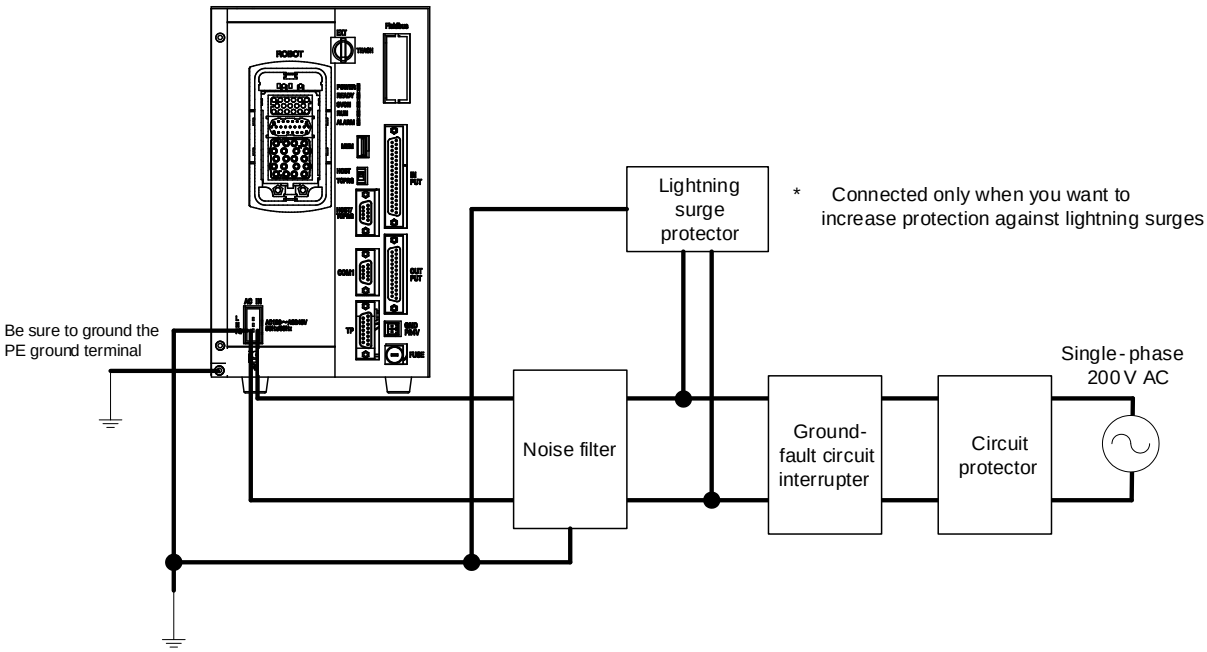


2.3 Power Cable Connection Example

A connection example of the power cable is shown below.

The KSL3000 does not include ground-fault circuit interrupters or noise filters, and so these must be installed by the customer.

<Ground-fault circuit interrupter>
Specifications: Single phase 20 A, sensitivity current 30 mA
Recommended ground-fault circuit interrupter:
BKW2203CCK by Panasonic Electric Works, Co., Ltd.
<Noise filter>
Recommended noise filter:
SUPF-EX20-ER-6 by Okaya Electric Industries, Co., Ltd.



Note the following when install a ground-fault circuit interrupter:
- A ground-fault circuit interrupter must be installed for each power supply to the machine.
- "O" (open) or "|" (closed) must be indicated as the operation status.
- The ground-fault circuit interrupters must be equipped with an external operating mechanism (e.g., a handle) and installed 0.6 m to 1.9 m above the ground so that they can be easily accessed.
- All the power circuit phases must be shut down. However, do NOT disconnect the ground wire or PE cable.

For details on the power cable connection, see the Installation & Transport Manual provided separately.

For details of the power cable connection, see the Installation & Transport Manual provided separately.

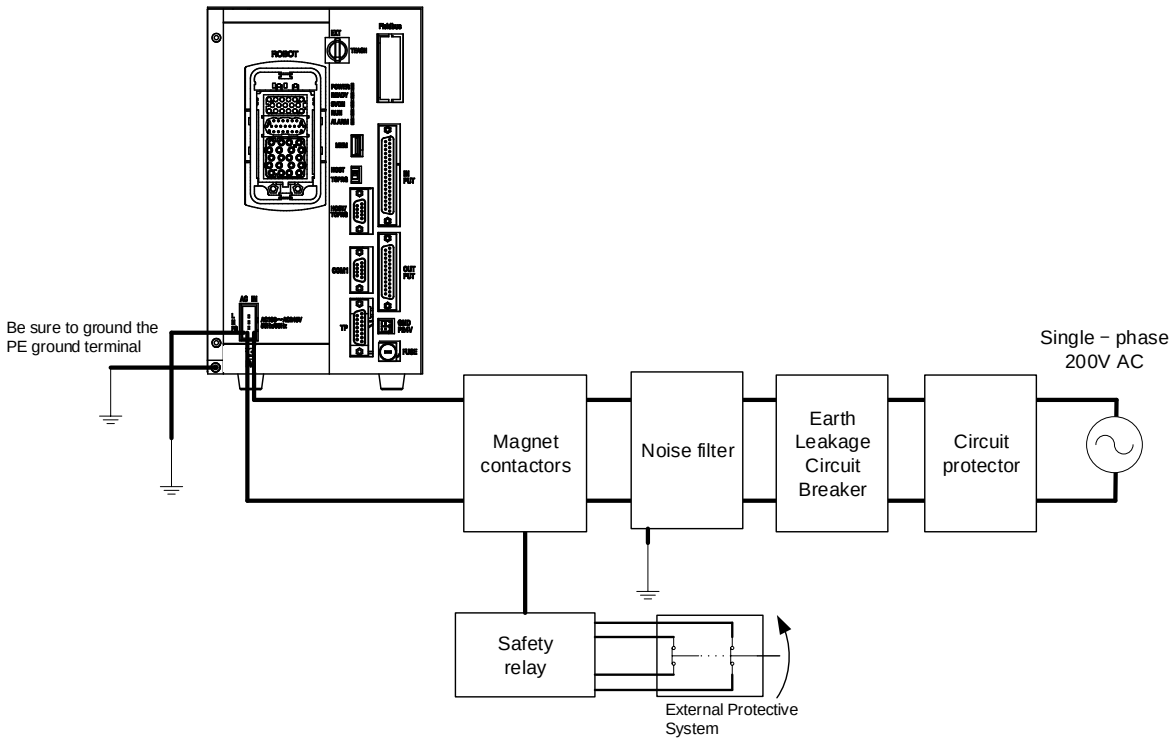
2.4 External Protective System Connection Example

Shown below is a connection example in which an external protective system is installed for shutting down the power supply to the KSL3000.

The power source to the robot is shut down by connecting a safety relay and contactor. It is requested to choose the safety relay and contactor in accordance with the customer's specifications. A noise filter for meeting a standard is available. Consult the sales representative.

<Safety relay>
Recommended safety relay: G9SA-321-T075 by Omron Corporation

<Contactor>
Recommended magnet contactor: SC-4-1/G (24 V DC) by Fuji Electric Co., Ltd.



! CAUTION

In order to prevent direct or indirect contact with the robot controller, provide a sufficient distance between the robot controller and the operator, for example, by placing the robot controller in an enclosure.
If the robot controller is contained in an enclosure, the enclosure must be a fixed-cover structure or it must be locked not to be opened/closed freely.
Take protective measures when making the cable inlet in the enclosure so that the cables will not be damaged.

Section 3 Robot Control Cable

3.1 KSL3000 Motor Drive Cable, KSL3000 Brake Cable

To connect the motors, use the attached cables.

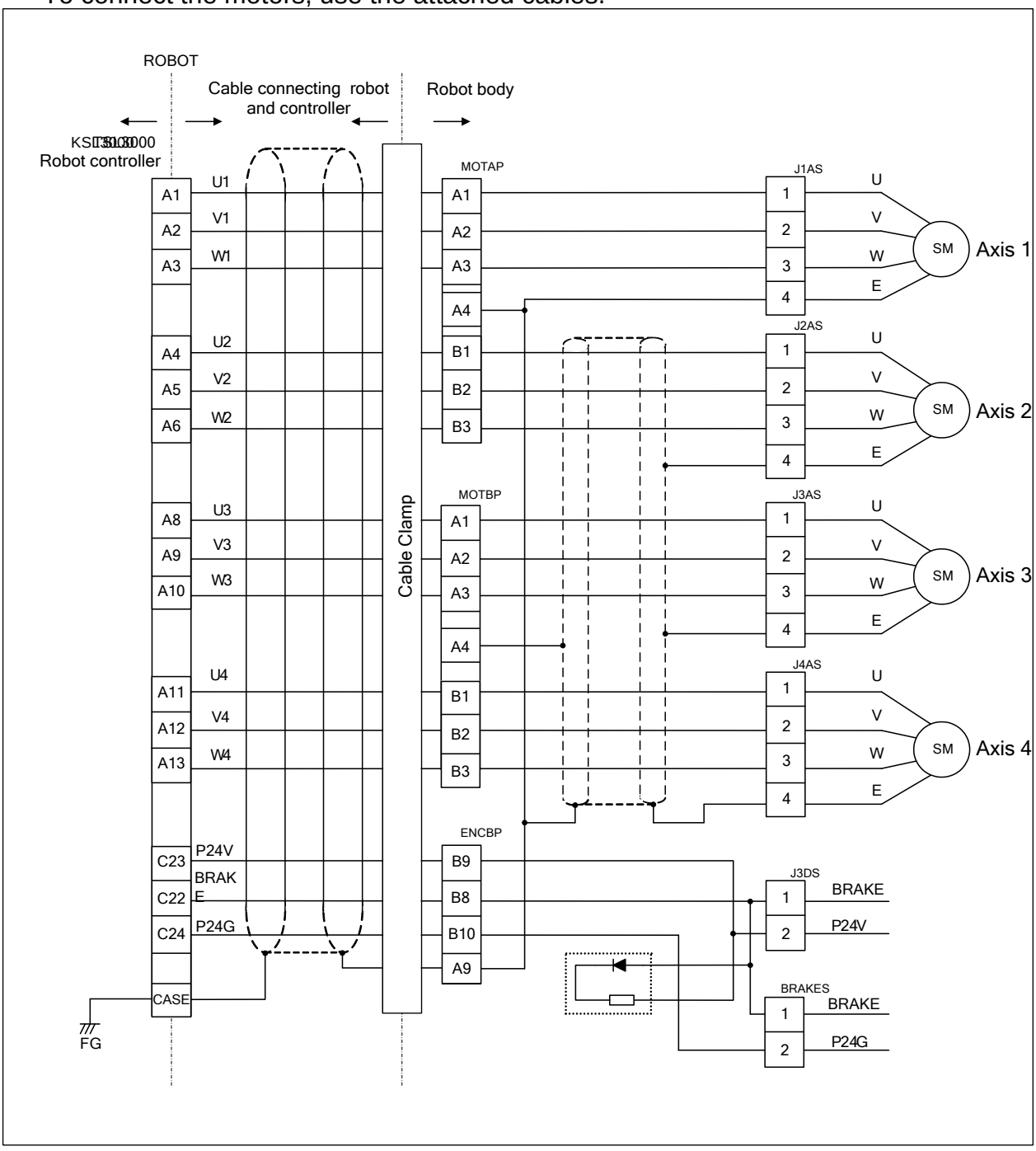


Fig. 3.1 Connection of motor drive cables

3.2 KSL3000 Encoder Cable

To connect the encoders, use the attached cables.

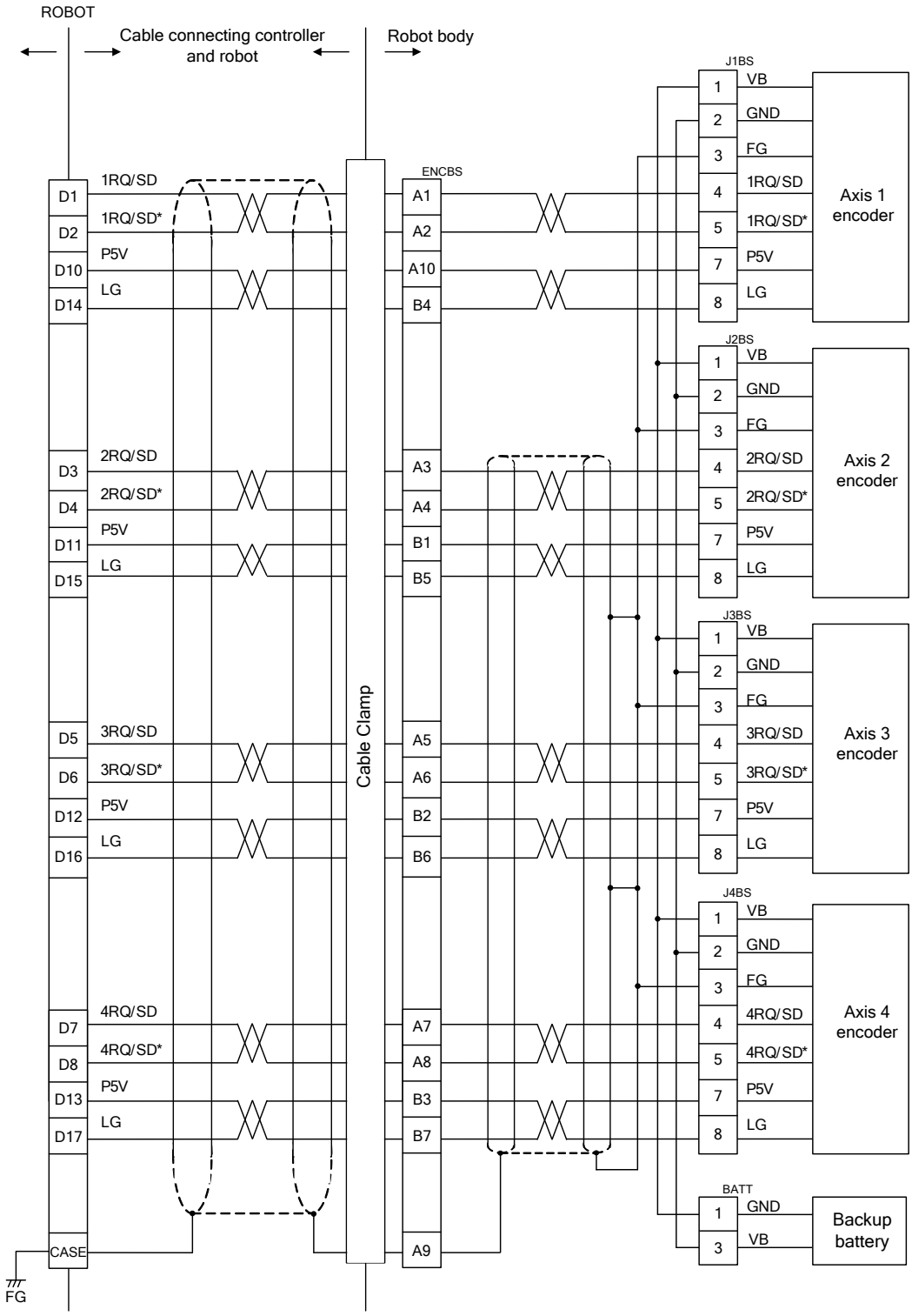


Fig. 3.2 Connection of encoder cables

3.3 Connecting Hand I/O Signal Cable (KHL, KHE Series)

Use the supplied cable to connect the robot control signal cable. The available I/O common includes "Type N" for selecting an output sink type I/O board and "Type P" for selecting an output source type. After checking the type of controller that you are using, connect the robot control signal cable.

To use a user's special system, use the attached connector XM3A-2521 (plug type connector), XM2S–2511 (connector cover)] for connecting the CN0 cable (motor drive power connections) on the robot side.

Because the number of hand I/Os differs among robots to be used, be sure to check the specification on the robot side.

Connection for Type N

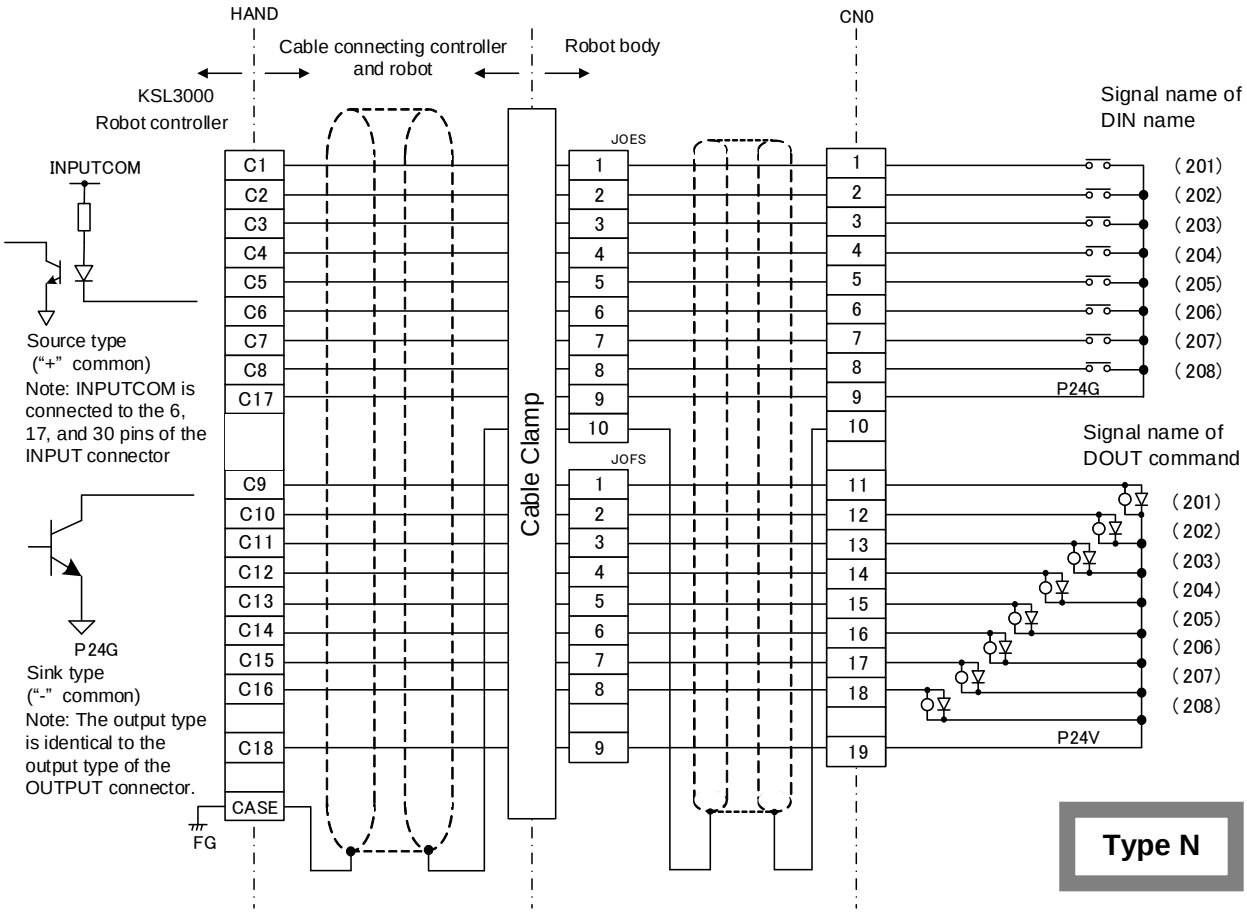


Fig. 3.3 Connection of hand I/O signal cable (Type N)

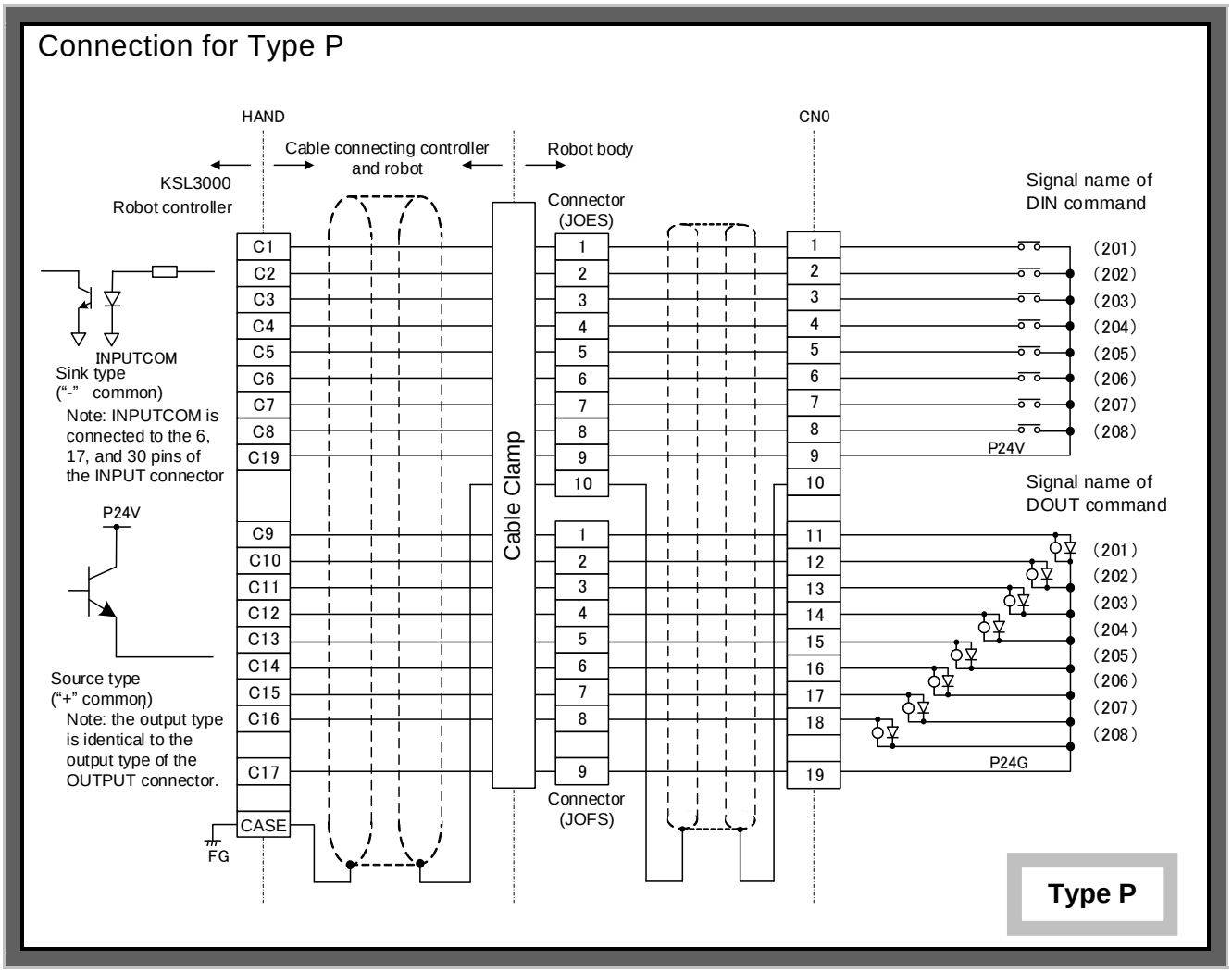


Fig. 3.4 Connection of hand I/O signal cable (Type P)

3.4 Fabricating Hand I/O Signal Cable

When fabricating a hand I/O signal cable, observe the following matters.
When using this function, use of exclusive cables (option) is recommended. For details, contact our after-sale service agent in your territory.

3.4.1 KHL/KHE Series Hand

a. The CN0 connector on the robot side should be either the attached connector or equivalent connectors. The equivalent of other makers (D-SUB connector) can also be used.

Connector name	Type of connector	Maker
CN0	XM3A–2521 (plug type connector)	OMRON
	XM2S–2511 (connector cover)	OMRON

b. Select the cables which meet the following specifications.

- Core wires : 0.18 mm^2 to 0.32 mm^2 twisted wires
- Cable outer diameter : Max. 10 mm
- Shield : Batch shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c. The CN0 connectors are of a solder cup type which joints cables by soldering. For how to joint cables to connectors and how to shield cables, see Appendix 2.

3.5 Attaching and Detaching Hand I/O Signal Cable

(When the hand I/S function of the controller is used)
Before attaching or detaching hand I/O signal cables to or from the robot, be sure to turn off the main power in the user's control panel.

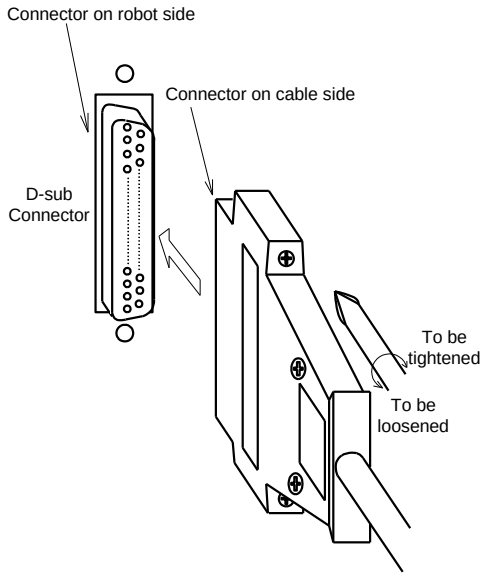


Fig. 3.5 Attaching and detaching hand I/O signal cable

To connect a hand I/O signal cable, completely insert the cable side connector into the robot side connector and tighten the lock screws on both sides of the connector with a screwdriver.
To disconnect the cable, loosen the lock screws, then pull out the connector. At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, resulting in damage of the cable.

3.6 Hand I/O Signal

The hand I/O signals control the end effector such as hand attached to the robot. The connector used is CN0 which is located on the robot arm 2.
The KSL3000 controller is provided with eight (8) input signals and eight (8) output signals to control the end effector. (Wiring from the motor drive power connections of the robot to the arm 2 is already finished before shipment.)

The specifications of the input signal are the same as those of the digital input signal. (For the connection of the common wire, see Figs. 3.3 and 3.4)

All hand output signals turn off when the controller power is turned off or turned on. Therefore, the end effector should be designed so that a product will not drop from the hand at the time of power failure.

The hand I/O signals can be controlled by a program created with the robot language. In the robot language program, the hand I/O signals are specified by the signal name assigned to each signal.
For further information on the robot language, see the Robot Language Manual.

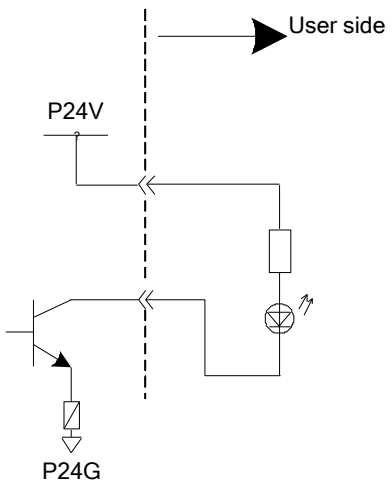
It is also possible to control a double solenoid device by combining two (2) hand output signals. When this happens, two (2) output signals bearing consecutive signal names are used for the double solenoid. Specify in the robot language program so that the two (2) output signals for the double solenoid can be exclusive during automatic operation. When the controller power is turned off and turned on, both output signals turn off.

The hand output signals can be turned on and off manually through the teach pendant. For this purpose, hand output signals to be turned on and off should be defined by the “USER.PAR” (user parameter) beforehand.
For the parameter setting, see the User Parameter Manual.

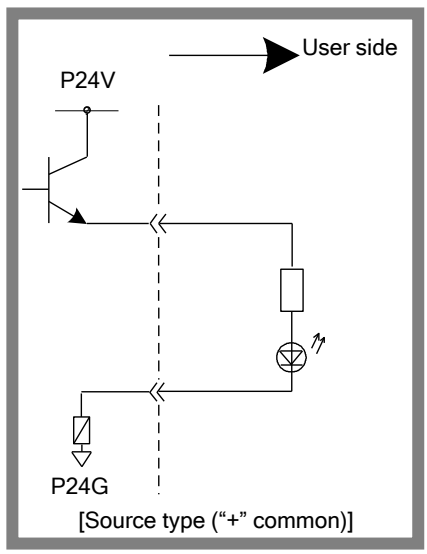
Note: When the double solenoid is defined by the user parameter, two (2) hand output signals are output exclusively through the teach pendant. These two (2) output signals for the double solenoid should be programmed by the robot language, however, so that they can be exclusive during automatic operation. Also, even if the double solenoid is defined, both two (2) output signals turn off when the controller power is turned on.
In the commands of OPEN1, OPEN2, CLOSE1, CLOSE2, OPENI1, OPENI2, CLOSEI1 and CLOSEI2, each set of signals (201, 202) and (203, 204) is exclusively output.
The hand output signal cannot be reset by the RESET SIG or RESET DOUT command.

The specifications of the hand output signal are as follows:

- Output type: Transistor output
- Electric rating: Rated voltage 24 V DC, rated current 100 mA (max.)
- Output circuit structure



[Sink type (“-” common)]



[Source type (“+” common)]

CAUTION

If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.
When using the hand I/O function, connect from the I/O P24V supply cable of the controller front panel.

3.7 ROBOT Connector Attaching and Detaching Procedures

! CAUTION

- Before attaching or detaching the cable to or from the controller, be sure to turn off the power in advance.
- When detaching the cable, hold the ROBOT connector by hand and then pull out the cable.
  Forcibly pulling the cable can cause cable wire breakage.
- When detaching the cable, pull out the cable plug while securely holding the controller. If you do not securely hold the controller, the controller may tip over while you pull out the cable connector.

a) KSL3000 Robot Connector: ROBOT
To connect the ROBOT connector, securely insert the cable connector into the connector on the controller side while pressing down the top and bottom buttons of the cable connector. When the ROBOT connector is inserted in position, you will hear a clicking sound. If the ROBOT connector is loose, it may cause an accident due to connector contact failure. So, be sure to check that it is securely connected.
To detach the ROBOT connector, follow the same procedure in reverse order. Pull out the cable connector while pressing down the top and button buttons of the ROBOT connector.

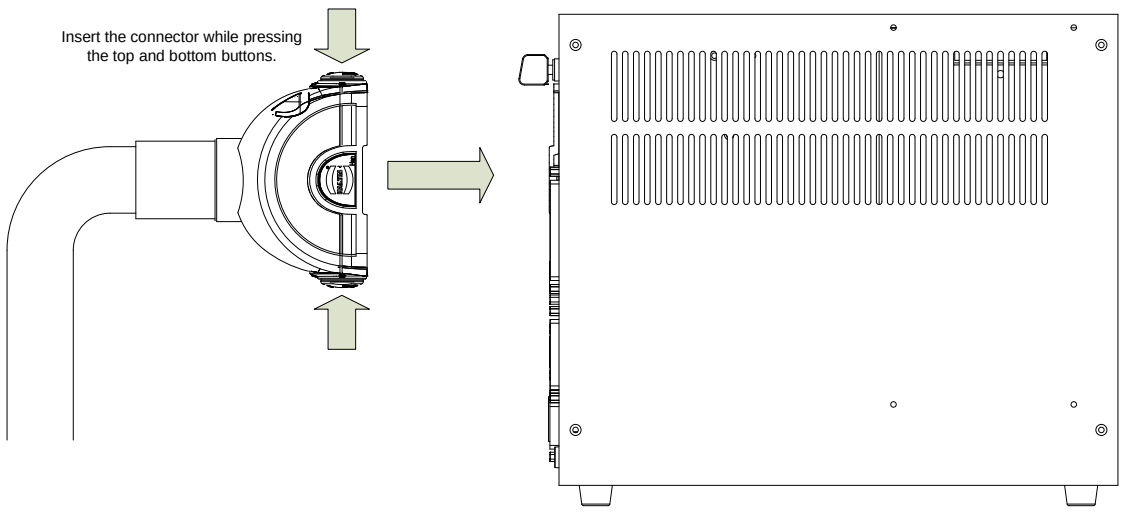


Fig. 3.7 Attaching/detaching ROBOT connector (KSL3000)

Insert the connector after checking the orientation of the top and bottom buttons. A lock mechanism is implemented by rotating the top and bottom buttons to prevent anti-locking. Be careful if the orientation of the buttons is incorrect, you cannot push them down.

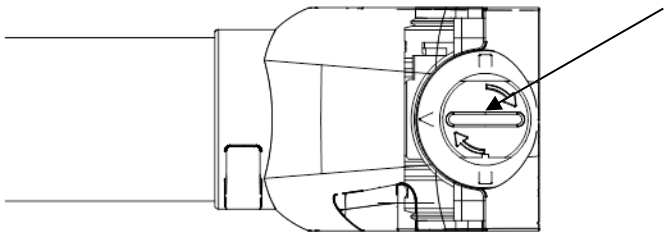


Fig. 3.8 Top view of ROBOT connector

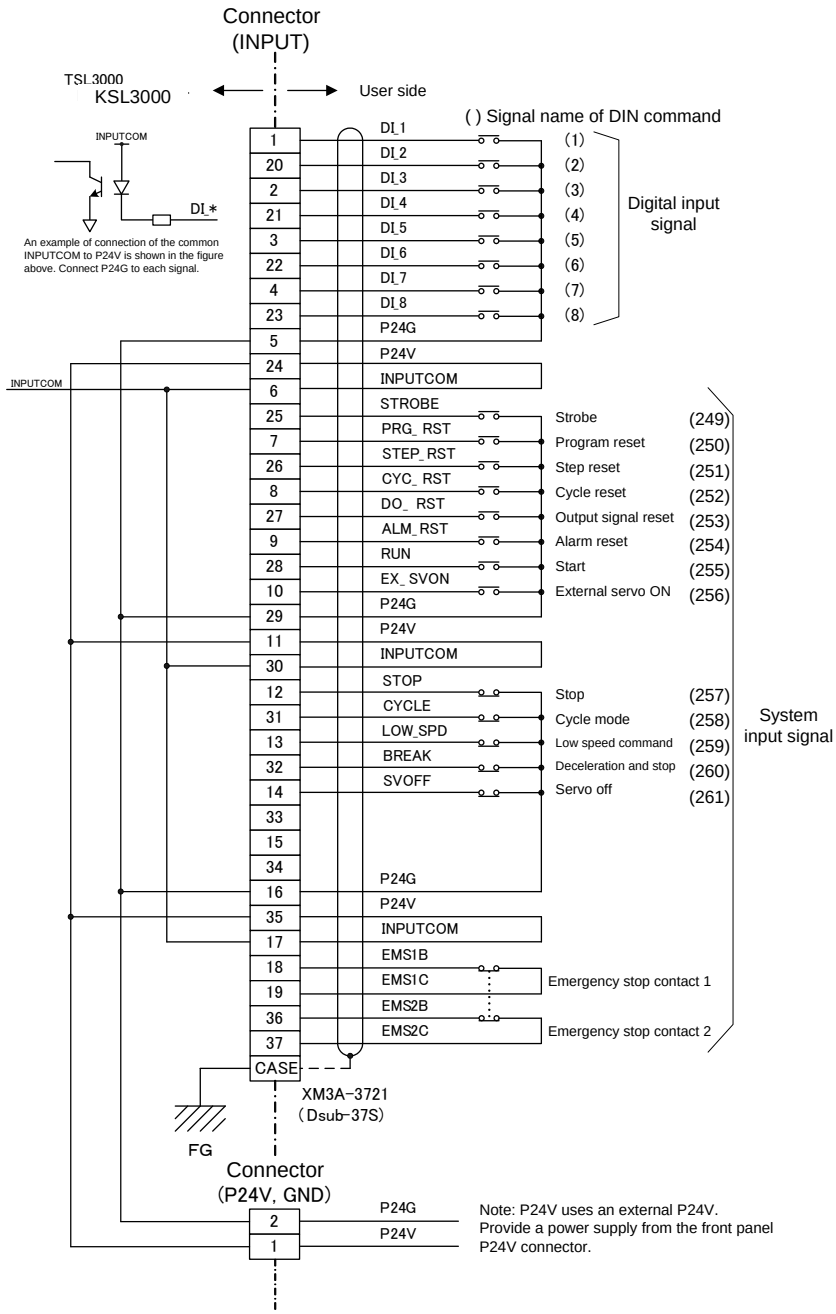
Section 4 External I/O Signal Cable

4.1 External Input Signal Cable

4.1.1 Connection of External Input Signal Cable

To connect the external input signal cable, use the attached dummy connector [XM3A–3721 (plug type connector), XM2S–3711 (connector cover)]. Some system input signals (normal close contact) of this dummy connector are jumpered. Remove the jumpers, when necessary.
A cable with its single side soldered to the connector (KSL3000: INPUT cable) is provided optionally. Contact our after-sale service agent in your territory.

Connection for Type N



Type N

Fig. 4.1 Connection of external input signal cable (Type N)

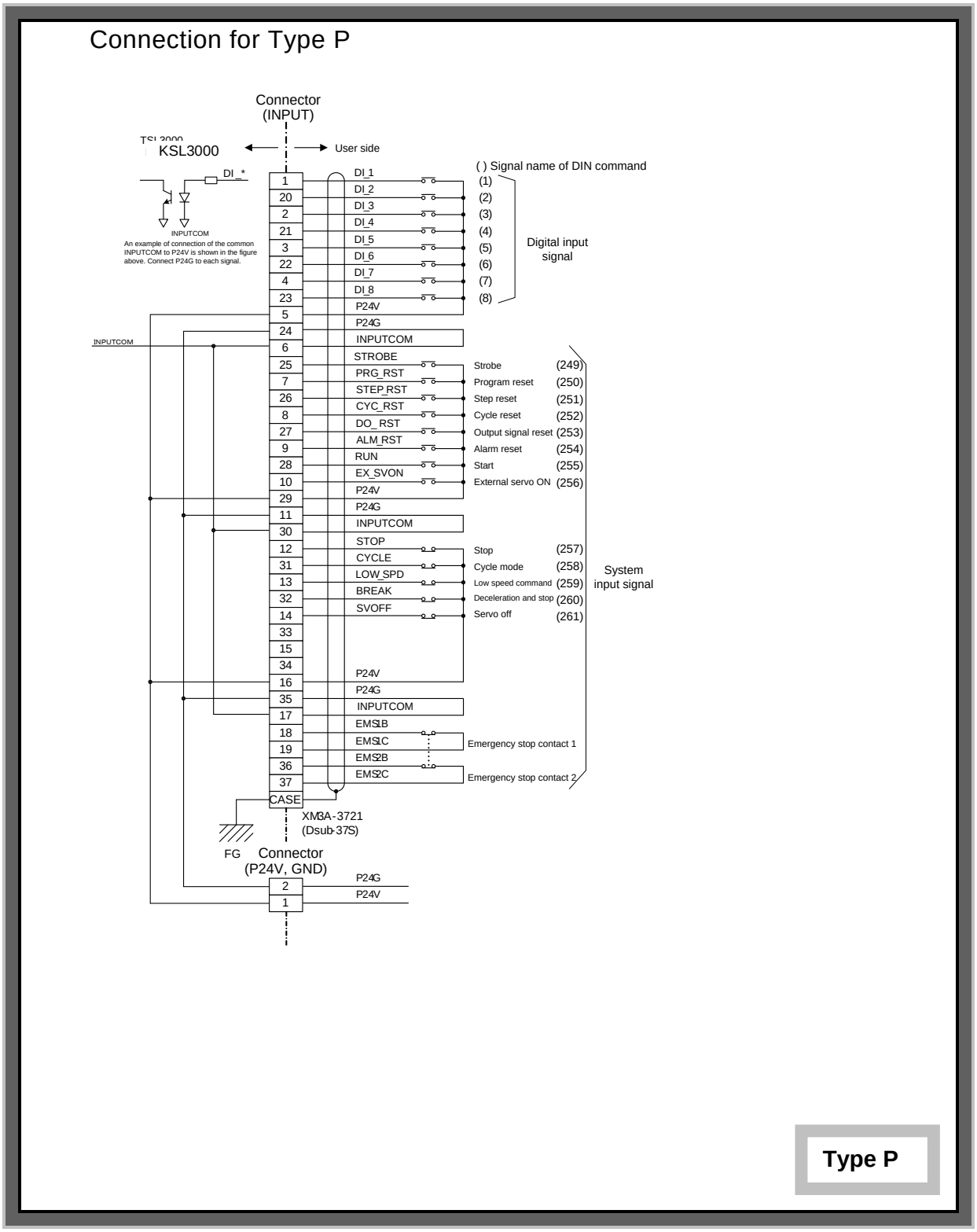
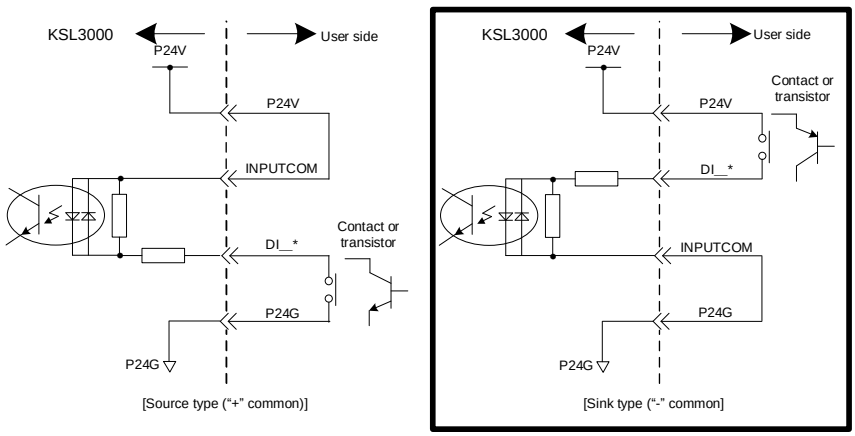
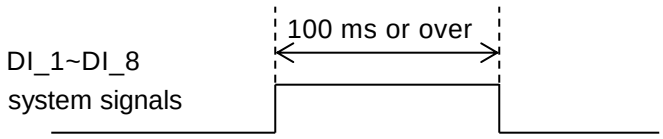


Fig. 4.2 Connection of external input signal cable (Type P)

As shown in Figs. 4.1 and 4.2 above, the external input signals are non-voltage contact inputs or open collector inputs. Some of the system inputs (“STOP”, “CYCLE”, “LOW_SPD”, “BREAK”, “SVOFF”), “emergency stop contact 1” and “emergency stop contact 2” (two (2) contacts are interconnected) are normal close contact inputs, and the others are normal open contact inputs.
For the function, circuit to use, changeover of common wire, etc., see Para. 4.1.2.

4.1.2 Digital Input Signal

Designation	Digital input signal DI_1 ~ DI_8, system input signals
Connector input terminal	Signals DI_1 ~ DI_8 are assigned to INPUT-1 ~ 4 pins and 20 ~ 23 pins. (See Fig. 4.1.) The system input signals are assigned to INPUT-7 ~ 10 pins, 12~14 pins, 25~28 pins and 31~32 pins. For details of the common wire connection, see the figure below (i.e., example of circuit).
Function	Each signal status of DI_1 ~ DI_8 can be identified by the robot program (DIN command) to branch the processing of program. Also, it is possible to perform interruptive processing of each signal (DI_1 ~ DI_8) with change in signal status monitored during the robot operation.
Input type	Non-voltage contact input or transistor open collector input.
Example of circuit (Input circuit structure)	
Signal logic	Input terminal — Signal judgment Open — OFF Short-circuit — ON

Specifications of non-voltage contact and transistor	• Non-voltage contact specifications Contact rating: 24 V DC, 10 mA or over Circuit current: Approx. 7 mA Minimum current: 24 V DC, 1 mA Contact impedance: 100 Ω or less • Transistor specifications Withstand voltage between collector and emitter: 30 V or over Current between collector and emitter: 10 mA or over Circuit current: Approx. 7 mA Leakage current between collector and emitter: 100 μA or less
Signal timing	When the pulse type input signals are used, the pulse width should be 100 ms or over. 

4.1.3 System Input Signal

A total of thirteen (13) system input signals are available, which control STOP, CYCLE, etc., sent from the external equipment to the KSL3000 robot controller. The system input signal is provided with an exclusive input terminal for each function. The structure of the system input signal is quite the same as that of the digital input signal. See the descriptions in Para. 4.1.2. (However, the two (2) signals of emergency stop contact 1 and emergency stop contact 2 differ from the above specifications. See the descriptions on each signal.)

When inputting the system input signal, keep the input status until the output signal corresponding to each input is output to assure each signal input. The relationship between input signal and output signal is stipulated by the timing chart of each signal. Also, for each signal of system input, two modes are available; enable mode and disable mode which are selectable with the master mode switch on the front of the controller. Each signal ON mode is shown in Table 4.1 below.

Table 4.1 List of system input signal ON modes

Master mode / Designation	ON mode		
	TEACHING	EXT. SIGNAL	EXT. HOST
STROBE (Strobe)		○	
PRG_RST (Program reset)		○	
STEP_RST (Step reset)		○	
CYC_RST (Cycle reset)		○	
DO_RST (Output signal reset)		○	
ALM_RST (Alarm reset)		○	
RUN (Start)		○	
EX_SVON (External servo ON)		○	
STOP (Stop)	○	○	○
CYCLE (Cycle operation mode)		○	
LOW_SPD (Low speed command)	○	○	○
BREAK (Deceleration and stop)	○	○	○
SVOFF (Servo OFF)	○	○	○
EMS*B ~ EMS*C (Emergency stop contacts 1 and 2)	○	○	○

○ : Available

CAUTION

The control unit pushbutton to be attached to the robot controller must be manufactured and installed in a way that unexpected system startup can be prevented (e.g., attachment of a wrong operation prevention card).

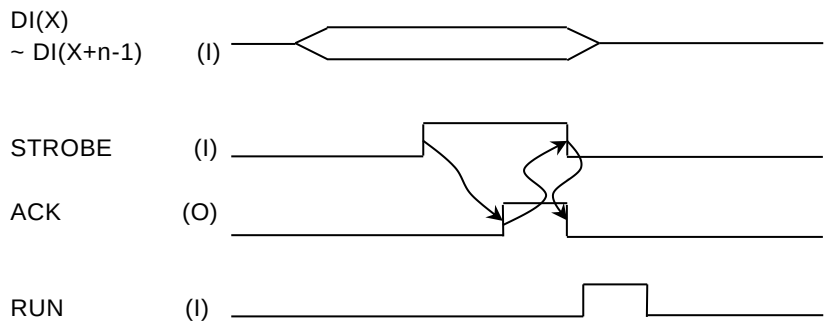
CAUTION

If the system contains more than one controller, specify so that the robot can operate only when the same operation mode is selected for all the controllers. In addition, display the operation mode of each controller on the operation equipment.

<table>
<tr><td>Designation</td><td>STROBE (Strobe)</td></tr>
<tr><td>Input terminal</td><td>INPUT-25 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>249</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to select an execution program for the KSL3000 robot controller from the external equipment.
The program number selected should use any successive "n" numbers (max. four (4) numbers) of external digital input signal, which are coded.

<table>
<tr><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>
← Program Number (max. four (4) bits)
DI(X+n–1) --------- DI (X) ← External digital input signal
* n = 1 ~ 4

For the program file name and register of it to the program number, and assignment of bits to external digital input signals, see the User Parameter Manual.

This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 

With the start of the STROBE signal, the above digital signals are read to select an appropriate program. After the program has been selected, the ACK signal turns on. Turn on the RUN signal and execute the program.</td></tr>
</table>

Cautions	The STROBE signal should not be input together with the PRG_RST, CYC_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. If a file other than the current file is selected, the program is reset to step 1 and the values of variables are reset also.

* Program file name and register of it to program number, and assignment of bits to external digital input signals:

To select an execution file (i.e., program selection), using digital input or extension input signals, assignment of bits to the controller input signals is necessary.

User parameter [U07]
[U07] Specify signal for EXTSELECT.
{Signal No.} (1 –)
{Bit length} (1 – 4)
= 1 4

Bits underlined = (Leading signal name in DIN command) (Bit length).
"Signal name in DIN command" signifies an input signal number assigned in a program to run the internal sequence. (The signal name is predetermined in the program and cannot be changed by the user.)
For the digital input signal, "signal name in DIN command" represents a number in parentheses as shown on the right side of the signal name in Fig. 4.1.

(Leading signal name in DIN command):
Specify the leading number of input signals to be used.
(Allowable range: 1 ~ 8, 101 ~ 164)

(Bit length):
Specify the number of signals to be used. (Allowable range 1 ~ 4)

Set value underlined (ex.) = 1 4
This signifies that four (4) external digital input signals 1 ~ 4 are used.

Correspondence table
between [U07] set value (example) and [U08] program file name

Signal name in DIN command / Program file name (EXTRNSEL.PAR)	4	3	2	1
"PROG1"	0	0	0	0
"PROG2"	0	0	0	1
"PROG3"	0	0	1	0
"PROG4"	0	0	1	1
"PROG5"	0	1	0	0
"PROG6"	0	1	0	1
"PROG7"	0	1	1	0
"PROG8"	0	1	1	1
"PROG9"	1	0	0	0
"PROG10"	1	0	0	1
"PROG11"	1	0	1	0
"PROG12"	1	0	1	1
"PROG13"	1	1	0	0
"PROG14"	1	1	0	1
"PROG15"	1	1	1	0
"PROG16"	1	1	1	1

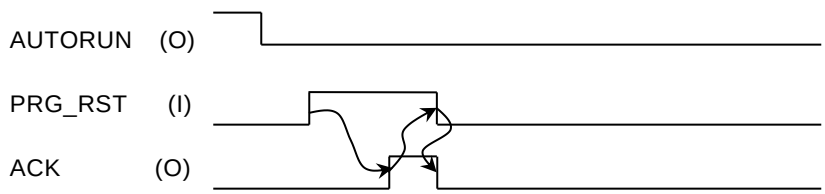
When bits underlined = 1 2, two (2) external digital input signals 1 and 2 are used, and the number of program files selected is four (4) from "PROG1" ~ "PROG4".

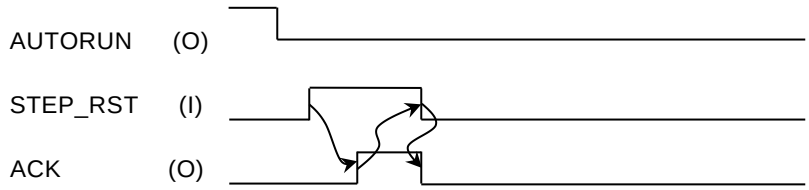
To register the program file name to the program number, register on the EXTRNSEL.PAR file.

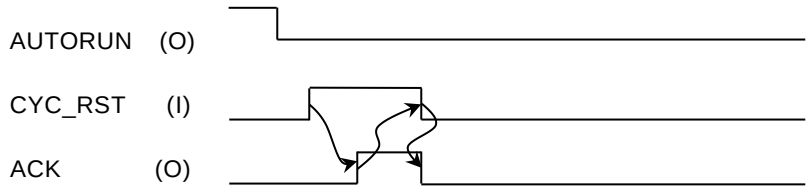
EXTERNAL SELECT FILE
*** [00 - 0F] *****
= "PROG00"
= "PROG01"
= "PROG02"
= "PROG03"
= "PROG04"
= "PROG05"
= "PROG06"
= "PROG07"
= "PROG08"
= "PROG09"
= "PROG0A"
= "PROG0B"
= "PROG0C"
= "PROG0D"
= "PROG0E"
= "PROG0F"

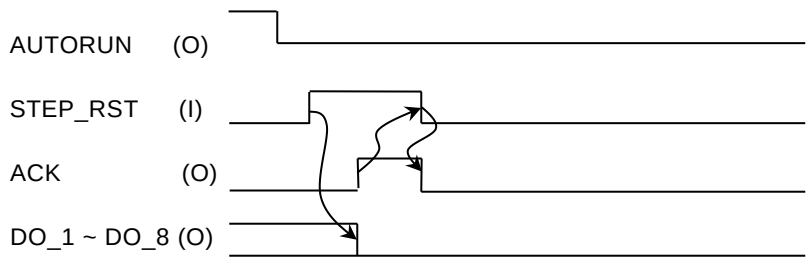
The initial setting is as shown above. Specify a file name you registered beforehand for the underlined of "PROG**".

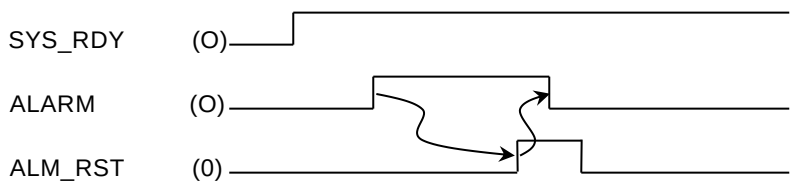
After the above parameter has been changed, save the data, turn the power off and on again. Otherwise, the parameter will not be operative.

<table>
<tr><td>Designation</td><td>PRG_RST (Program reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-7 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>250</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset a currently stopped program to step 1.
The value of each variable is also reset to zero (0).
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. The PRG_RST signal should not be input together with the STROBE, CYC_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid.
2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>STEP_RST (Step reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-26 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>251</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset a currently stopped program to step 1.
The value of each variable used in the program remains unchanged.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. The STEP_RST signal should not be input together with the STROBE, PRG_RST, CYC_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid.
2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.</td></tr>
</table>

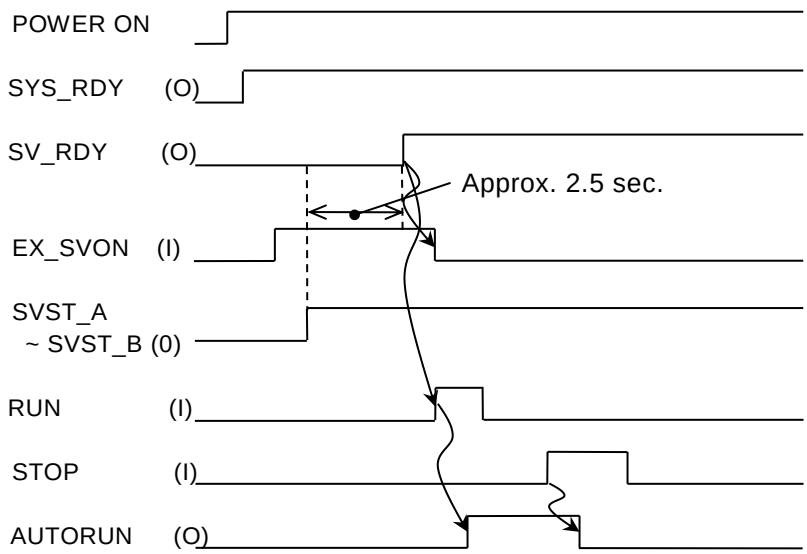
<table>
<tr><td>Designation</td><td>CYC_RST (Cycle reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-8 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>252</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset a currently stopped program to the step labeled "RCYCLE". The value of each variable used in the program remains unchanged.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. The CYC_RST signal should not be input together with the STROBE, PRG_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid.
2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.</td></tr>
</table>

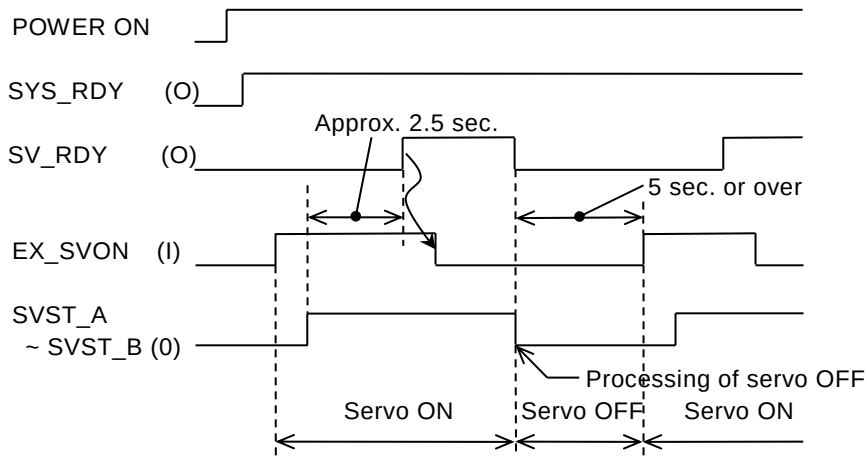
<table>
<tr><td>Designation</td><td>DO_RST (Output signal reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-27 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>253</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset digital output signals (DO_1 ~ DO_8, DO_101 ~ DO_120, DO_133 ~ DO_152) of the KSL3000 robot controller from the external equipment. When reset, all signals of DO_1 ~ DO_8 turn off. However, the system output signals are turned on.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. The DO_RST signal should not be input together with the STROBE, PRG_RST, CYC_RST or STEP_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. Neither system output signals nor hand output signals are reset.
2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.</td></tr>
</table>

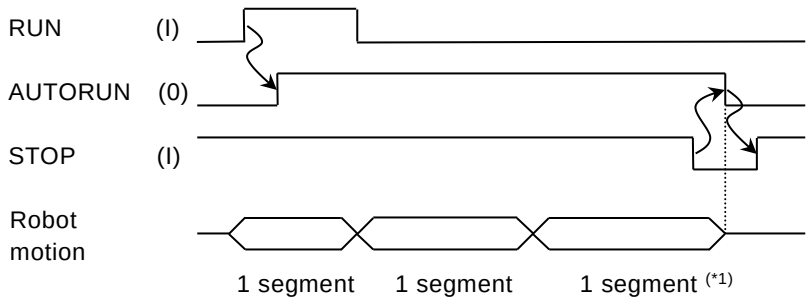
<table>
<tr><td>Designation</td><td>ALM_RST (Alarm reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-9 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>254</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to cancel an alarm from the external equipment, which occurred while the KSL3000 robot controller was able to start. This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>If an alarm of the emergency stop level which will not allow the processing of EX_SVON, or EMSST_A ~ EMSST_B is output, alarm reset by the ALM_RST signal is not possible.</td></tr>
</table>

Designation	RUN (Start)
Input terminal	INPUT-28 pin
Signal name in DIN command	255
Signal logic	

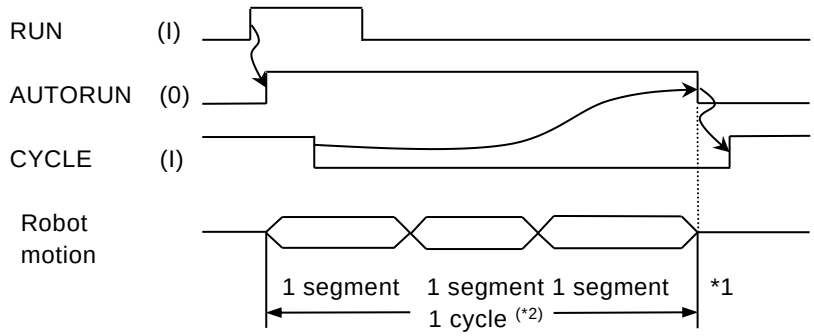
Signal judgment / Signal terminal	ON	OFF
Open		○
Short-circuit	○	

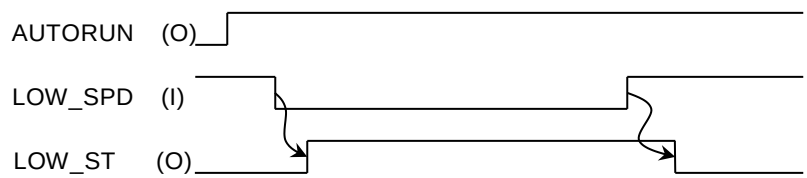
Function	Used to start a program registered in the KSL3000 robot controller from the external equipment to execute an automatic cycle operation. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	
Cautions	After servo ON, automatic operation starts with the start of the RUN signal. It takes about two (2) seconds from the input of EX_SVON to the time when the robot is actually ready to work. Thus, it is necessary to program a delay of 2.5 seconds or over between the SVST_A ~ SVST_B signal ON and the RUN signal ON. Set ON the RUN signal only after the SV_RDY signal is ON. If the RUN signal is input without a delay, it is neglected and the automatic operation may not be started.

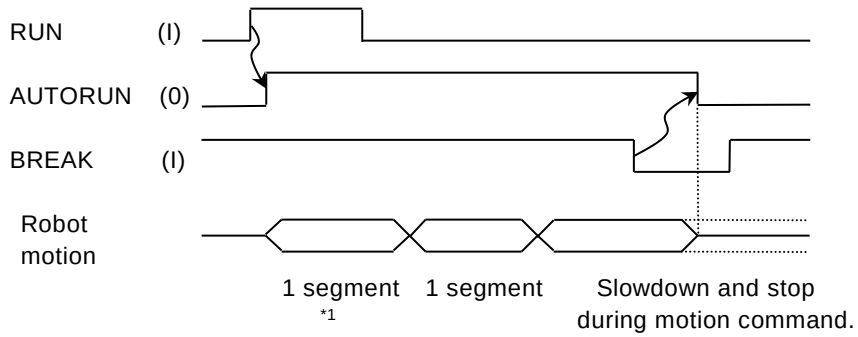
<table>
<tr><td>Designation</td><td>EX_SVON (External input servo ON)</td></tr>
<tr><td>Input terminal</td><td>INPUT-10 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>256</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to turn on the servo driver main power from the external equipment. Once the servo power is turned on, it is maintained even after this signal turns off.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>To prevent an internal damage, the servo cannot be turned on about 4.5 seconds after it is turned off. To turn the servo on again, wait at least five (5) seconds after the SVST_A ~ SVST_B signal turns off. For the third turning on of the servo, the interval time is seven (7) seconds.
For the third turning on of the servo, the interval time is seven (7) seconds.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>STOP (Stop)</td></tr>
<tr><td>Input terminal</td><td>INPUT-12 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>257</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to stop executing a program registered in the KSL3000 robot controller from the external equipment. When this signal is open, the program stops after the current motion command has been executed.
When this signal is open, the robot cannot be operated.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 

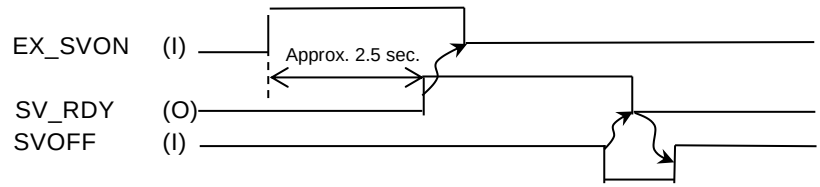
*1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment".</td></tr>
<tr><td>Cautions</td><td>1. When the RUN command is executed after cancel of STOP, the program restarts from the step next to the interrupted step.
2. RUN signal input is ineffective at the input of STOP signal.
3. Unless this signal is used, short-circuit INPUT-12 according to the common wire connection.</td></tr>
</table>

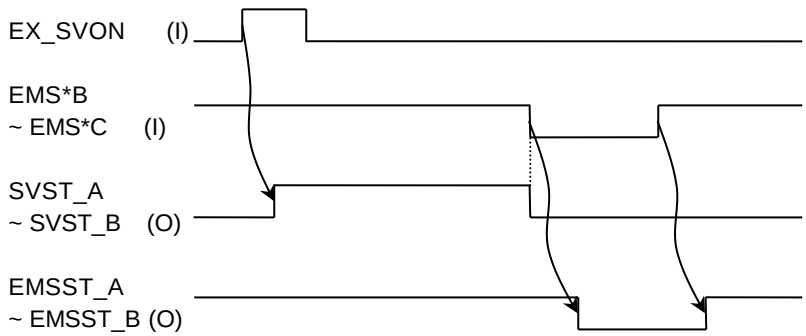
Designation	CYCLE (Cycle operation mode)
Input terminal	INPUT-31 pin
Signal name in DIN command	258
Signal logic	<table><tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr><tr><td>Open</td><td>○</td><td></td></tr><tr><td>Short-circuit</td><td></td><td>○</td></tr></table>
Function	Used to stop from the external equipment a program registered in the KSL3000 robot controller after current one (1) cycle operation has been executed during automatic operation. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	 *1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment". *2 Duration from the top of the main program to the END command is called "1 cycle".
Cautions	

<table>
<tr><td>Designation</td><td>LOW_SPD (Low speed command)</td></tr>
<tr><td>Input terminal</td><td>INPUT-13 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>259</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td>O</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to cause the robot operation speed to low speed from the external equipment.
The robot operates at a low speed (the low speed command is valid) while this signal is open.
The robot operation speed in the low speed mode can be set by means of the parameter. (Initial set value: 25 %)
When this signal is short-circuited, the previously set value (initial set value: 100 %) takes effect again.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

<table>
<tr><td>Designation</td><td>BREAK (Deceleration and stop)</td></tr>
<tr><td>Input terminal</td><td>INPUT-32 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>260</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to stop the robot motion from the external equipment.
The robot slows down and stops at the same time that this signal is open. After the stop, the robot enters a STOP (RETRY) status.
Even if this signal is short-circuited again after the stop of robot motion, the robot will not operate. To restart the robot, short-circuit this signal, then execute the RUN command.
If this signal is open, the robot cannot be started.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 

*1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment".</td></tr>
<tr><td>Cautions</td><td>1. If the robot is operating, processing of execution is interrupted and the robot slows down and stops.
2. Unless this signal is used, short-circuit INPUT-32 according to the common wire connection.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SVOFF (Servo OFF)</td></tr>
<tr><td>Input terminal</td><td>INPUT-14 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>261</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON
(Servo OFF)</th><th>OFF
(Normal)</th></tr>
<tr><td>Open</td><td>O</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to turn off the servo driver main power from the external equipment.
While this signal is open, the servo power is turned off.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. <u>While this signal is open, the servo power cannot be turned on in any mode.</u>
2. Unless this signal is used, short-circuit INPUT-14 according to the common wire connection.</td></tr>
</table>

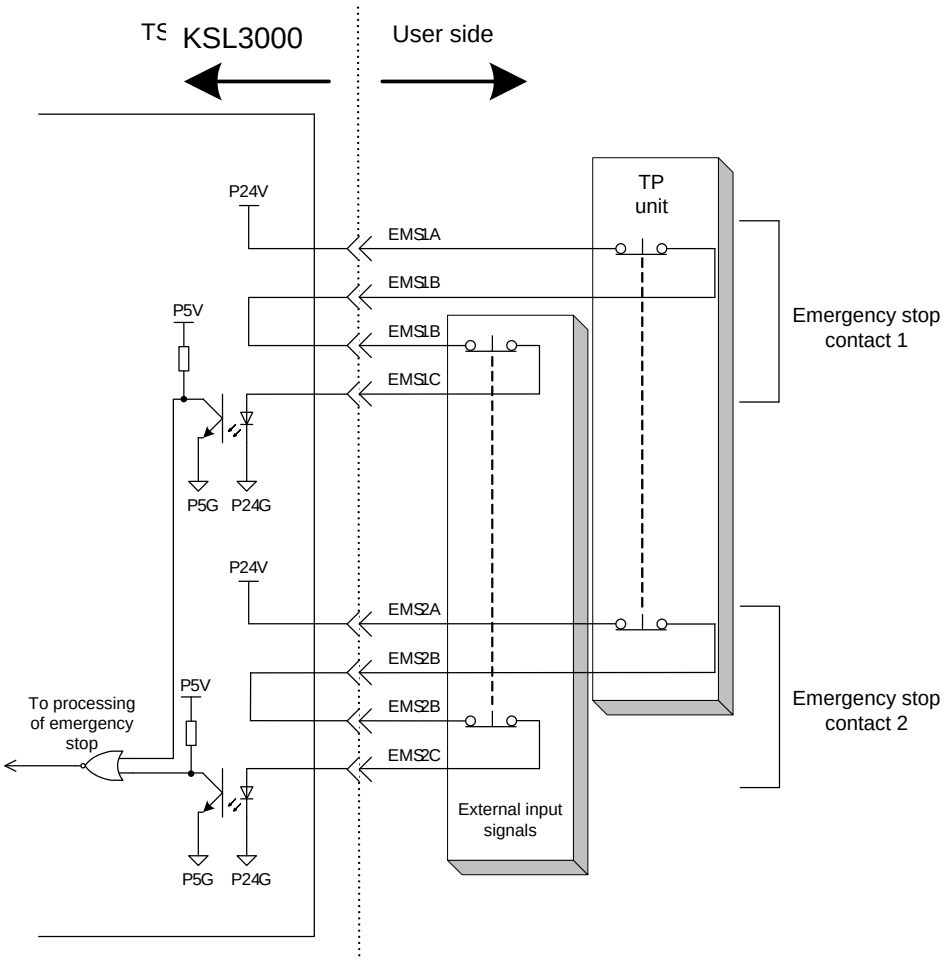
<table>
<tr><td>Designation</td><td>EMS*B ~ EMS*C (Emergency stop contacts 1 & 2)</td></tr>
<tr><td>Input terminal</td><td>Between INPUT-18 ~ INPUT-19 (Emergency stop contact 1)
Between INPUT-36 ~ INPUT-37 (Emergency stop contact 2)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON (Emergency stop)</th><th>OFF (Normal)</th></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to emergency-stop the robot from the external equipment.
While this signal is open, the processing of robot emergency stop is executed.
Use this signal by connecting a safety device such as external emergency stop switch, photoelectric type sensing safety device and safety mat switch.
When the emergency stop contact is open, system output signals EMSST_A ~ EMSST_B are short-circuited.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
</table>

Cautions	1. While this signal is open, the servo power cannot be turned on in any mode. 2. EMS*A ~ EMS*B are assumed to have two (2) normal close contacts interconnected, which should be turned on and off at the same time. If there is a delay in contact operation, the non-conformity detecting function of hardware works to effect an emergency stop. When this happens, the system can be restored only by tuning off and on again the controller power. For the contact structure of the emergency stop switch, see the descriptions on the emergency stop signal line given below. 3. Unless this signal is used, short-circuit INPUT-18 ~ INPUT-19, and INPUT-36 ~ INPUT-37.

* Emergency stop signal line

The connection diagram of the emergency stop switch is shown below. After wiring, be sure to check the operation of the emergency stop switch several times.

Check if the controller detects 8-014 "Emergency Stop SW ON" error when the emergency stop switch is pressed. Conversely, check if 8-014 "Emergency Stop SW ON" error is recovered when the emergency stop switch is deactivated. If any other errors occur, wiring is incorrect. If you continue to use the system without recovering from errors, the robot can no longer be stopped, leading to serious accidents. Never use the system under such error conditions. It can also cause controller failures.


TS KSL3000
User side
TP unit
P24V
EMS1A
EMS1B
P5V
EMS1B
EMS1C
P5G
P24G
Emergency stop contact 1
P24V
EMS2A
EMS2B
P5V
To processing of emergency stop
EMS2B
EMS2C
External input signals
P5G
P24G
Emergency stop contact 2

Notes on emergency stop switches

Note on the following when choosing an emergency stop switch:

- Install an emergency stop device to the KSL3000 and other locations where emergency stop is required. All the emergency stop devices must be placed where they can be easily accessed.
- Choose an emergency stop device which has such a structure that when the emergency stop device works, the circuit will not be automatically reset until the emergency stop device is reset manually and the contact will be reset only after the emergency stop device is reset.
- Choose any of the following shapes of emergency stop device that is suitable for the machine structure and characteristics so that unsafe conditions can be eliminated:
  1) Mushroom-type pushbutton
  2) Rope pull type, or bar type
  3) Belly or knee action type
  4) Pedal switch without a protective cover
- The pushbutton type of emergency stop device shall have a red actuator on a yellow background.
- The rope pull type of emergency stop device shall always maintain proper tension on the rope, and the rope shall be identified colored red and yellow.

4.1.4 Jumper of Safety Measure Signal

Of the system input signal cables, the following signals are used for the safety measures.

System input signal cables	·····	INPUT-12	(STOP)
		INPUT-14	(SV_OFF)
		INPUT-32	(BREAK)
		INPUT-18, 19	(EMS1B ~ EMS1C)
		INPUT-36, 37	(EMS2B ~ EMS2C)
		INPUT-17, 35	(INCOM ~ P24V)

For the dummy connector provided with the KSL3000 robot controller, these signals are already jumpered. If these signals are used or changed, perform wiring with the jumper of connector removed. When operating the robot without using system input signals, be sure to connect the attached dummy connector to the INPUT connector on the controller side.

Unless the following signals are used as the external signals, jumper the cables also.

INPUT-13	(LOW_SPD)
INPUT-31	(CYCLE)

Jumper of connector [P24G(+) common is assumed as per Fig. 4.1.]

INPUT			
12–16	14–16	32–16	36–37
(13–16)	(31–16)	18–19	17–35

! CAUTION

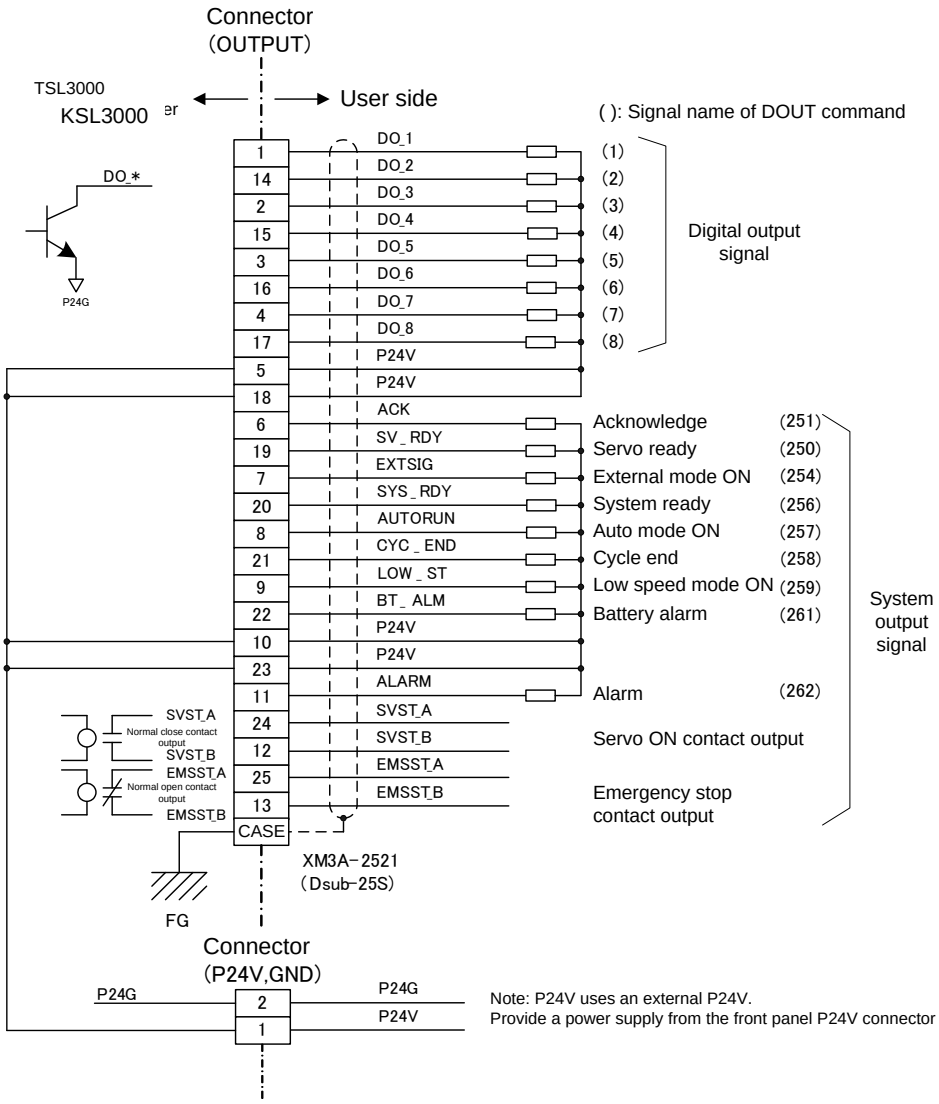
- Unless the signals of SVOFF and emergency stop contacts 1 and 2 are jumpered, the controller servo power cannot be turned on.
- If the CYCLE signal is not connected by a jumper, the controller runs in cycle operation mode.
- If the LOW_SPD signal is not connected by a jumper, the robot automatic operation speed is low speed.
- If the STOP signal is not connected by a jumper, robot automatic operation is not performed.
- If the BREAK signal is not connected by a jumper, robot automatic operation is not performed.

4.2 External Output Signal Cable

4.2.1 Connection of External Output Signal Cable

To connect the external output signal cable, use the attached connector [XM3A–2521 (plug type connector), XM2S–2511 (connector cover)].
A cable with its single side soldered to the connector (KSL3000: OUTPUT cable) is provided optionally. Contact our after-sale service agent in your territory.

Connection for Type N



Type N

Fig. 4.3 Connection of external output signal cable (Type N)

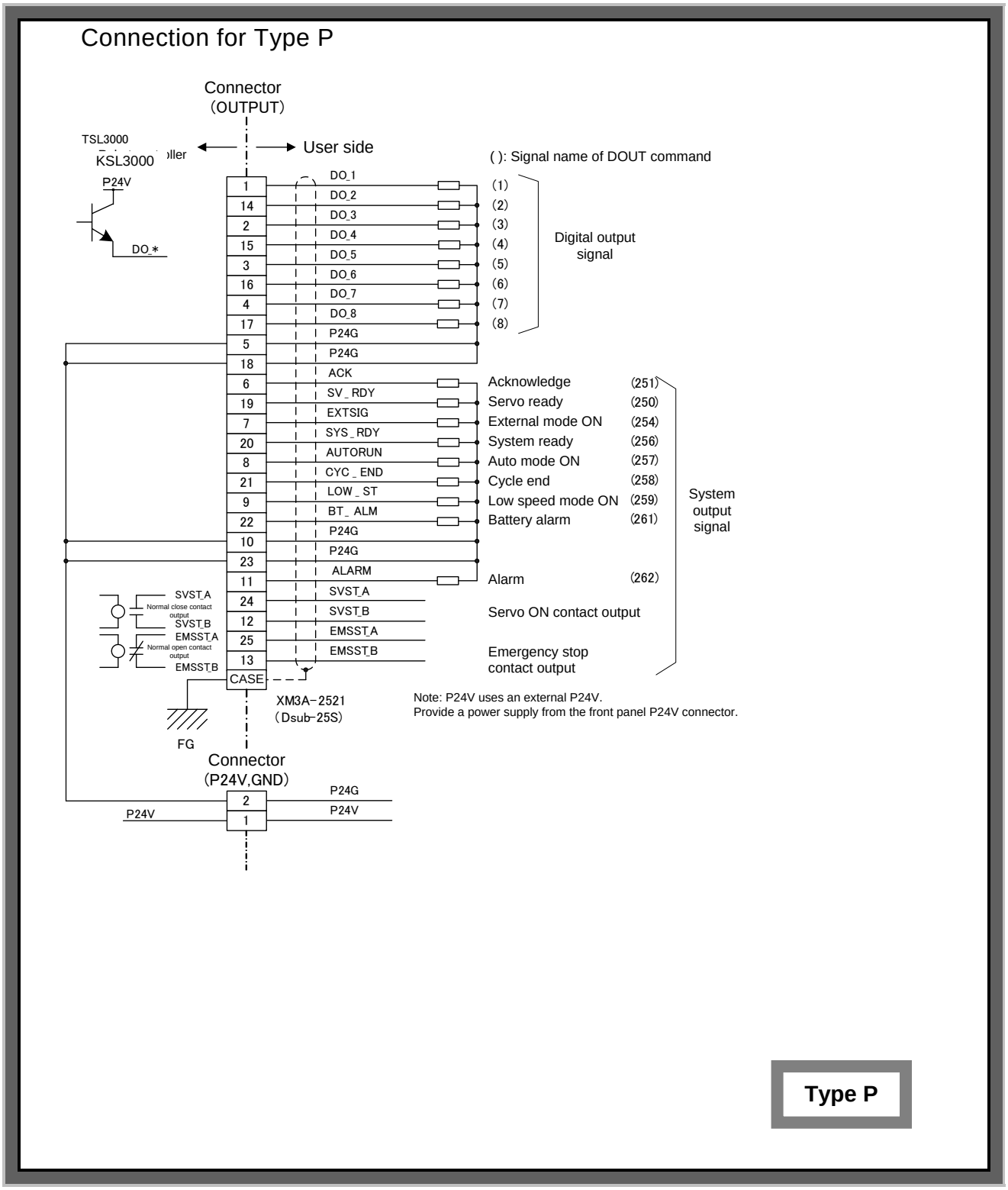
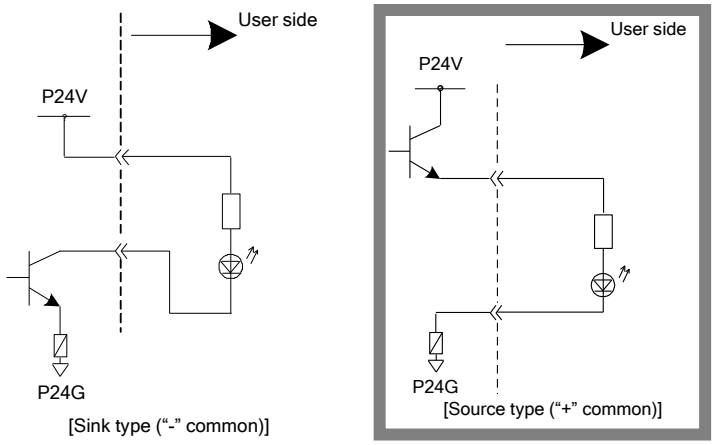
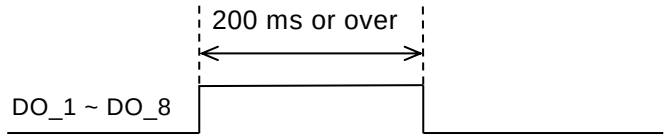
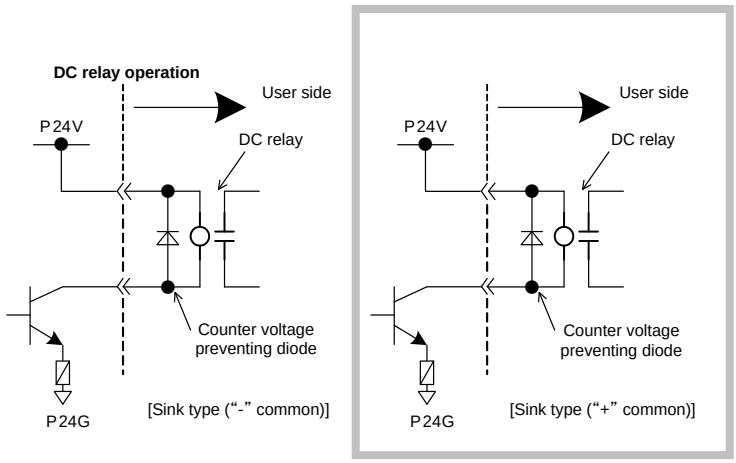


Fig. 4.4 Connection of external output signal cable (Type P)

As shown in Figs. 4.3 and 4.4 above, all sixteen (16) digital output signals are transistor outputs. Two (2) system output signals (i.e., servo ON contact output and emergency stop contact output) are non-voltage relay contact outputs, and all other system output signals are transistor outputs.
For the function, circuit to use, etc., see Para. 4.2.2.
External output can be controlled by the KSL3000 internal sequencer. For details, see the Simplified PLC Manual.

4.2.2 Digital Output Signal

Designation	Digital output signal DO_1 ~ DO_8 (system output signals)
Connector output terminal	Signals DO_1 ~ DO_8 are assigned to OUTPUT-1 ~ 4 pins and 14 ~ 17 pins. (See Fig. 4.2.) The system output signals are assigned to OUTPUT-6 ~ 9 pins, 11 pin, and 19 ~ 22 pins.
Function	ON/OFF of signals DO_1 ~ DO_8 and pulse output can be performed by the robot program (BCDOUT command and PULOUT command).
Output type	Transistor output
Output circuit structure	
Electric rating	Rated voltage: 24 V DC Rated current: 100 mA (max.) **<u>Caution:</u>** If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.

Signal timing	When performing pulse output by the PULOUT command, the output pulse width should be 200 ms or over. 
Example of circuit	

4.2.3 System Output Signal

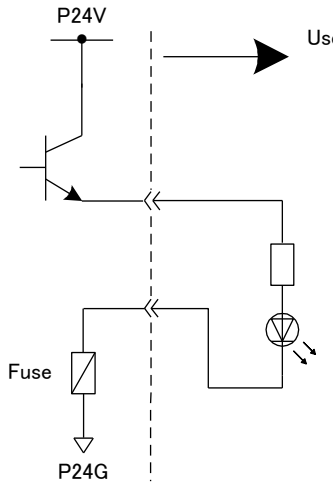
A total of eleven (11) system output signals are available. Of them, nine (9) signals are used to output the run status of the KSL3000 robot controller and the remaining two (2) signals are output via relay contact.
The system output signal is provided with an exclusive output terminal for each function.
The two (2) relay output signals are SVST_A ~ SVST_B and EMSST_A ~ EMSST_B. The former signal (SVST_A ~ SVST_B) is of a normal open contact type and the latter signal (EMSST_A ~ EMSST_B) is of a normal close contact type. They differ in contact operation at the time of output signal ON/OFF. When using, take careful precautions not to mistake.
The specifications of the system output signals are as follows:

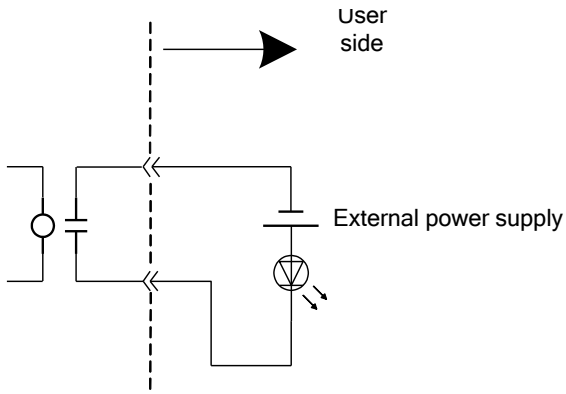
- Output type
  (1) Transistor output (system output signal)
  (2) Relay contact output (SVST_A ~ SVST_B, EMSST_A ~ EMSST_B)

  Note: SVST_A ~ SVST_B : Normal open contact output
  EMSST_A ~ EMSST_B : Normal close contact output

- Output circuit structure

  (1) Transistor output (2) Relay contact output





* The above figure exemplifies a normal open contact output structure.
The servo ON contact output is of a normal open contact type and the emergency stop contact output is of a normal close contact type. Take utmost care when using.

- Transistor specification

  Rated voltage: 24 V DC

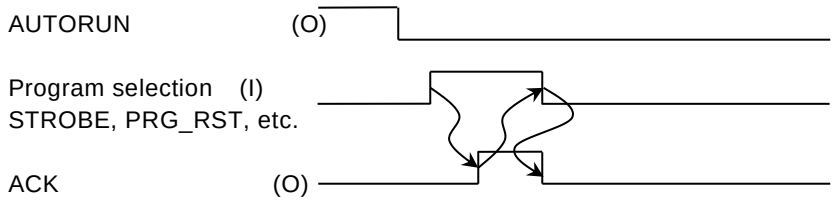
  Rated current: 100 mA max.

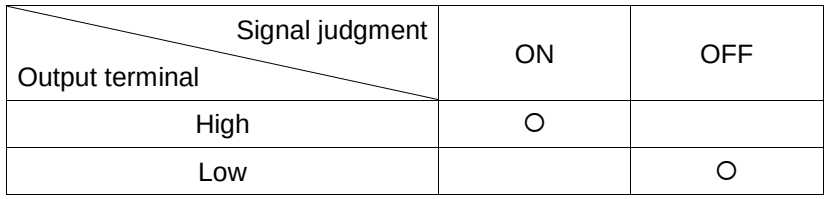
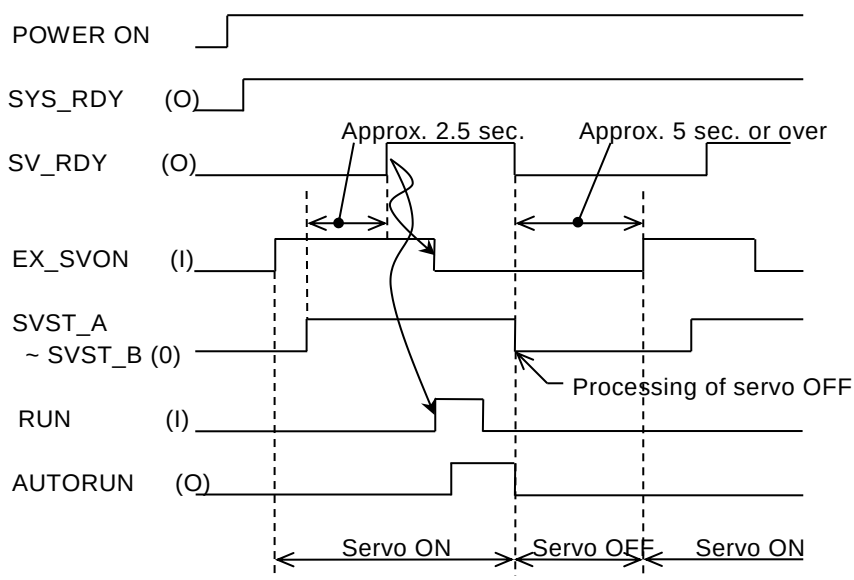
- Relay contact specification

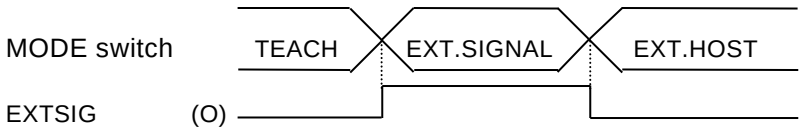
  Maximum rating: 125 V AC, 0.5 A / 60 V DC, 1.0 A

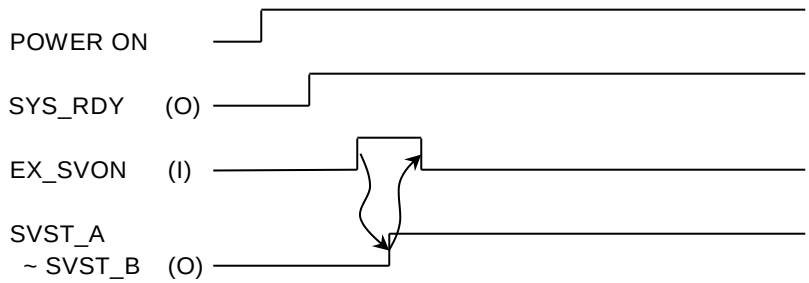
! CAUTION

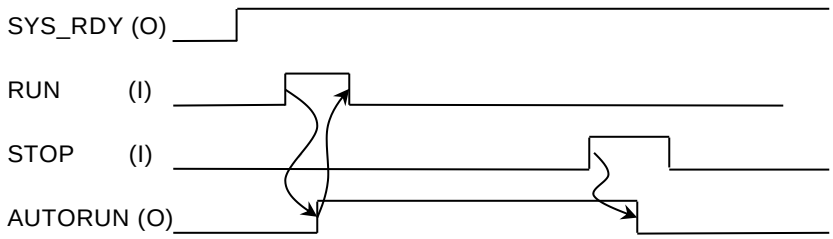
If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.

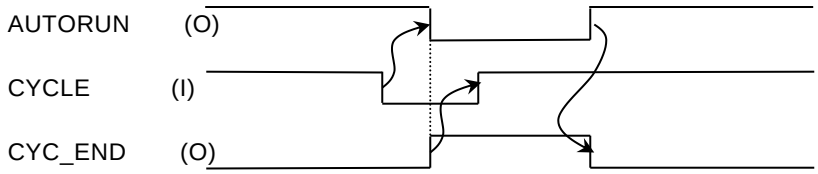
Designation	ACK (Acknowledge)
Output terminal	OUTPUT-6 pin
Signal name	251
Signal logic	<table><tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr><tr><td>High</td><td>○</td><td></td></tr><tr><td>Low</td><td></td><td>○</td></tr></table>
Function	This is a response signal to the STROBE, PRG_RST, STEP_RST, CYC_RST and DO_RST signals. When one of these signals is input, the ACK signal is sent back to inform that appropriate processing has finished. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	
Cautions	If two (2) or more input signals shown above are input at the same time, only the signal which was input first is processed, then the ACK signal is output.

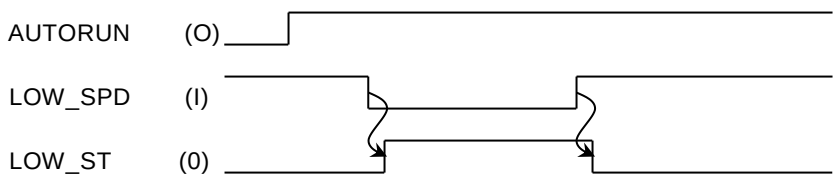
Designation	SV_RDY (Servo ready)
Output terminal	OUTPUT-19 pin
Signal name	250
Signal logic	
Function	This signal indicates that the servo power of the KSL3000 robot controller can be turned on. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	
Cautions	1. Program so that the RUN signal can be turned on only after the SV_RDY signal turns on. 2. To prevent an internal damage, the servo cannot be turned on about 4.5 seconds after it is turned off. To turn the servo on again, wait at least five (5) seconds after the SVST_A ~ SVST_B signal turns off. For the third turning on of the servo, the interval time is seven (7) seconds.

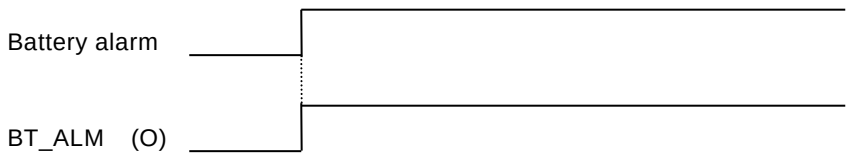
<table>
<tr><td>Designation</td><td>EXTSIG (External mode ON)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-7 pin</td></tr>
<tr><td>Signal name</td><td>254</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on when the MODE switch of the KSL3000 robot controller is set to "EXT. SIGNAL".</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>When the EXT. SIGNAL mode is selected by means of the MODE switch, all system input signals become operative.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SYS_RDY (System ready)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-20 pin</td></tr>
<tr><td>Signal name</td><td>256</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on when the robot can start after the controller main power is turned on.
With this signal, it is possible to confirm that the robot can be operated.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

Designation	AUTORUN (Auto mode ON)
Output terminal	OUTPUT-8 pin
Signal name	257
Signal logic	<table><tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr><tr><td>High</td><td>○</td><td></td></tr><tr><td>Low</td><td></td><td>○</td></tr></table>
Function	This signal turns on when the robot is operating in the automatic operation mode. When the RUN signal is made valid after the SYS_RDY signal is turned on, automatic operation starts with this signal output. This signal remains on as long as the robot is operating in the automatic operation mode. This signal turns on when the EXT. SIGNAL or EXT. HOST mod is selected by means of the MODE switch of the KSL3000 robot controller.
Signal timing	
Cautions	This signal will not turn on while the TEACH mode is selected by means of the MODE switch of the KSL3000 robot controller.

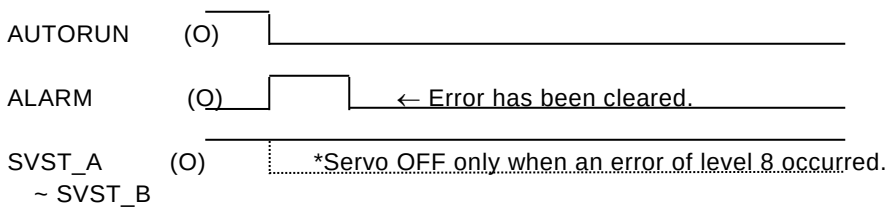
<table>
<tr><td>Designation</td><td>CYC_END (Cycle end)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-21 pin</td></tr>
<tr><td>Signal name</td><td>258</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on after the stop of 1-cycle automatic operation only when the CYCLE signal is made valid in the program execution (RUN) mode and an automatic operation is executed.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. This signal turns off when the RUN mode takes effect.
2. This signal turns on also when the cycle operation has been stopped by the STOP, BREAK or ALARM signal.</td></tr>
</table>

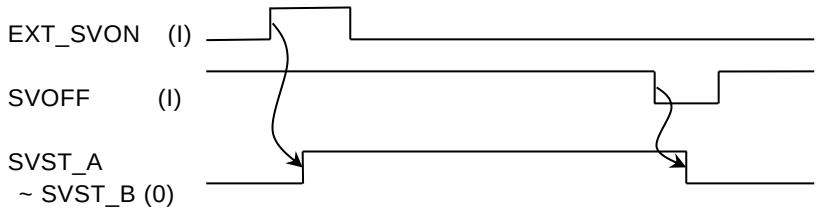
<table>
<tr><td>Designation</td><td>LOW_ST (Low speed mode ON)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-9 pin</td></tr>
<tr><td>Signal name</td><td>259</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on while the robot is operating in the low speed mode by the input of system input signal LOW_SPD. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

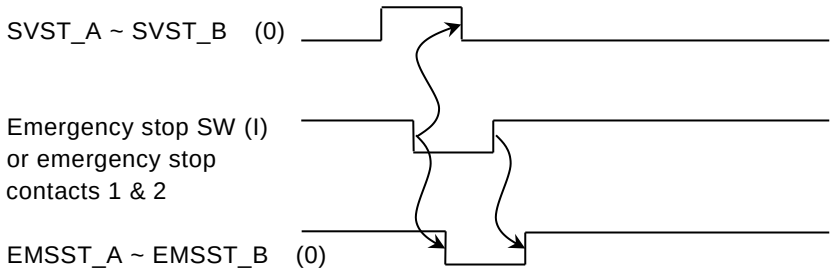
<table>
<tr><td>Designation</td><td>BT_ALM (Battery alarm)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-22 pin</td></tr>
<tr><td>Signal name</td><td>261</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on if a battery alarm has occurred in the robot or robot controller.
The battery alarm detects all encoders of axis 1 to axis 4 and battery level in the main control board (X8YC).
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>If the battery alarm has occurred, replace the battery immediately by identifying a battery whose voltage has dropped and referring to the Maintenance Manual.</td></tr>
</table>

Designation	ALARM (Alarm)
Output terminal	OUTPUT-11 pin
Signal name	262
Signal logic	
Function	This signal turns on if an error of level 2, 4 or 8 has occurred in the robot or KSL3000 robot controller. This signal is kept ON during error detection and turns off after the error has been cleared. For details on the errors, see the Operator's Manual. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	
Cautions	

Output terminal \ Signal judgment	ON	OFF
High	○	
Low		○



<table>
<tr><td>Designation</td><td>SVST_A ~ SVST_B (Servo ON contact output)</td></tr>
<tr><td>Output terminal</td><td>Between OUTPUT-12 pin and OUTPUT-24 pin (contact output)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>Open</td><td>Short-circuit</td></tr>
<tr><td>OFF</td><td>○</td><td></td></tr>
<tr><td>ON</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>While the servo power is turned on, the output terminals are short-circuited.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>The signal is of a non-voltage contact output type. The logic is a normal open contact output. The contact capacity is 125 V AC (max.), 0.5 A (max.) / 60 V DC (max.), 1 A (max.).
It takes about two (2) seconds from the servo ON to the time when the robot is actually ready to work. Thus, it is necessary to program a delay of 2.5 seconds or over between the SVST_A to SVST_B signal ON and the RUN signal ON.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>EMSST_A ~ EMSST_B (Emergency stop contact output)</td></tr>
<tr><td>Output terminal</td><td>Between OUTPUT-13 pin and OUTPUT-25 pin (contact output)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment
Output terminal</td><td>Open</td><td>Short-circuit</td></tr>
<tr><td>OFF</td><td></td><td>○</td></tr>
<tr><td>ON</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>While the EMERGENCY stop pushbutton switch provided on the control panel or teach pendant is pressed ON or system input signals "Emergency stop contacts 1 & 2" are ON, the output terminals of this signal are open.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>The signal is of a non-voltage contact output type. The logic is a normal close contact output. The contact capacity is 125 V AC (max.), 0.5 A (max.) / 60 V DC (max.), 1 A (max.).</td></tr>
</table>

4.3 Fabricating External I/O Signal Cable

When fabricating an external I/O signal cable, observe the following matters.

a. Connectors INPUT and OUTPUT for the KSL3000 robot controller should be either the connectors attached to the controller or equivalent connectors. The equivalent of other makers (D-SUB connectors) can also be used.

Connector name	Type of connector	Maker
INPUT	XM3A–3721 (plug type connector) XM2S–3711 (connector cover)	OMRON
OUTPUT	XM3A–2521 (plug type connector) XM2S–2511 (connector cover)	

b. Select the cables which meet the following specifications.

- Core wires : 0.18 mm^2 ~ 0.32 mm^2 twisted wires
- Cable outer diameter : Max. 13 mm (INPUT), 11 mm (OUTPUT)
- Shield : Batch shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c. The INPUT and OUTPUT connectors are of a solder cup type which joints cables by soldering. For how to joint cables to connectors and how to shield cables, see Appendix 2.

* Cables with their single side soldered to the connector (KSL3000: INPUT/OUTPUT cables) are provided optionally. (We can advise of the cable length.) Contact our after-sale service agent in your territory.

4.4 Attaching and Detaching External I/O Signal Cable

Before attaching or detaching an external I/O signal cable to or from the KSL3000 robot controller, be sure to turn off the main power in the user's control panel.

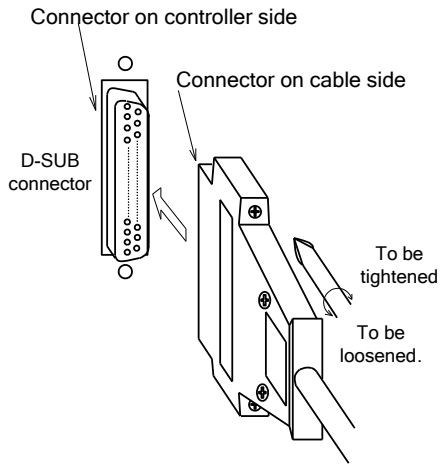


Fig. 4.4 Attaching and detaching external I/O signal cable

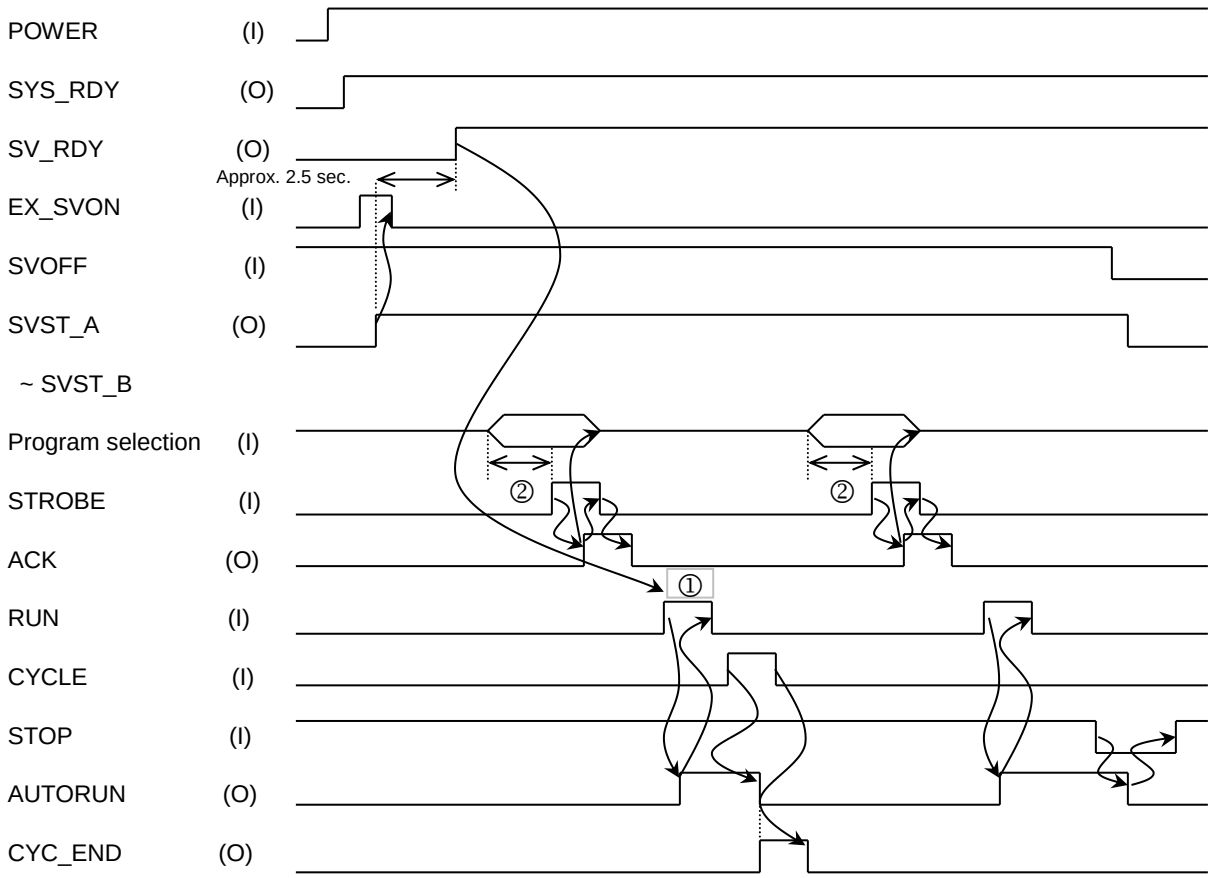
To connect an external I/O signal cable, completely insert the cable side connector into the controller side connector and tighten the lock screws on both sides of the connector with a screwdriver, as shown in Figure 4.4.
To disconnect the cable, loosen the lock screws, then pull out the connector. At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, resulting in damage of the cable.

! CAUTION

When attaching or detaching the cable, be sure to hold the connector rather than the cable.

4.5 Example of Controller Operation, Using External Signals

(1) Normal operation sequence



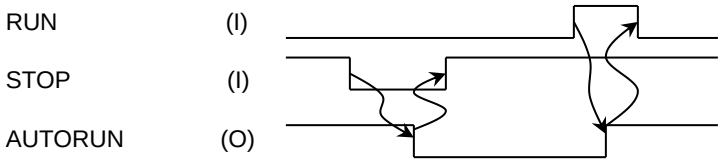
① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

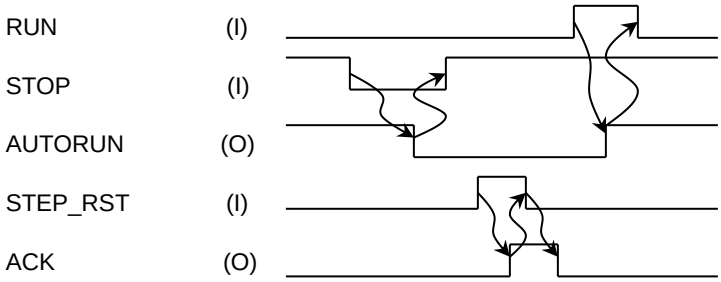
Note: If the SVOFF signal remains (O), the servo cannot be turned on. Before the servo can be turned on, the SVOFF signal must be set to (I).

(2) Example of restarting the stopped robot

a) Restart after stop (to resume the operation)

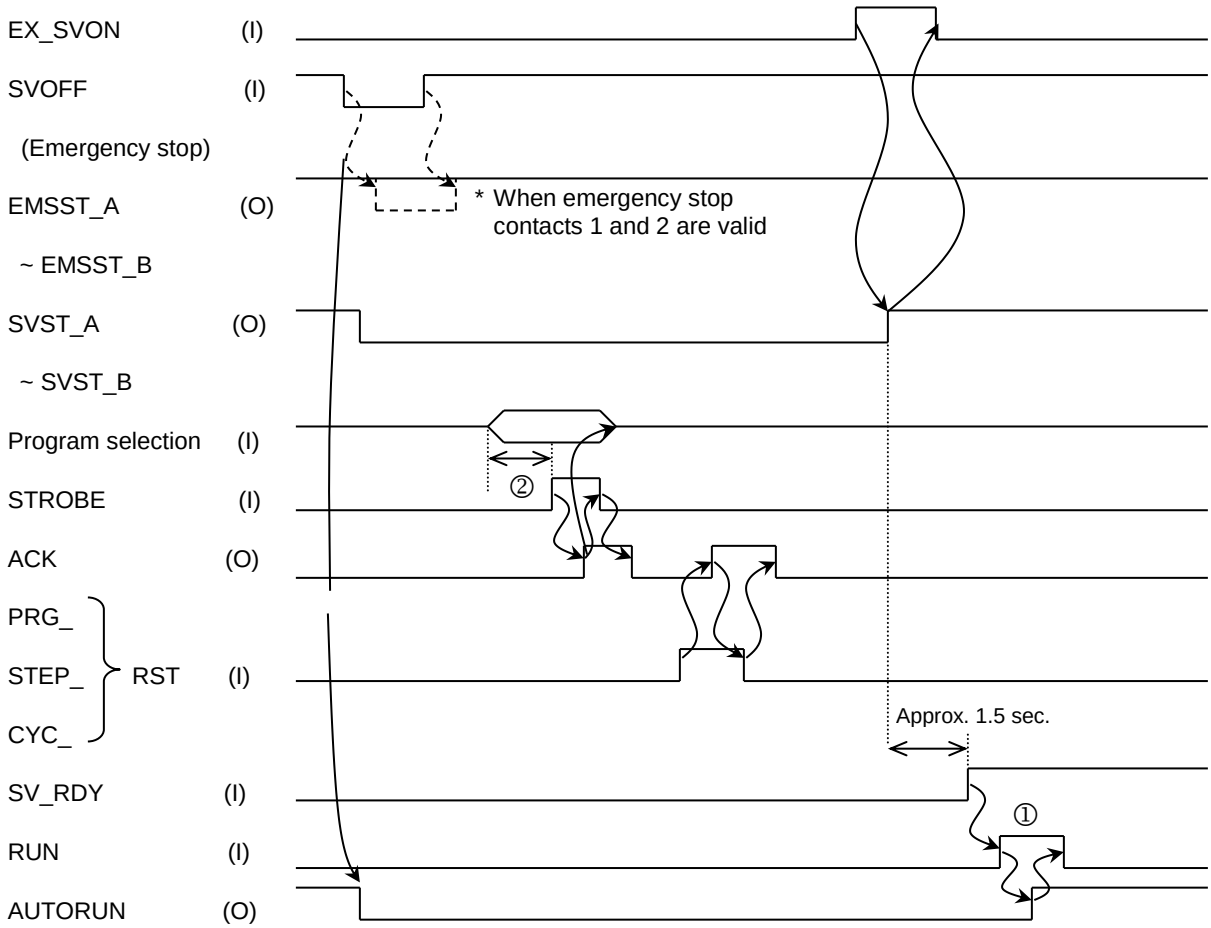


b) Restart after stop (to start the program from the top)



(3) Example of restarting the robot after servo OFF (emergency stop)

Restart after servo OFF (emergency stop)



① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

Note 1: Signals EMSST_A ~ EMSST_B (emergency stop contact output) turn on when the emergency stop contacts 1 and 2 become valid.

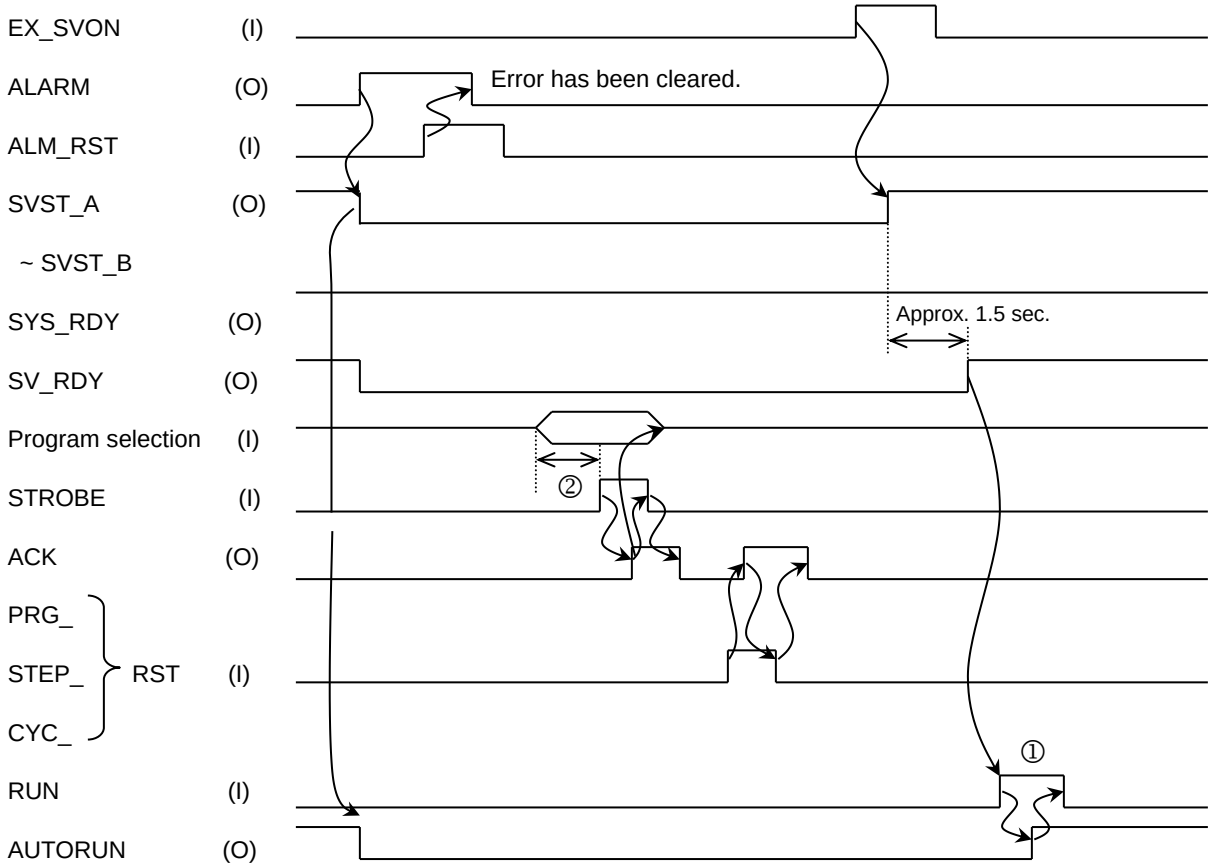
Note 2: Program selection, PRG_RST, STEP_RST and CYC_RST can be skipped unless necessary.

Note 3: Program selection, PRG_RST, STEP_RST and CYC_RST can be executed at any timing unless the auto operation mode is selected.

Note 4: To prevent an internal damage, the servo cannot be turned on about 4.5 seconds after it is turned off. To turn the servo on again, wait at least five (5) seconds after the SVST_A ~ SVST_B signal turns off. For the third turning on of the servo, the interval time is seven (7) seconds.

(4) Example of restarting the robot after error correction

To resume the automatic operation after an error has occurred (i.e., processing of automatic operation after error correction):



① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

Note 1: To continue the automatic operation, program selection, PRG_RST, STEP_RST and CYC_RST are necessary.

Note 2: The servo power may not be turned off with some type of error.

Note 3: Program selection, PRG_RST, STEP_RST and CYC_RST can be executed at any timing unless the auto operation mode is selected.

4.6 Definition of Colors for Operation Buttons and Indicator Lamps

If the switches or the likes to operate the KSL3000 robot controller are to be placed by the customer, it is requested that the colors of operation buttons be defined as follows:

- Operation buttons
  Red - Emergency
  Yellow - Trouble
  Green - Normal
  Blue - Required action (e.g., reset)

- Indication of operation buttons

Start	Stop	Pushbutton which alternately starts and stops	Button which allows operation only when held down, and stops it when released
			

- It is requested that the colors of indicator lamps be defined as follows:
  Red - Emergency
  Yellow - Trouble
  Green - Normal
  Blue - Required action (e.g., reset)

Section 5 Serial I/O Signal Cable

5.1 Connecting Serial I/O Signal Cables

The KSL3000 robot controller is provided with two (2) channels of RS-232C serial I/O signals COM1 and 2. For the connection, see the figure below.
It is recommended to use commercially available cables.

Using a surge protector is also recommended in order to protect serial I/O signals from an electrostatic discharge-induced surge or switching surge.

Recommended surge protector: RSP-232-9 manufactured by Okaya Electric Industries Co., Ltd.

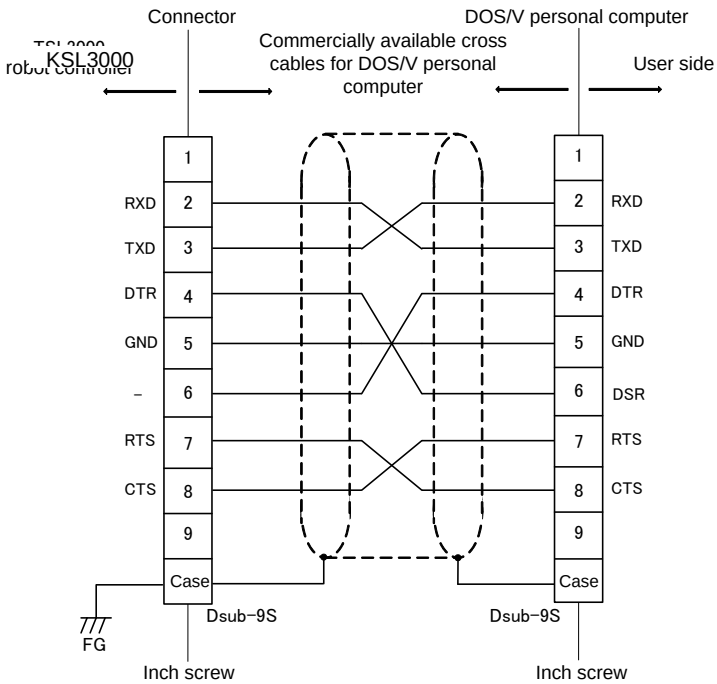


Fig. 5.1 Connection of serial I/O signals HOST/TCPRG and COM1

5.2 Attaching and Detaching Serial I/O Signal Cables

Before attaching or detaching the serial I/O cables to or from the KSL3000 robot controller, be sure to turn off the main power in the user's control panel.

The procedures for attaching and detaching serial I/O signal cables HOST/TCPRG and COM1 are the same as in Para. 4.4. For details, see Para. 4.4.

! CAUTION

Be sure to turn off the main power before attaching or detaching the cables.

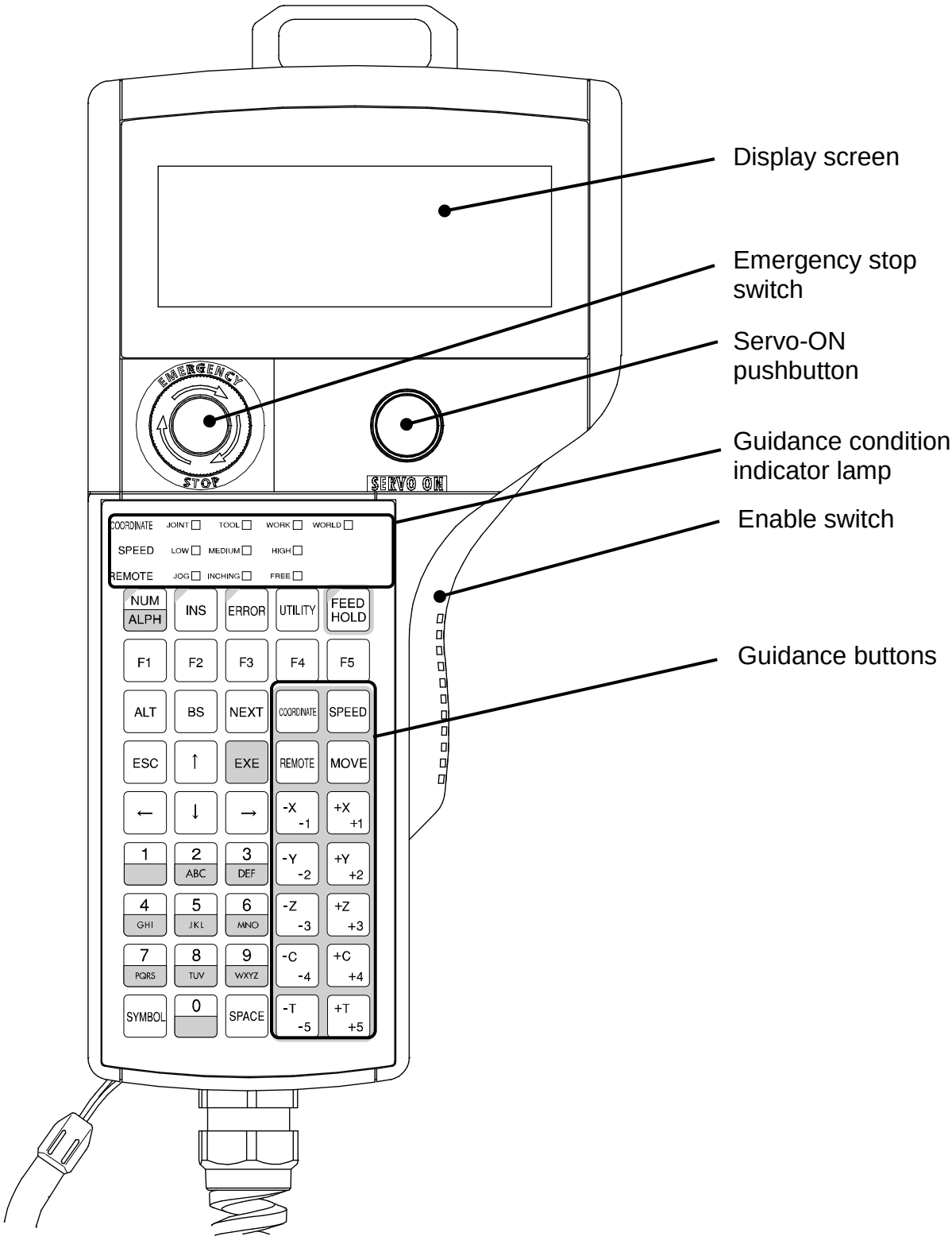
Attaching or detaching the cables with the main power turned on may cause damage on the substrate ICs.

! CAUTION

The connectors below in the KSL3000 robot controller have connector caps.
HOST/TCPRG, COM1
When these connectors are not used, be sure to always attach the connector caps for protecting from electrostatic discharge and damage.

Section 6 Teach Pendant Cable

6.1 External View and Functional Names of the TP1000



6.2 Connecting Teach Pendant (TP) Cable

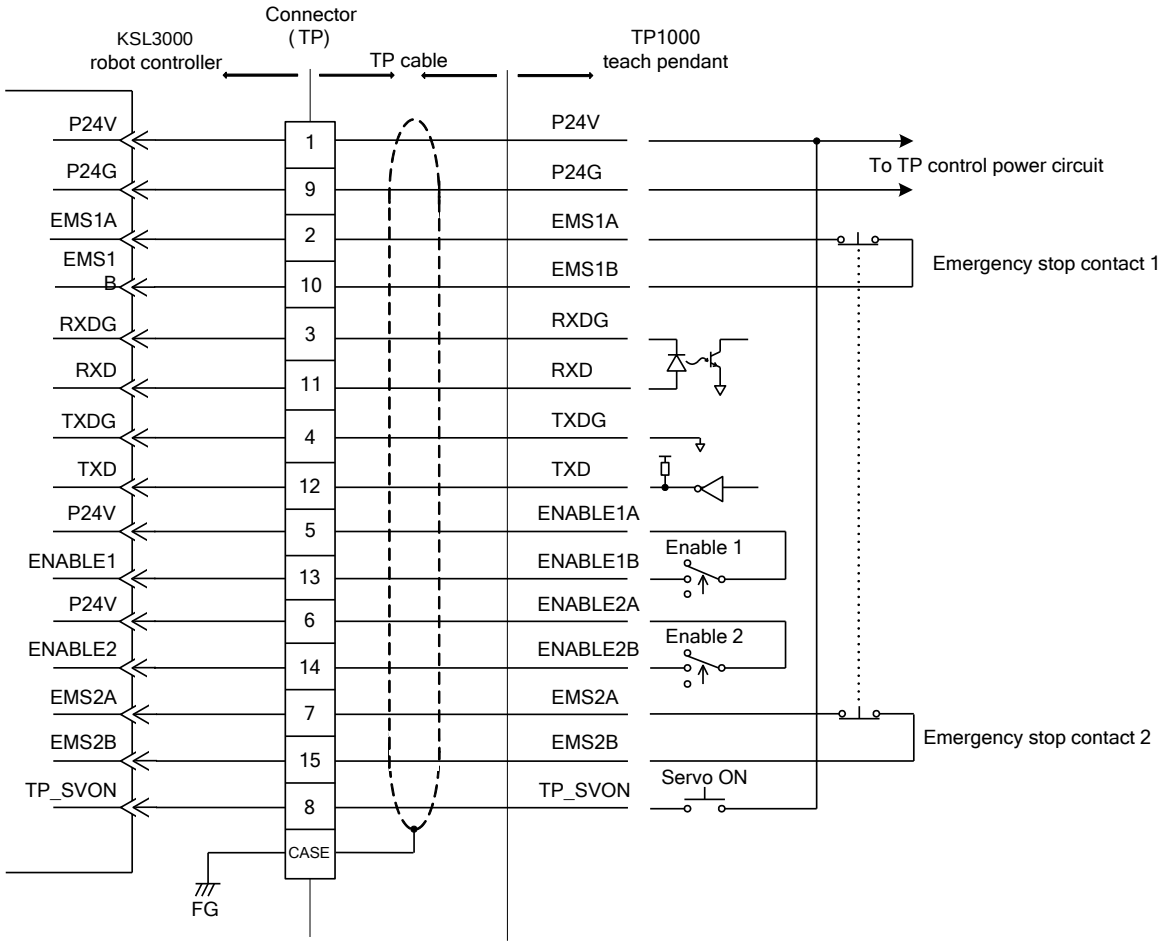


Fig. 6.2 Connection of TP1000 teach pendant I/O signals

The TP cable is a serial I/O signal cable used only for the TP1000 teach pendant (option). One side of the TP cable is secured to the teach pendant and the other side has a D-SUB 15-pin connector.

Unless the teach pendant is connected, insert the attached dummy plug to connector TP on the front panel of the controller.

When connecting the teach pendant, remove this dummy plug first. (The attaching and detaching procedures are the same as in Para. 4.4. For details, see Para. 4.4.)

The dummy plug can be removed while the power of the controller is set ON or OFF. If the dummy plug is removed while the servo power is turned on, however, the servo power is turned off automatically. (While the dummy plug or teach pendant is not connected, safety measures are effected to prevent the servo power from actuating.)

CAUTION

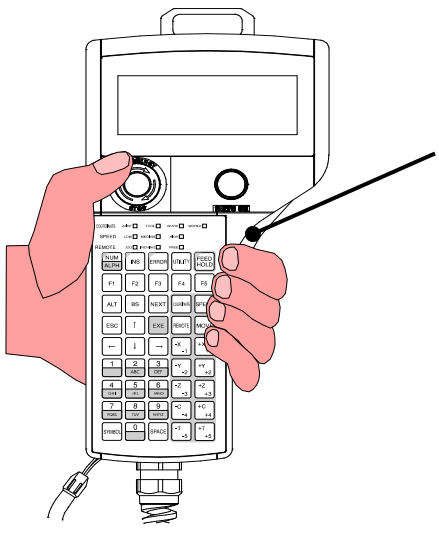
Unless the teach pendant or dummy plug is connected with the TP connector of the KSL3000 robot controller, the servo power cannot be turned on.

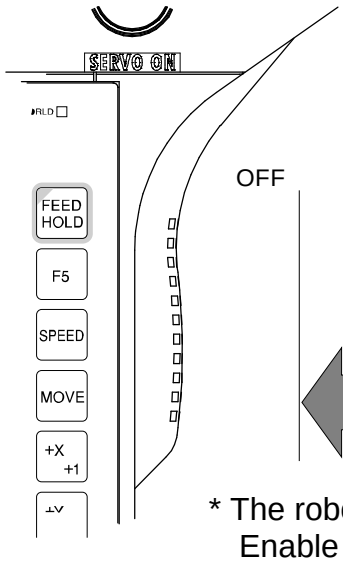
As shown in Fig. 6.1, the teach pendant I/O signals include the I/O signals for data transmission between the teach pendant and controller, signals for identifying servo ON, emergency stop and enable input from the teach pedant, and P24V and P24G signals for supplying the power to the teach pendant.

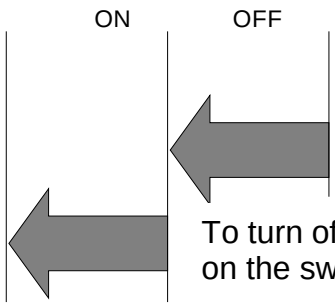
Data transmission between the teach pendant and KSL3000 robot controller is performed in the current loop system.
These I/O signals are used exclusively for the TP1000 teach pendant, and cannot be used for any other equipment.
While the teach pendant is disconnected, processing of emergency stop is effective and the servo power cannot be turned on. Unless the teach pendant is used, use the attached jumper connector (D-SUB 15 pin).

6.3 How to Operate the Enable Switch

The TP1000 (Teach Pendant) is equipped with a 3-position Enable switch. Use the Enable switch to turn on the servo in teach mode or guide the robot in teach mode.







To turn on the Enable switch, gently hold the switch.

To turn off the Enable switch, grip on the switch. (The robot stops.)

* The robot cannot be guided manually when the Enable switch is OFF.
  Keep the Enable switch ON when guiding the robot manually.

Section 7 External I/O Cable (Option)

7.1 Connecting External I/O Cable

The external I/O cable is used to connect the TR48DIOCN-1/TR48DIOC-1 module (option) or CKD's designated remote I/O module (option) serving as the slave station. Power (24 V, 0 V) is supplied to TR48DIOCN-1/TR48DIOC-1 by an external power supply provided by the customer.
Select the optimum external power supply based on the system specifications (power capacity) of the customer.

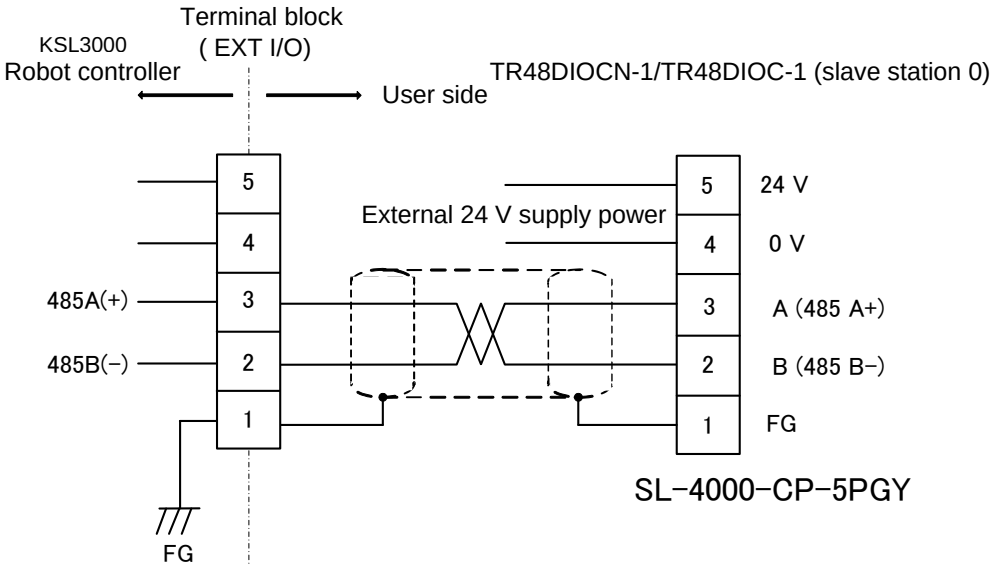


Fig. 7.1 Connection of RS485 cable

a. Use the cable attached to the TR48DIOCN-1/TR48DIOC-1 module, or the cable which satisfies the following specifications.

- Core wires : 0.3 mm^2 ~ 0.75 mm^2 twisted wires
- Twisted pair : Required.
- Cable outer diameter : Max. 7 mm
- Shield : Batch braided shield
- Cable length : 400 m or less in total
  When the external power is supplied and only the RS485 communication cable is extended.

- Characteristic impedance : 100 Ω
- Others : For RS485 250 kbps data communication.

Recommended twisted pair cable with shield
TKVVBS 0.3 sq. × 2 P (made by Tachii Densen)

NEVER use a cable which does not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

b. When connecting two (2) TR48DIOCN-1/TR48DIOC-1 modules for I/O extension, be sure to branch from the terminal block of slave station 0, as shown in Fig. 8.2. (For the I/O extension, up to two (2) TR48DIOCN-1/TR48DIOC-1 modules can be connected.)

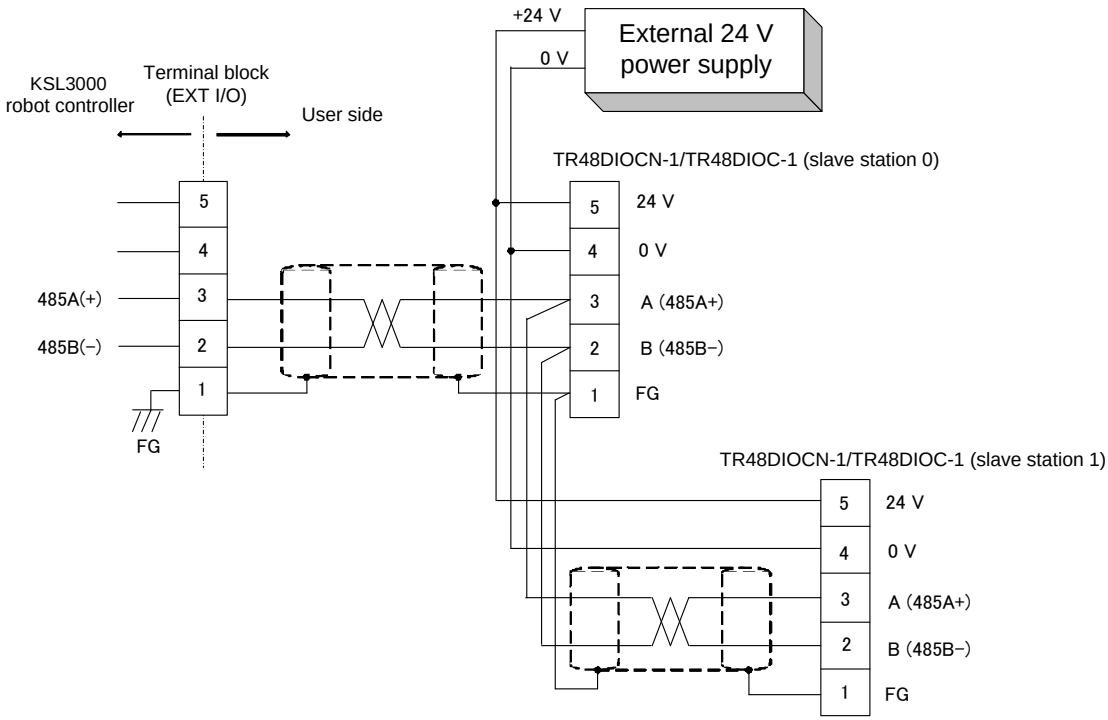


Fig. 7.2 Connection of external I/O cable when external power supply is used

7.2 External I/O Communication

If the number of digital I/Os is insufficient for the system, up to two (2) TR48DIOCN-1/TR48DIOC-1 modules [option; twenty-eight (28) inputs and twenty (20) outputs] can be connected as the I/O function extension unit. When the KSL3000 robot controller is assigned to the master station and the TR48DIOCN-1/TR48DIOC-1 module to the slave station, inputs and outputs can be controlled via the RS485 serial communication.
In addition to the TR48DIOCN-1/TR48DIOC-1 module, a distribution I/O module designated by CKD, which can serve as the slave station, can be used also.

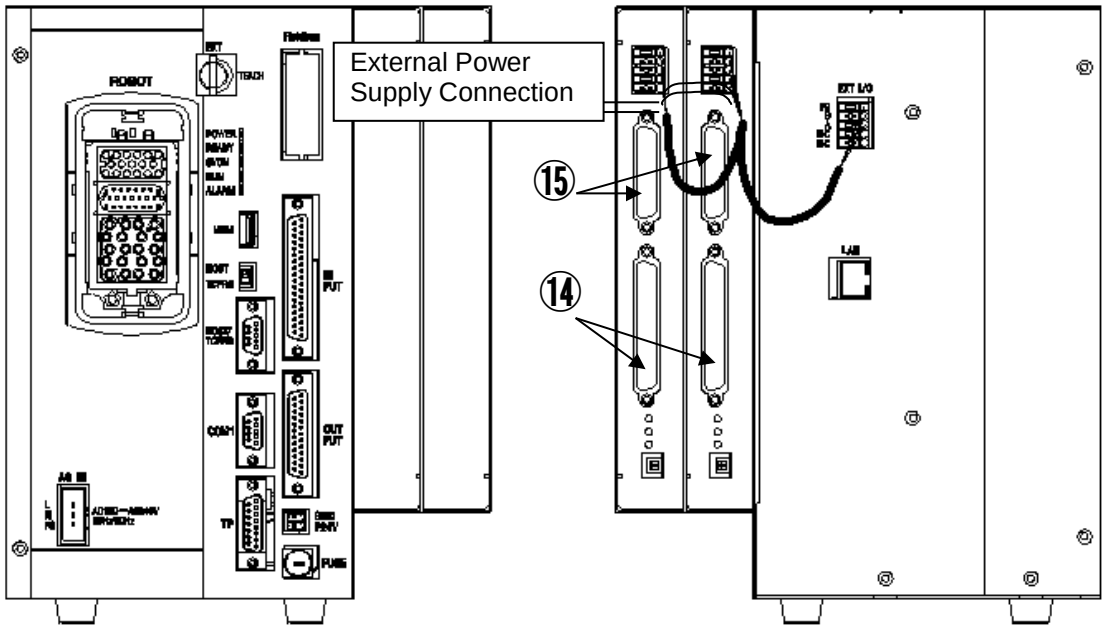


Fig. 7.3 KSL3000 + TR48DIOC-1 (2 units)

* To designate the slave station number of the KSL3000, observe the following steps. Under [U12] of the USER.PAR (user parameter) file, you can find the following parameter setting related to the extension input and output.

  [U12] Extend I/O setting
  {Use/Not Use} (0: Not Use, 1: Use)
  {Not Use}
  {Not Use}
  = 0 28 20 → Corresponds to station 0.
  = 0 28 20 → Corresponds to station 1.

  If you wish to use only station 0 (i.e., one (1) TR48DIOC-1 module), for instance, change the underlined bit corresponding to station 0 to "1".
  = 1 28 20
  = 0 28 20

  After saving the parameter file, turn off the controller power and on again. Then the above parameter becomes effective.

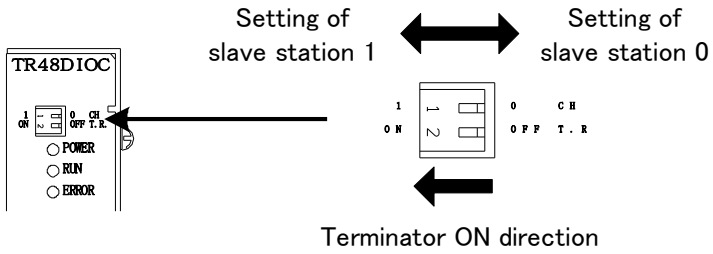
  If you wish to use both stations 0 and 1 (i.e., two (2) TR48DIOC-1 modules), specify as follows and perform the same operation as above to make the parameter valid.
  = 1 28 20
  = 1 28 20

When using the TR48DIOC-1 module, careful precautions should be taken on the following matters.

[1] Make sure that the slave station number set in "USER.PAR" (User parameter) coincides with the station number setting of the TR48DIOC-1 module.

[2] When the TR48DIOC-1 module or modules are connected, set ON the terminator setting switch equipped on the TR48DIOC-1 module which is located on the extreme right side in terms of cable wiring when seen from the controller front side.

The switches (2 pins) provided on the front upper side of the TR48DIOC-1 module represent pin 1 (upper) for slave station number setting and pin 2 (lower) for terminator setting.



The slave station setting is already described above. Specify the slave station of TR48DIOC-1 to be used, according to the station number set in “USER. PAR” (User parameter).

For the terminator, when only one (1) TR48DIOC-1 module is used, set ON the terminator setting switch equipped on the module.
When two (2) TR48DIOC-1 modules are used, see Fig. 7.3 for example. As the TR48DIOC-1 module on the extreme right side as viewed from the controller front side is the terminal station in terms of cable wiring, set ON the terminator setting switch equipped on this module alone. The terminator of the left TR48DIOC-1 module should remain OFF.

Be sure to execute Items [1] and [2] above. Otherwise, the system may not function normally or go wrong.

With the above setting, make sure that both the POWER and RUN LEDs on each TR48DIOC-1 module are illuminated.

7.3 Attaching and Detaching External I/O Cable

For the external I/O cable, use the cable attached to the TR48DIOCN-1/TR48DIOC-1 module, or a cable which meets the specifications.
Before attaching or detaching the external I/O cable to or from the KSL3000 robot controller, be sure to turn off the main power in the user's control panel.

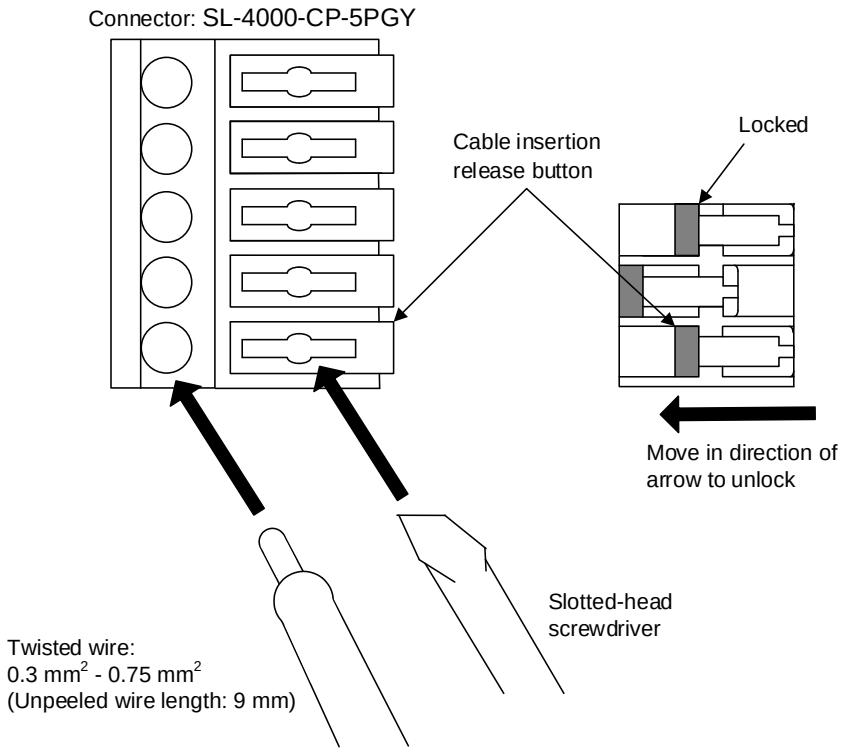


Fig. 7.3 Attaching and detaching external I/O cable

To connect the external I/O cable, press a slotted-head screwdriver onto the cable insertion release button of the connector as shown in Fig. 7.5 to lock the cable insertion release button so that the cable can be inserted or removed. After the cable is firmly pressed in, raise the cable insertion release button upwards to release the lock.
(Lightly pull the cable and make sure that the cable is connected completely and will not come off. DO NOT pull the cable by force, however. If an unusually large force is exerted on the cable, the cable may be damaged.)
To remove the cable, press the slotted-head screwdriver onto the cable insertion release button so that the cable insertion release button is locked, and then pull out the cable.

Section 8 Extension I/O Signal Cable

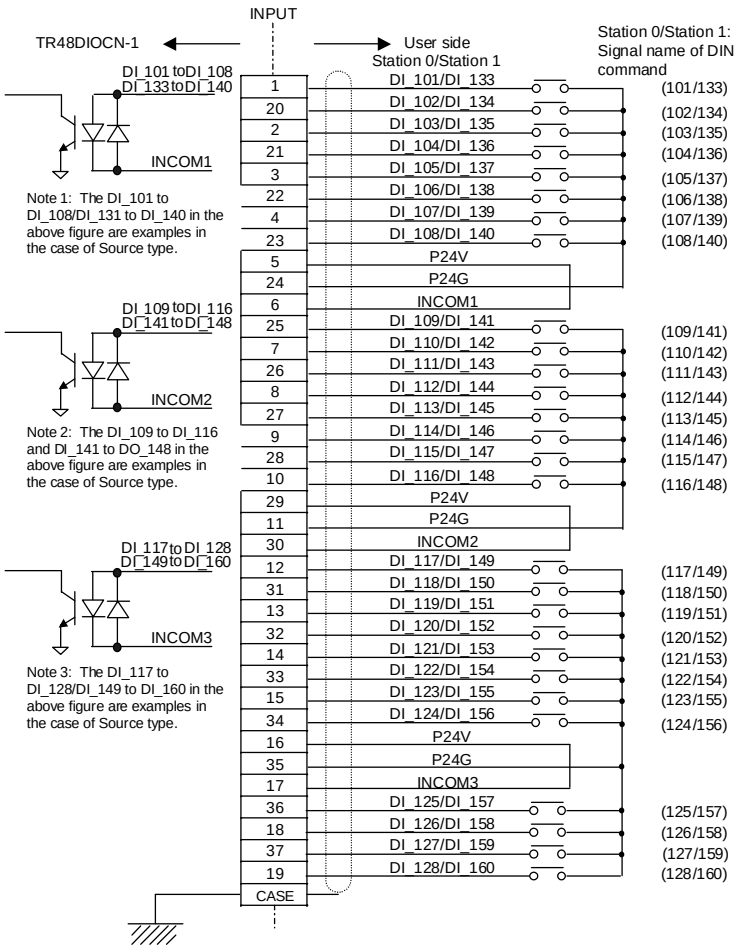
The TR48DIOCN-1/TR48DIOC-1 is provided as a dedicated extension I/O module. The TR48DIOCN-1/TR48DIOC-1 is an extension I/O module having 28 inputs and 20 outputs. The KSL3000 can be expanded up to a maximum of two stations. The output specifications are different between the TR48DIOCN-1 and TR48DIOC-1 (Source type/Sink type). Check which type of extension I/O module you are using before connecting the extension I/O signal cable.

8.1 TR48DIOCN-1

The TR48DIOCN-1 output specifications are Sink type.
It has the same polarity as the Type N output of the I/O board X8YX of this controller.
Because the input specifications use bidirectional photocouplers in the input circuit, the selection of INCOM* enables switching between Source type and Sink type.

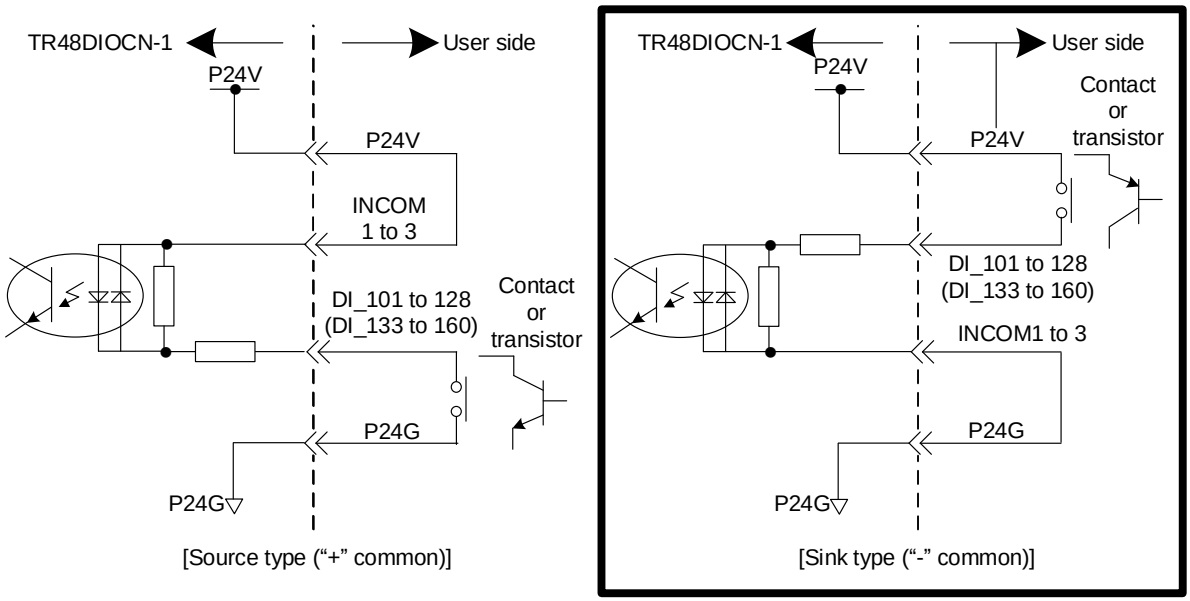
8.1.1 Connecting Extension Input Signal Cable

The connection of the extension input signal cable uses the connector XM3A-3721 (plug type) and XM2S-3711 (connector cover) supplied with the TR48DIOCN-1. The TR48DIOCN-1 inputs (DI_101 to DI_128 (Station 0) and DI_133 to DI_160 (Station 1), are connected to the connector INPUT on the module panel.



The specifications of the extension input signals are shown below.

- Input format: No-voltage contact input or transistor open collector input
- Application circuit examples and input circuit configuration

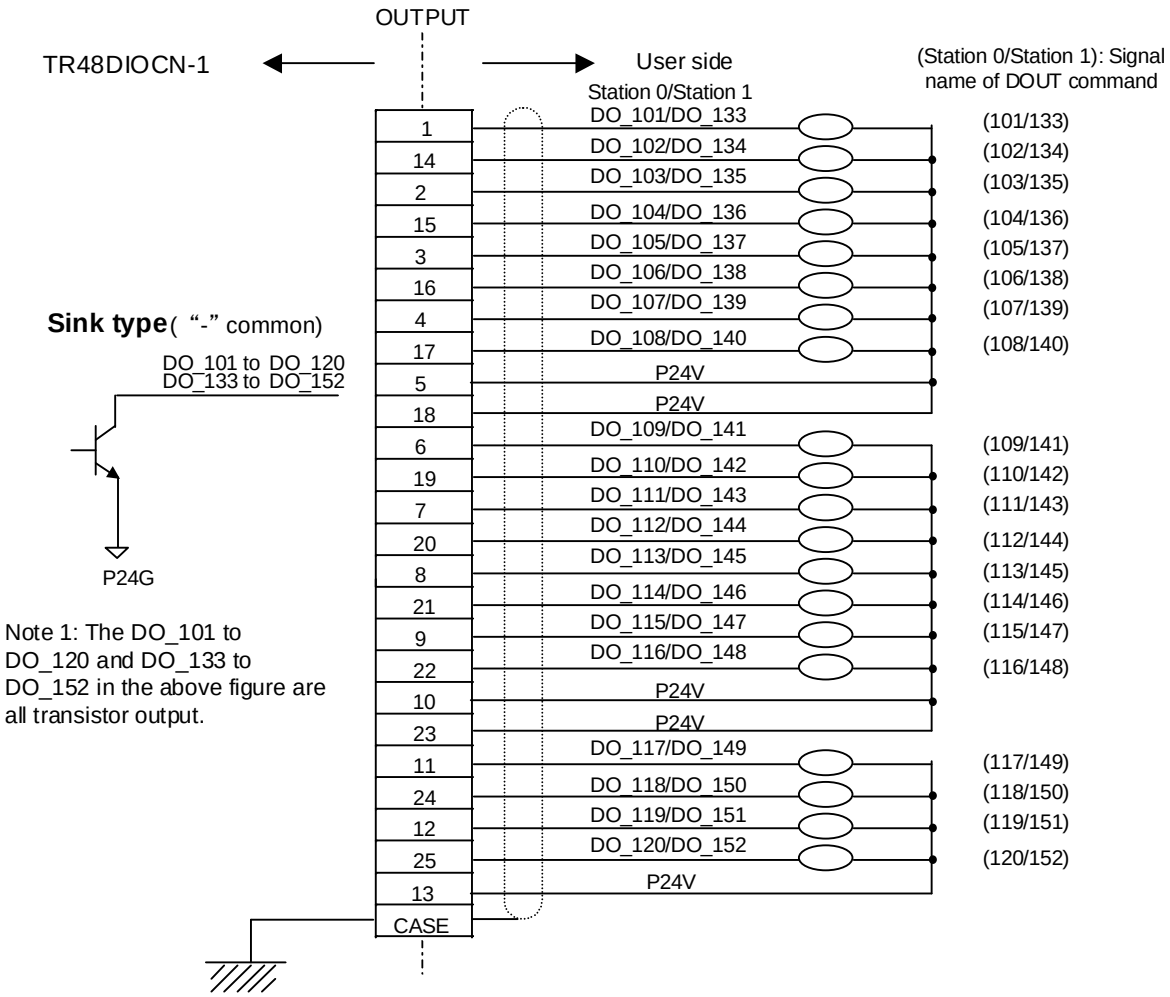


- No-voltage contact/transistor required specifications

No-voltage contact specifications		Transistor specifications	
Contact rating	24V DC 10 mA or more	Collector-emitter voltage	30 V or more
Circuit current	Approx. 7 mA	Collector-emitter current	10 mA
Minimum current	24V DC 1 mA	Circuit current	Approx. 7 mA
Connection impedance	100 Ω or less	Collector-emitter leakage current	100 μA

8.1.2 Connecting the Extension Output Signal Cable

The connection of the extension output signal cable uses the connector XM3A-2521 (plug type) and XM2S-2511 (connector cover) supplied with the TR48DIOCN-1. The TR48DIOCN-1 outputs (DO_101 to DO_120 (Station 0) and DO_133 to DO_152 (Station 1), are connected to the connector OUTPUT on the module panel.



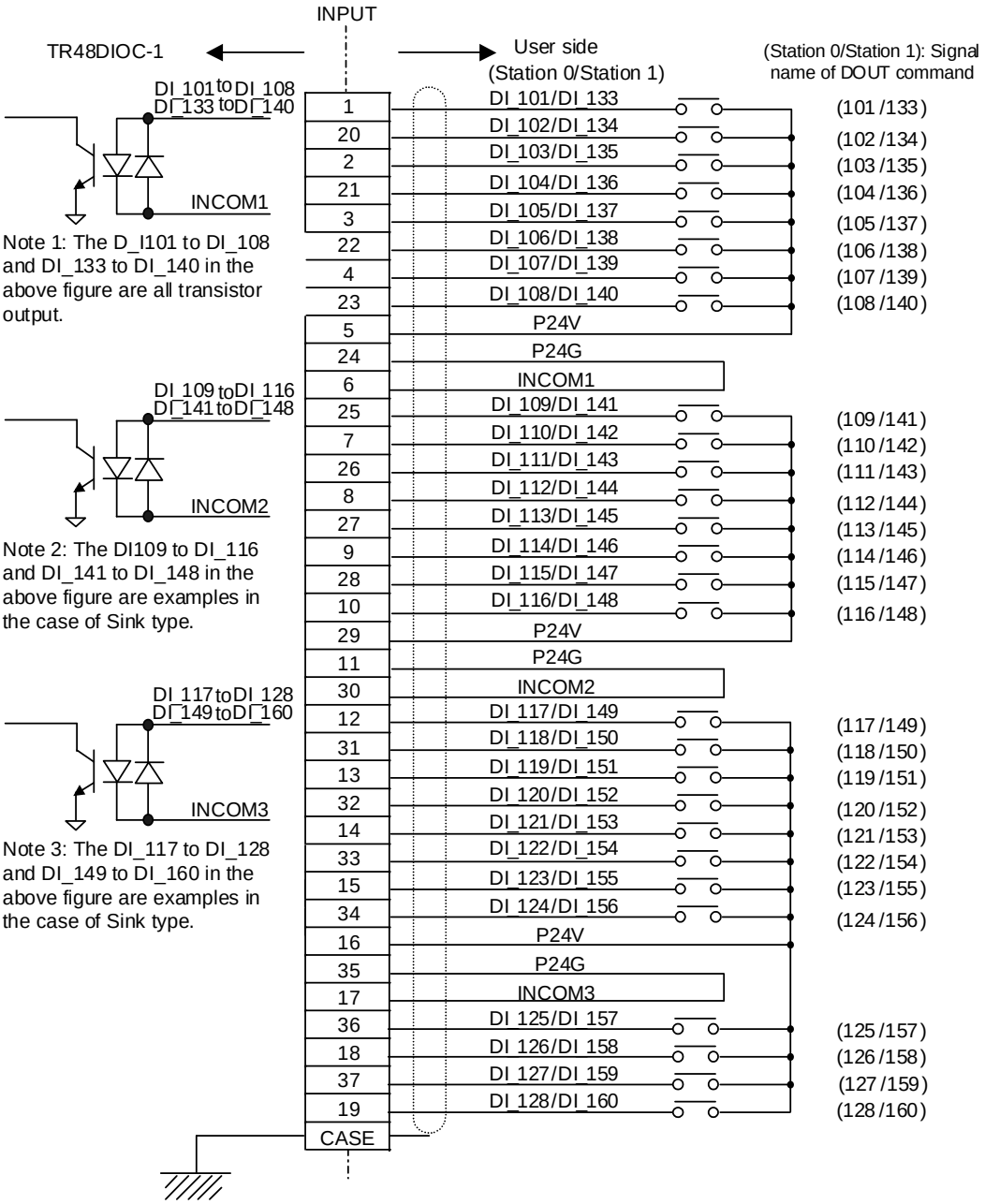
Because the extension output signal specifications are identical to the digital output signal specifications (Sink type) in Para. 4.8, refer to this for further information.

8.2 TR48DIOC-1

The TR48DIOC-1 output specifications are Source type.
It has the same polarity as the Type P output of the I/O board X8YX of this controller.
Because the input specifications use bidirectional photocouplers in the input circuit, the selection of INCOM* enables switching between Source type and Sink type.

8.2.1 Connecting the Extension Input Signal Cable

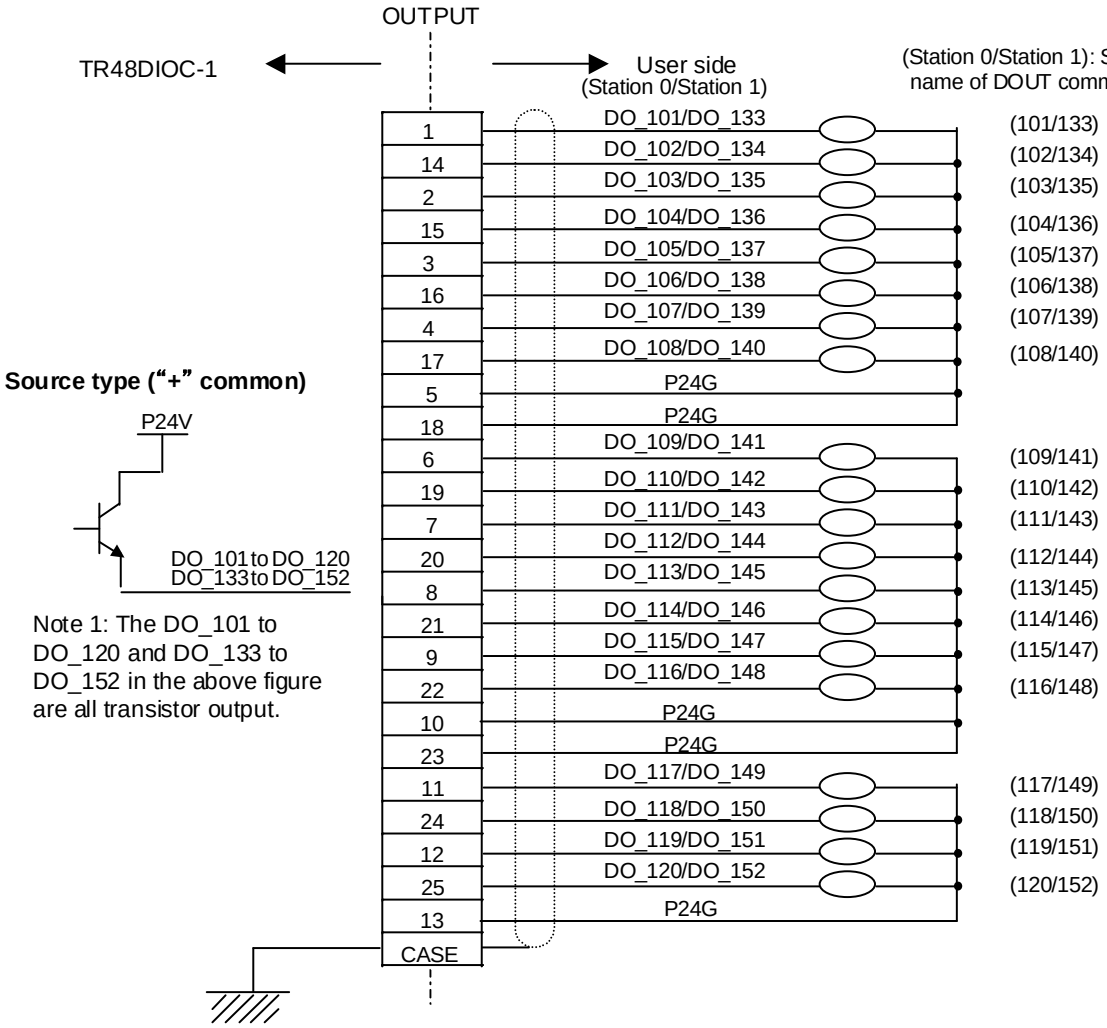
The connection of the extension input signal cable uses the connector XM3A-3721 (plug type) and XM2S-3711 (connector cover) supplied with the TR48DIOC-1. The TR48DIOC-1 inputs (DI_101 to DI_128 (Station 0) and DI_133 to DI_160 (Station 1), are connected to the connector INPUT on the module panel.



The specifications of the TR48DIOC-1 extension input signals are identical to those for TR48DIOCN-1, and so see Para. 8.1.1 for the input specifications.

8.2.2 Connecting Extension Output Signal Cable

The connection of the extension output signal cable uses the connector XM3A-2521 (plug type) and XM2S-2511 (connector cover) supplied with the TR48DIOC-1. The TR48DIOC-1 outputs (DO_101 to DO_120 (Station 0) and DO_133 to DO_152 (Station 1), are connected to the connector OUTPUT on the module panel.



Because the extension output signal specifications are identical to the digital output signal specifications (Source type) in Para. 4.8, refer to this for further information.

Electrical rating

Electrical rating		Notes
Rated voltage	24 V DC	Select the optimum external power supply based on the system specifications (power capacity) of the customer. If a current exceeding the rated output flows, the output elements can be damaged or the board can be burned. Therefore, be sure to always use within the rated current range. Use of an external power supply can result in a breakdown, and so never use an external power supply.
Rated current	100 mA (Max.)	

8.3 Fabricating Extension I/O Signal Cable

Follow the points below when fabricating the extension I/O signal cables.

a. Either use the connectors supplied with the TR48DIOCN-1/TR48DIOC-1, or prepare the same type of connectors for use. Equivalent products by other manufacturers (D-sub connectors) can also be used.

Connector name	Connector model	Manufacturer
INPUT	XM3A-3721 (plug-type connector) XM2S-3711 (connector cover)	OMRON
OUTPUT	XM3A-2521 (plug-type connector) XM2S-2511 (connector cover)	OMRON

b. Select the cables that are used based on the specifications below.
- Core wires: 0.18 mm^2 to 0.32 mm^2 twisted wire
- Cable outer diameter: Maximum 10.5 mm diameter (INPUT), 9 mm diameter (OUTPUT)
- Shielding: Uniform shielding
- Cable length: 30 m max.

Use of cables that do not match the specifications can result in a meltdown due to a short-circuit or core wire overheating and also presents a danger of robot malfunction due to the intrusion of noise. Therefore, never use cables outside the specifications range.

c. The INPUT and OUTPUT connectors are solder cup type where the wires are joined by soldering. For further information about the methods of joining wires to a connector and shielding processes, see Appendix 2, "Fabricating Cable Using D-SUB Connector".

8.4 Attaching and Detaching Extension I/O Signal Cable

For attaching and detaching the extension I/O signal cable, see Para. 4.4.

Section 9 Connecting External I/O Power Supply Cable

The connection of the external I/O power supply cable uses the supplied connector SL-4000-CP-2PGY (connector). P24V power is supplied from the controller front panel.
The I/O that uses the external power supply (24 V DC) is shown below. Be sure to always provide an external power supply (24 V DC).

- External I/O
- External operation I/O
- Extension I/O
- Hand I/O

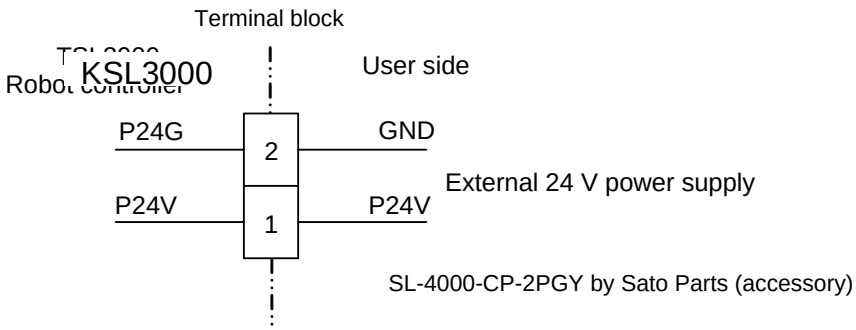


Fig. 9-1 Connection of external power supply

The compatible cable sizes for the connector are AWG24 to AWG16.
Select the optimum external power supply based on the system specifications (power capacity) of the customer.
For details on attaching and detaching the external I/O power supply cable, see Para. 7.4, "Attaching and Detaching External I/O Cable".

! CAUTION

Be sure to always connect an external power supply (24 V DC). Otherwise, the safety protection signals will not be valid, and the controller servo power cannot be turned on.

Section 10 I/O Cables (Option)

10.1 INPUT Cable

10.1.1 Specifications

Type : 368M54□□
↑
Symbol in the table below.

* To designate the cable length (L), see the table below.

Symbol	L (m)	Symbol	L (m)
01	3	06	12
02	5	07	15
03	6		
04	8		
05	10		

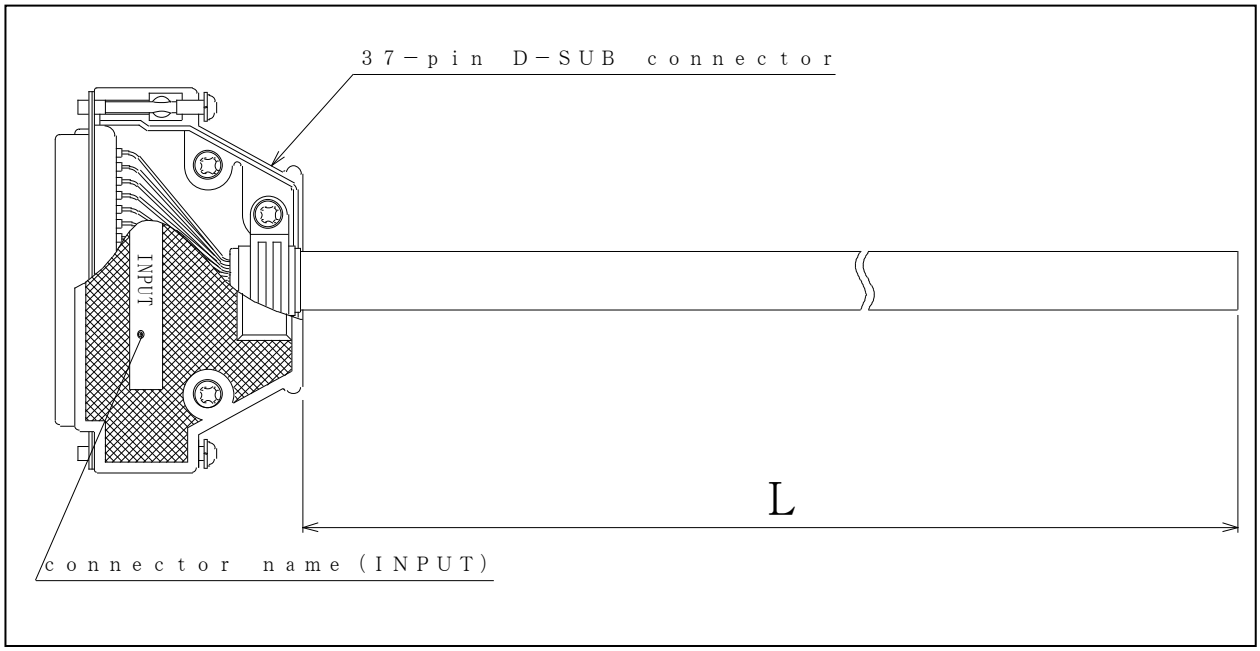
* For details and connection of the signals, see Para. 4.1 External Input Signal Cable.
* This cable cannot be used for the sliding part or moving part which will bend repeatedly.

Cable specifications

Items	Specifications
Nominal sectional area of conductor	0.2 mm^2
Structure of conductor	7/0.18
No. of cable cores	40C
Insulator material	Heat-proof vinyl chloride
Shield material	Tin-plated annealed copper wire
Sheath material	Heat-proof vinyl chloride
Conductor resistance (20°C)	119 Ω/km or less
Operating temperature	–20°C ~ 75°C (See Note 1.)
Operating voltage	AC 50 V, DC 60 V

Note 1: Heat-proof grade: 90°C

10.1.2 Outline drawing



10.1.3 Wiring table

I/O type: Type-N

Signal name	Connector pin	Cable color
DI_1	1	Black
DI_2	20	White
DI_3	2	Red
DI_4	21	Green
DI_5	3	Yellow
DI_6	22	Brown
DI_7	4	Blue
DI_8	23	Gray
P24G	5	Orange
P24V	24	Purple
INCOM	6	Pink
STROBE	25	Light green
PRG_RST	7	Light blue
STEP_RST	26	Black/White
CYC_RST	8	Red/White
DO_RST	27	Green/White
ALM_RST	9	Yellow/White
RUN	28	Brown/White
EX_SVON	10	Blue/White
P24G	29	Gray/White
P24V	11	Orange/White
INCOM	30	Purple/White
STOP	12	Pink/White
CYCLE	31	Light green/White
LOW_SPD	13	Light blue/White
BREAK	32	White/Black
SVOFF	14	Red/Black
	33	Green/Black
	15	Yellow/Black
	34	Brown/Black
P24G	16	Blue/Black
P24V	35	Gray/Black
INCOM	17	Orange/Black
EMS2B	36	Purple/Black
EMS1B	18	Pink/Black
EMS2C	37	Light green/Black
EMS1C	19	Light blue/Black
FG	Case	Shield

Type N

I/O type: Type-P

Signal name	Connector pin	Cable color
DI_1	1	Black
DI_2	20	White
DI_3	2	Red
DI_4	21	Green
DI_5	3	Yellow
DI_6	22	Brown
DI_7	4	Blue
DI_8	23	Gray
P24V	5	Orange
P24G	24	Purple
INCOM	6	Pink
STROBE	25	Light green
PRG_RST	7	Light blue
STEP_RST	26	Black/White
CYC_RST	8	Red/White
DO_RST	27	Green/White
ALM_RST	9	Yellow/White
RUN	28	Brown/White
EX_SVON	10	Blue/White
P24V	29	Gray/White
P24G	11	Orange/White
INCOM	30	Purple/White
STOP	12	Pink/White
CYCLE	31	Light green/White
LOW_SPD	13	Light blue/White
BREAK	32	White/Black
SVOFF	14	Red/Black
	33	Green/Black
	15	Yellow/Black
	34	Brown/Black
P24V	16	Blue/Black
P24G	35	Gray/Black
INCOM	17	Orange/Black
EMS2B	36	Purple/Black
EMS1B	18	Pink/Black
EMS2C	37	Light green/Black
EMS1C	19	Light blue/Black
FG	Case	Shield

Type P

10.2 OUTPUT Cable

10.2.1 Specifications

Type : 368M55□□
↑
Symbol in the table below.

* To designate the cable length (L), see the table below.

Symbol	L (m)	Symbol	L (m)
01	3	06	12
02	5	07	15
03	6		
04	8		
05	10		

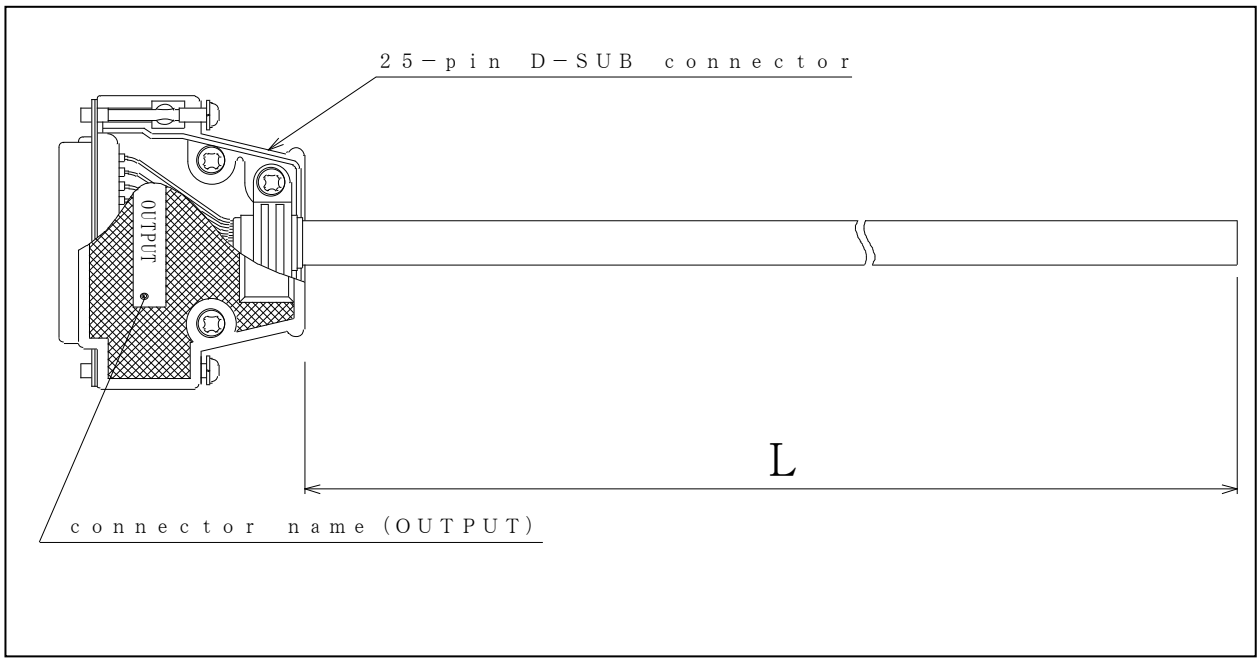
* For details and connection of the signals, see Para. 4.2 External Output Signal Cable.
* This cable cannot be used for the sliding part or moving part which will bend repeatedly.

Cable specifications

Items	Specifications
Nominal sectional area of conductor	0.2 mm^2
Structure of conductor	7/0.18
No. of cable cores	25C
Insulator material	Heat-proof vinyl chloride
Shield material	Tin-plated annealed copper wire
Sheath material	Heat-proof vinyl chloride
Conductor resistance (20°C)	119 Ω/km or less
Operating temperature	–20°C ~ 75°C (See Note 1.)
Operating voltage	AC 50 V, DC 60 V

Note 1: Heat-proof grade: 90°C

10.2.2 Outline drawing



10.2.3 Wiring table

I/O type: Type-N

Signal name	Connector pin	Cable color
DO_1	1	Black
DO_2	14	White
DO_3	2	Red
DO_4	15	Green
DO_5	3	Yellow
DO_6	16	Brown
DO_7	4	Blue
DO_8	17	Gray
P24V	5	Orange
P24V	18	Purple
ACK	6	Pink
SV_RDY	19	Light green
EXTSIG	7	Light blue
SYS_RDY	20	Black/White
AUTORUN	8	Red/White
CYC_END	21	Green/White
LOW_ST	9	Yellow/White
BT_ALM	22	Brown/White
P24V	10	Blue/White
P24V	23	Gray/White
ALARM	11	Orange/White
SVST_A	24	Purple/White
SVST_B	12	Pink/White
EMSST_A	25	Light green/White
EMSST_B	13	Light blue/White
FG	Case	Shield

Type N

I/O type: Type-P

Signal name	Connector pin	Cable color
DO_1	1	Black
DO_2	14	White
DO_3	2	Red
DO_4	15	Green
DO_5	3	Yellow
DO_6	16	Brown
DO_7	4	Blue
DO_8	17	Gray
P24G	5	Orange
P24G	18	Purple
ACK	6	Pink
SV_RDY	19	Light green
EXTSIG	7	Light blue
SYS_RDY	20	Black/White
AUTORUN	8	Red/White
CYC_END	21	Green/White
LOW_ST	9	Yellow/White
BT_ALM	22	Brown/White
P24G	10	Blue/White
P24G	23	Gray/White
ALARM	11	Orange/White
SVST_A	24	Purple/White
SVST_B	12	Pink/White
EMSST_A	25	Light green/White
EMSST_B	13	Light blue/White
FG	Case	Shield

Type P

10.3 TR48DIOCN-1/ TR48DIOC-1 INPUT Cable

10.3.1 Specifications

Type : 368M54□□
↑
Symbol in the table below.

* To designate the cable length (L), see the table below.

Symbol	L (m)	Symbol	L (m)
01	3	06	12
02	5	07	15
03	6		
04	8		
05	10		

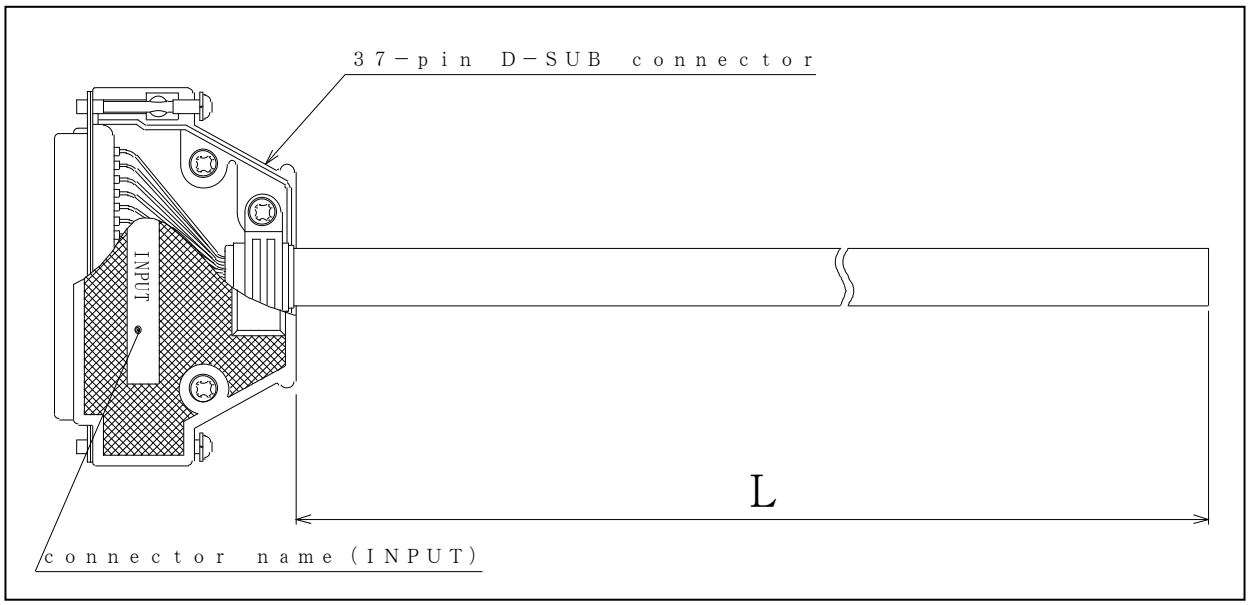
* The TR48DIOC N-1/ TR48DIOC-1 INPUT cable is the same as the INPUT cable.
* For details and connection of the signals, see 8 Extension I/O Signal Cable.
* This cable cannot be used for the sliding part or moving part which will bend repeatedly.

Cable specifications

Items	Specifications
Nominal sectional area of conductor	0.2 mm^2
Structure of conductor	7/0.18
No. of cable cores	40C
Insulator material	Heat-proof vinyl chloride
Shield material	Tin-plated annealed copper wire
Sheath material	Heat-proof vinyl chloride
Conductor resistance (20°C)	119 Ω/km or less
Operating temperature	–20°C ~ 75°C (See Note 1.)
Operating voltage	AC 50 V, DC 60 V

Note 1: Heat-proof grade: 90°C

10.3.2 Outline drawing



10.3.3 Wiring table

I/O type: Type-N, Type-P

Signal name	Connector pin	Cable color
DI_101/DI_133	1	Black
DI_102/DI_134	20	White
DI_103/DI_135	2	Red
DI_104/DI_136	21	Green
DI_105/DI_137	3	Yellow
DI_106/DI_138	22	Brown
DI_107/DI_139	4	Blue
DI_108/DI_140	23	Gray
P24V	5	Orange
P24G	24	Purple
INCOM1	6	Pink
DI_109/DI_141	25	Light green
DI_110/DI_142	7	Light blue
DI_111/DI_143	26	Black/White
DI_112/DI_144	8	Red/White
DI_113/DI_145	27	Green/White
DI_114/DI_146	9	Yellow/White
DI_115/DI_147	28	Brown/White
DI_116/DI_148	10	Blue/White
P24V	29	Gray/White
P24G	11	Orange/White
INCOM2	30	Purple/White
DI_117/DI_149	12	Pink/White
DI_118/DI_150	31	Light green/White
DI_119/DI_151	13	Light blue/White
DI_120/DI_152	32	White/Black
DI_121/DI_153	14	Red/Black
DI_122/DI_154	33	Green/Black
DI_123/DI_155	15	Yellow/Black
DI_124/DI_156	34	Brown/Black
P24V	16	Blue/Black
P24G	35	Gray/Black
INCOM3	17	Orange/Black
DI_125/DI_157	36	Purple/Black
DI_126/DI_158	18	Pink/Black
DI_127/DI_159	37	Light green/Black
DI_128/DI_160	19	Light blue/Black
FG	Case	Shield

Type N

Type P

* As up to two (2) extension I/O units (TR48DIOCN-1/TR48DIOC-1) can be connected, the cable signal names are station 0 and station 1.

10.4 TR48DIOCN-1/ TR48DIOC-1 OUTPUT Cable

10.4.1 Specifications

Type : 368M55□□
↑
Symbol in the table below.

* To designate the cable length (L), see the table below.

Symbol	L (m)	Symbol	L (m)
01	3	06	12
02	5	07	15
03	6		
04	8		
05	10		

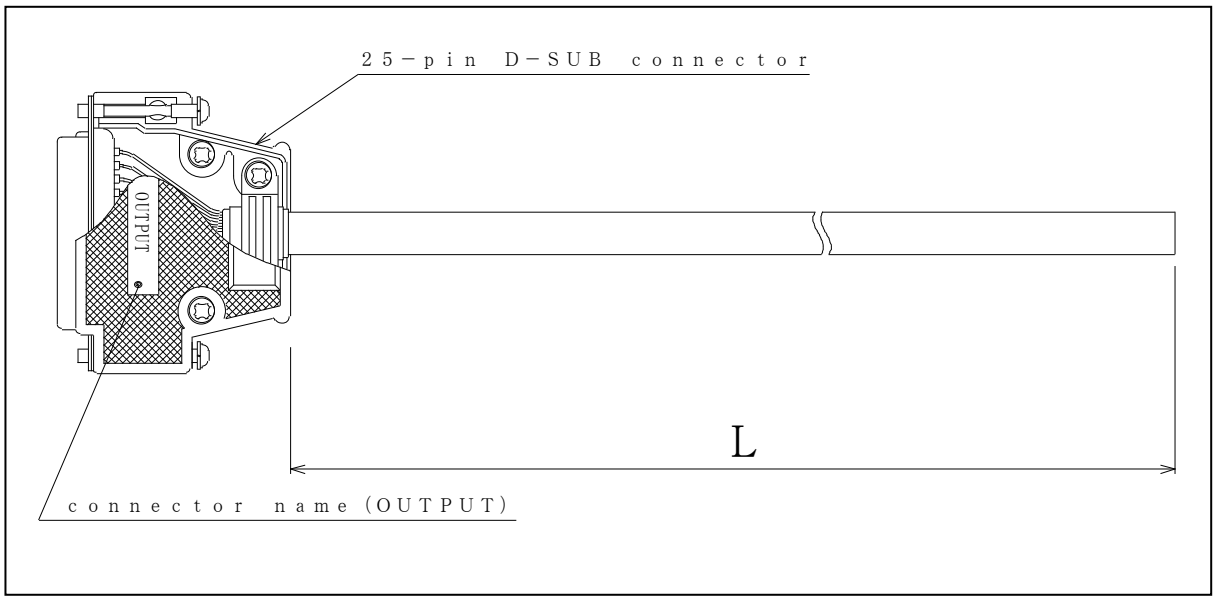
* The TR48DIOC N-1/ TR48DIOC-1 OUTPUT cable is the same as the OUTPUTcable.
* For details and connection of the signals, see 8 Extension I/O Signal Cable.
* This cable cannot be used for the moving part or sliding part which will bend repeatedly.

Cable specifications

Items	Specifications
Nominal sectional area of conductor	0.2 mm^2
Structure of conductor	7/0.18
No. of cable cores	25C
Insulator material	Heat-proof vinyl chloride
Shield material	Tin-plated annealed copper wire
Sheath material	Heat-proof vinyl chloride
Conductor resistance (20°C)	119 Ω/km or less
Operating temperature	–20°C ~ 75°C (See Note 1.)
Operating voltage	AC 50 V, DC 60 V

Note 1: Heat-proof grade: 90°C

10.4.2 Outline drawing



10.4.3 Wiring table

I/O type: Type-N

Signal name	Connector pin	Cable color
DO_101/DO_133	1	Black
DO_102/DO_134	14	White
DO_103/DO_135	2	Red
DO_104/DO_136	15	Green
DO_105/DO_137	3	Yellow
DO_106/DO_138	16	Brown
DO_107/DO_139	4	Blue
DO_108/DO_140	17	Gray
P24V	5	Orange
P24V	18	Purple
DO_109/DO_141	6	Pink
DO_110/DO_142	19	Light green
DO_111/DO_143	7	Light blue
DO_112/DO_144	20	Black/White
DO_113/DO_145	8	Red/White
DO_114/DO_146	21	Green/White
DO_115/DO_147	9	Yellow/White
DO_116/DO_148	22	Brown/White
P24V	10	Blue/White
P24V	23	Gray/White
DO_117/DO_149	11	Orange/White
DO_118/DO_150	24	Purple/White
DO_119/DO_151	12	Pink/White
DO_120/DO_152	25	Light green/White
P24V	13	Light blue/White
FG	Case	Shield

Type N

* Up to two (2) expansion I/O units (TR48DIOCN-1/TR48DIOC-1) can be connected. The cable signal names are station 0 and station 1.

I/O type: Type-P

Signal name	Connector pin	Cable color
DO_101/DO_133	1	Black
DO_102/DO_134	14	White
DO_103/DO_135	2	Red
DO_104/DO_136	15	Green
DO_105/DO_137	3	Yellow
DO_106/DO_138	16	Brown
DO_107/DO_139	4	Blue
DO_108/DO_140	17	Gray
P24G	5	Orange
P24G	18	Purple
DO_109/DO_141	6	Pink
DO_110/DO_142	19	Light green
DO_111/DO_143	7	Light blue
DO_112/DO_144	20	Black/White
DO_113/DO_145	8	Red/White
DO_114/DO_146	21	Green/White
DO_115/DO_147	9	Yellow/White
DO_116/DO_148	22	Brown/White
P24G	10	Blue/White
P24G	23	Gray/White
DO_117/DO_149	11	Orange/White
DO_118/DO_150	24	Purple/White
DO_119/DO_151	12	Pink/White
DO_120/DO_152	25	Light green/White
P24G	13	Light blue/White
FG	Case	Shield

Type P

* Up to two (2) expansion I/O units (TR48DIOCN-1/TR48DIOC-1) can be connected. The cable signal names are station 0 and station 1.

Appendix 1 System Signal Table

Name	DIN signal name	I/O	Function	Signal judgment
STROBE	249	I	Selects an execution program file from the external equipment.	ON: Short-circuit OFF: Open
PRG_RST	250	I	Resets a program currently stopped to step 1. The value of each variable is also reset to "0".	ON: Short-circuit OFF: Open
STEP_RST	251	I	Resets a program currently stopped to step 1. The value of each variable remains unchanged.	ON: Short-circuit OFF: Open
CYC_RST	252	I	Resets a program currently stopped to the step labeled "RCYCLE". The value of each variable remains unchanged.	ON: Short-circuit OFF: Open
DO_RST	253	I	Batch-resets the digital output signals (DO_1 ~ DO_16, DO_101 ~ DO_120, DO_133 ~ DO_152).	ON: Short-circuit OFF: Open
ALM_RST	254	I	Cancels an alarm which has occurred while the robot controller was able to work.	ON: Short-circuit OFF: Open
RUN	255	I	Starts a program currently stopped to execute an automatic operation.	ON: Short-circuit OFF: Open
EX_SVON	256	I	Turns on the servo power.	ON: Short-circuit OFF: Open
STOP	257	I	Stops a program during automatic operation.	ON: Open OFF: Short-circuit
CYCLE	258	I	Stops a program currently executed in automatic operation after one (1) cycle has finished.	ON: Open OFF: Short-circuit
LOW_SPD	259	I	Reduces the robot operating speed in automatic operation.	ON: Open OFF: Short-circuit
BREAK	260	I	Slows down and stops the ongoing robot operation.	ON: Open OFF: Short-circuit
SVOFF	261	I	Turns off the servo power.	ON: Open OFF: Short-circuit
EMS*B ~ EMS*C	-	I	Emergency-stops the robot.	ON: Open OFF: Short-circuit

I : Input signal

O : Output signal

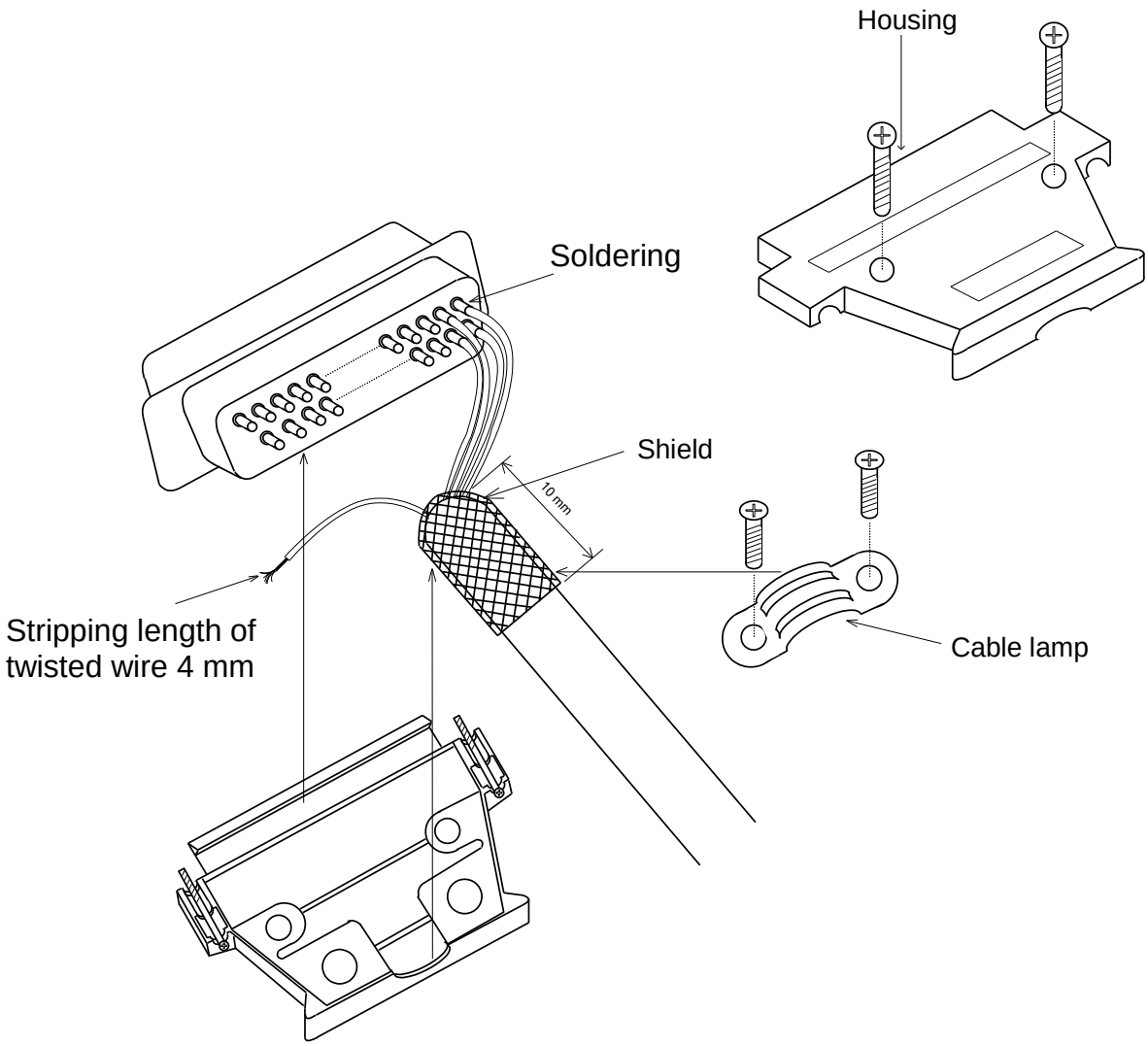
Name	DOUT signal name	I/O	Function	Signal judgment
ACK	251	O	Serves as a response signal to input signals STROBE, PRG_RST, STEP_RST, CYC_RST and DO_RST.	ON: High OFF: Low
SV_RDY	250	O	This signal is output when the servo power is turned on and the robot is ready to start.	ON: High OFF: Low
EXTSIG	254	O	This signal is output when the EXT. SIGNAL mode is selected by means of the MODE switch.	ON: High OFF: Low
SYS_RDY	256	O	System ready signal	ON: High OFF: Low
AUTORUN	257	O	This signal is output while the program is executed in automatic operation.	ON: High OFF: Low
CYC_END	258	O	This is the output signal for verifying that the program has stopped by the CYCLE signal input.	ON: High OFF: Low
LOW_ST	259	O	This signal is output while the robot is operating at a low speed by the input of low speed command.	ON: High OFF: Low
BT_ALM	261	O	Battery voltage level error output for backup power supply.	ON: High OFF: Low
ALARM	262	O	Controller fault output.	ON: High OFF: Low
SVST_A ~ SVST_B	-	O	Servo power ON contact output.	ON: Contact close OFF: Contact open Non-voltage contact
EMSST_A ~ EMSST_B	-	O	Used to detect the EMERGENCY stop switch equipped on the control panel or teach pendant, and system input signal of emergency stop.	ON: Contact open OFF: Contact close Non-voltage contact

I : Input signal

O : Output signal

Appendix 2 Fabricating Cable Using D-SUB Connector

The cables to KSL3000 external I/O signal connectors INPUT, OUTPUT, TR48DIOCN-1/TR48DIOC-1 module INPUT (TR), OUTPUT (TR), serial I/O signal connectors and hand I/O signal connector CN0 (robot side connections) should be fabricated as shown below.



Note: The shield wire of the cable using a D-SUB connector is connected to the ground of the KSL3000 robot controller through the housing. Completely connect the shield wire to the housing using the cable clamp.
Also, it is recommended to attach a protective cover such as thermal contraction tube to the soldered part to prevent a short-circuit.