TS3000 series Robot Controller

TS3100 SCARA / LINEAR / 6-AXIS system

INSTRUCTION MANUAL

INTERFACE MANUAL

Notice

- Make sure that this instruction manual is delivered to the final user of Toshiba Machine's industrial robot.
- Before operating the industrial robot, read through and completely understand this manual.
- After reading through this manual, keep it nearby for future reference.

TOSHIBA MACHINE CO., LTD.

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Preface

This manual describes the type, function and handling method of external cables connecting the TS3100 robot controller with an external equipment.

This manual is intended for the system designers and manufacturing engineers.
The TS3100 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
- Operator's Manual
- User Parameter Manual
- Simple PLC Function Manual
- Communication Manual
- Conveyor Synchronous Function Instruction 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.

Cautions on Safety

This manual contains the important information on the robot and controller to prevent injury to the operators and persons nearby, to prevent damages to assets and to assure correct use.
Make sure that you well understand the following details (indications and symbols) before reading this manual. Always observe the information that is noted.

[Explanation of indications]

Indication	Meaning of indication
 **DANGER**	This means that "incorrect handling will lead to fatalities or serious injuries."
 **CAUTION**	This means that "incorrect handling may lead to personal injuries *1) or physical damage *2).

*1) Injuries refer to injuries, burns and electric shocks, etc., which do not require hospitalization or long-term medical treatment.
*2) Physical damage refers to damages due to destruction of assets or resources.

[Explanation of symbols]

Symbol	Meaning of symbol
	This means that the action is prohibited (must not be done). Details of the actions actually prohibited are indicated with pictures or words in or near the symbol.
	This means that the action is mandatory (must be done). Details of the actions that must be done are indicated with pictures or words in or near the symbol.
	This means danger. Details of the actual danger are indicated with pictures or words in or near the symbol.
	This means caution. Details of the actual caution are indicated with pictures or words in or near the symbol.

⚠ **CAUTION**	To perform the work ranging from robot installation to operation with safety, read through and through the Safety Manual provided separately before actually starting the work.

Maintenance and Inspection

To use the robot safety, strictly observe the following matters.

! DANGER	
 Prohibited	• NEVER burn, disassemble or charge the battery. Otherwise, it may explode.
 Mandatory	• Before performing the maintenance and inspection, be sure to turn off the main power switch of the controller. • When disposing of batteries, be sure to follow the user's regulations.

! CAUTION	
 Disassembly Prohibited	• The user should NEVER replace or change parts other than those stipulated in the instruction manual. Otherwise, the performance will deteriorate, resulting in troubles.
 Mandatory	• To replace parts, use the spare parts designated by Toshiba Machine. • Carry out the maintenance and inspection on a regular basis. Otherwise, the equipment may go wrong or accidents will be caused.

! 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.

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1. Type of External Cable

1.1 Layout and Name of Connectors

The TS3100 robot controller is connected with the robot and external equipment, using connectors and terminal block provided on the front and rear sides of the controller.

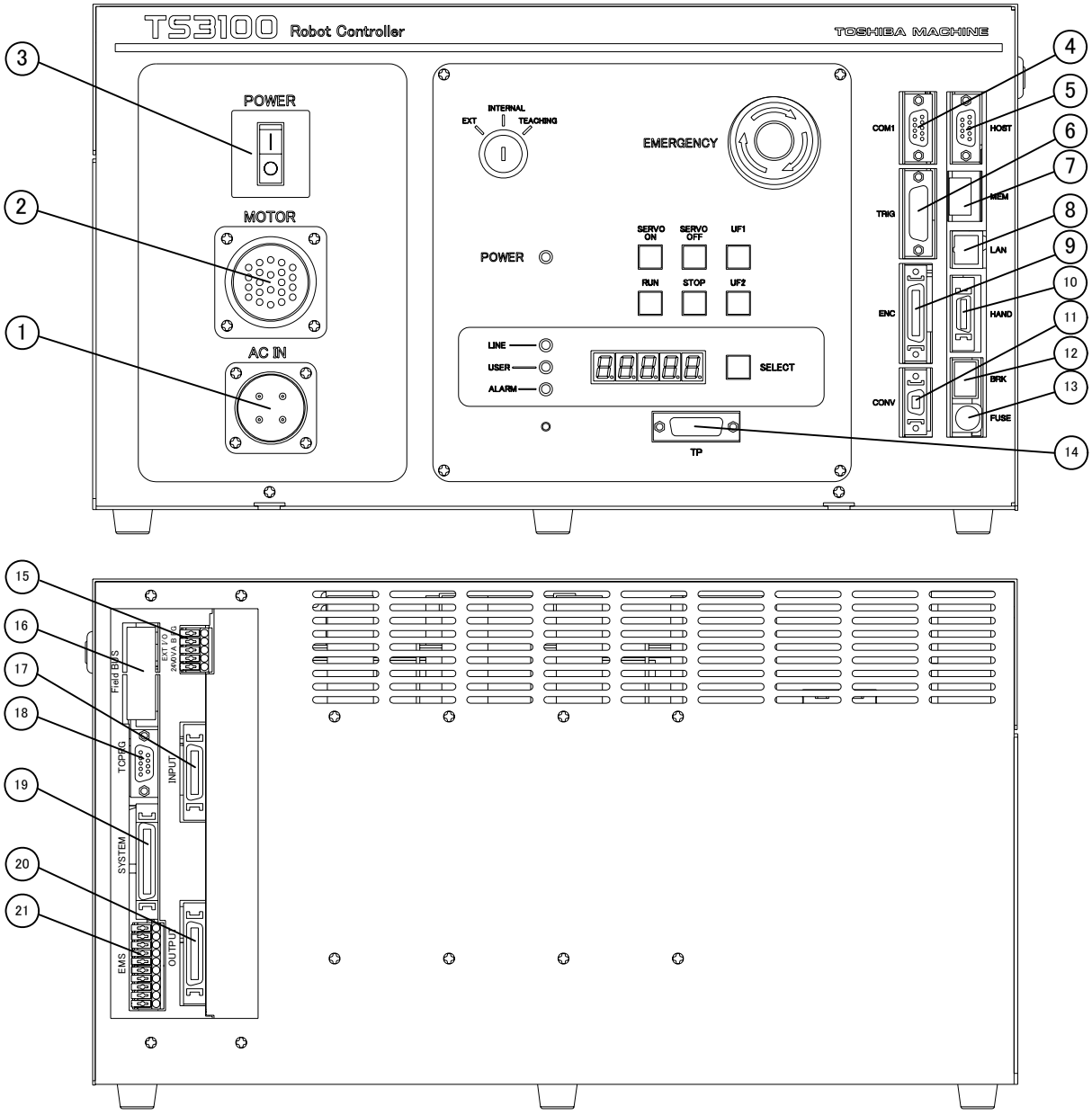


Fig. 1 Layout and name of connectors

1.2 TS3100 Power Cable "ACIN" "POWER"

Fig.1-[1], [3] (with connector)

TS2000：The power cable is an interface feeding the main power (single phase, 200–240 VAC, 50/60 Hz) to the TS3100 robot controller.

Connector "ACIN" is used. Switch “POWER” is used.

For details, see the Installation & Transport Manual provided separately.

1.3 Robot Control Cables

1.3.1 TS3100 Motor Drive Cable "MOTOR"

Fig. 1-[2] (with cable)

The motor drive cable connects the TS3100 robot controller and robot.

It feeds the 3-phase AC power to each axis feed motor of the robot.

Connector "MOTOR" is used.

For details, see the Installation & Transport Manual provided separately.

1.3.2 TS3100 Encoder Cable "ENC"

Fig. 1-[9] (with cable)

The encoder cable is an interface which inputs the rotation angle detection encoder signal (axis 1 to axis 6) of each robot axis to the TS3100 robot controller.

Connector "ENC" is used.

For details, see the Installation & Transport Manual provided separately.

1.3.3 Robot Control Signal Cable "HAND"

Fig. 1-[10] (with cable)

This cable is used to input and output the robot control signals through hand operation. Among the robot control signal cables, the input/output signal cables for controlling the hand effector such as robot hand can be controlled by the robot language program. Also, they can be turned on and off manually through the teach pendant.

Connector "HAND" is used.

For details, see the Installation & Transport Manual provided separately.

For the robot language, see the Robot Language Manual. For the operation of hand input and output signals from the teach pendant, see the Operation Manual.

1.3.4 Robot Control Signal Cable "BRK"

Fig. 1-[12] (with cable)
This cable is used to turn on and off the parking brake for securing the robot motor shaft. Connector "BRK" is used.

1.4 External I/O Signal Cables

1.4.1 Power Supply for I/O and Safe Input Cable “EMS”

Fig. 1-[21] (with dummy connector)
This is the connector for input of the power supply (P24 V) for digital input/output (32 inputs/32 outputs) and system input/output (13 inputs/12 outputs) of the TS3100 robot controller. These signals also turn on and off the emergency stop input (2 inputs) and safety stop input (2 inputs).

1.4.2 External Input Signal Cable "INPUT"

Fig. 1-[17]
This cable is used to input the digital signal from the external equipment to the TS3100 robot controller. The external input signals enable control by the user of 32 programmable digital input signals using robot language. Connector "INPUT" is used.

1.4.3 External Output Signal Cable "OUTPUT"

Fig. 1-[20]
The external output signal cable is an interface which outputs the digital signal from the external equipment to the TS3100 robot controller. Connector "OUTPUT" is used.

1.4.4 External I/O Signal Cable "SYSTEM"

Fig. 1-[19] (with dummy connector)
The external input/output signal cable is an interface which inputs the digital signal from the external equipment to the TS3100 robot controller, and outputs the digital signal from the TS3100 robot controller to the external equipment. There are 13 external operation input signals that enable operation of the controller from the external equipment and 12 external operation output signals that output the controller status. These signals, together with the external input signal in Para.

1.4.2 and external output signal in Para. 1.4.3, allow the robot controller to work in concert with the external equipment.

1.5 Serial I/O Signal Cable

1.5.1 Serial I/O Signal "COM1"

Fig. 1-[4]
Of the serial input and output signals of three (3) channels equipped on the TS3100 robot controller, the D-SUB 9-pin connector located on the first line of the front connector unit in Fig. 1 is COM1. COM1 is exclusively used for the RS-232C and allows data communication with an image processing equipment or other FA equipment that can connect an RS-232C interface. Connector "COM1" is used.

1.5.2 Serial I/O Signal "HOST"

Fig. 1-[5]
Of the serial input and output signals of three (3) channels equipped on the TS3100 robot controller, the D-SUB 9-pin connector located on the second line from the top of the front connector unit in Fig. 1 is HOST. HOST is exclusively used for the RS-232C and allows transfer and saving of various parameters and updating of the system when connected with the host computer. Connector "HOST" is used.

1.5.3 TCPRGOS "TCPRG"

Fig. 1-[18]
The TS3100 robot controller uses exclusive sequence control tool "TCPRGOS" (option) to transfer, save and monitor sequence programs in the built-in programmable controller (PLC).
To connect with this sequence control tool, the D-SUB 9-pin connector located at the upper rear part of Fig. 1 is TCPRG.
Connector "TCPRG" is used.
For the use of TCPRGOS, see the Simple PLC Function Manual (option) provided separately.

1.6 Trigger Cable "TRIG"

Fig. 1-[6]
The standard controller includes eight (8) trigger function inputs. This is used for data latch, conveyor synchronization, and other functions. Connector "TRIG" is used, which is the D-sub 15-pin connector located on the top section of the front panel.

1.7 Memory Cable "MEM"

Fig. 1-[7]
A USB memory device can be used to transfer and save various parameters and to back up programs and other data. Connector "MEM" located on the front panel is used.

1.8 LAN Cable "LAN"

Fig. 1-[8]
The controller supports 10BASE-T connections. If a hub is used, connect using a straight cable. Use a cross cable when connecting a computer directly to controller. Also, TCP/IP protocol can be used to enable communication on the same local area network with computers and visual equipment on the Ethernet. This allows program creation and editing, debugging start support, and maintenance using the computer programmer TSPC.

1.9 Conveyor Cable "CONV"

Fig. 1-[11]
This is used when using the conveyor synchronization function. Use an encoder having an output circuit with RS-422 differential output (line driver) and A and B phase signals with a 90-degree phase. Signals from an incremental encoder and input signals from a conveyor synchronization start trigger switch are required.

1.10 Fuse Cable "FUSE"

Fig. 1-[13]
This is a fuse for detecting over-current (3A) in the digital signal input/output to the robot controller. It is used for pattern protection. "FUSE" is located in the bottom section of the front panel in Fig. 1.

1.11 Fieldbus Cable "FieldBUS" (Option)

Fig. 1-[16]
The Fieldbus slave module supports three Fieldbus types: Profibus, DeviceNet, and CC-LINK. "FieldBUS" is located in the top section of the rear panel in Fig. 1.

1.12 Teach Pendant Cable "TP"

Fig. 1-[14] (with dummy connector)
This is an interface connecting the TS3100 robot controller and teach pendant. The TP1000 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.

1.13 Remote I/O Cable "EXT–I/O"

Fig. 1-[15] (with connector)
This is an RS-485 communication terminal connecting the optional remote I/O module function (TR48DIOCN/TR48DIOC module, etc.) of the TS3100 robot controller. To connect, the terminal block on the rear side of the controller is used.

2. Connecting Power Cable

To connect the power cable, use the attached connector (JL04V–6A22–22SE-EB-R; made by Japan Aviation Electronics Industry).

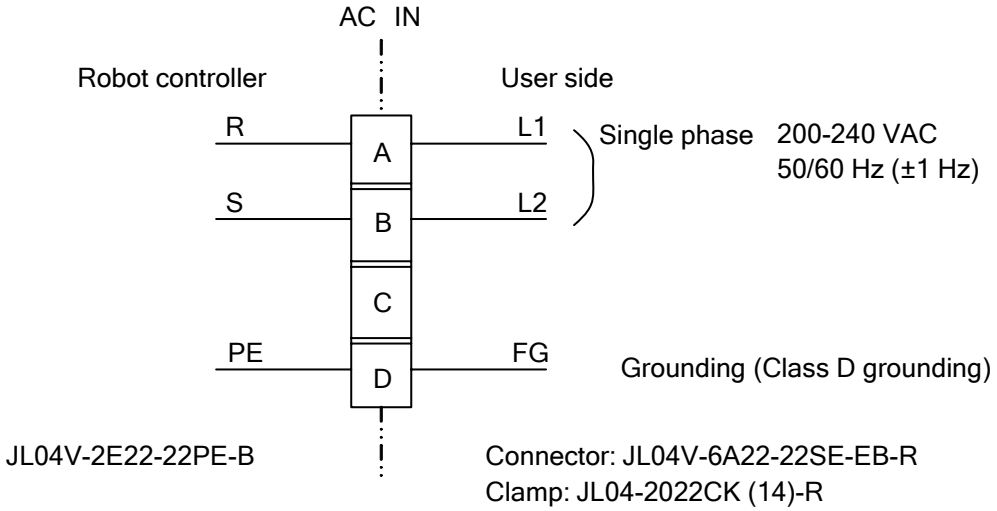


Fig. 1 Connection of power cable

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

3. Connecting Robot Control Cable

3.1 Connecting Motor Drive Cable

3.1.1 Connecting Motor Drive Cable (SCARA Type Robot)

To connect the motors, use the attached cables.

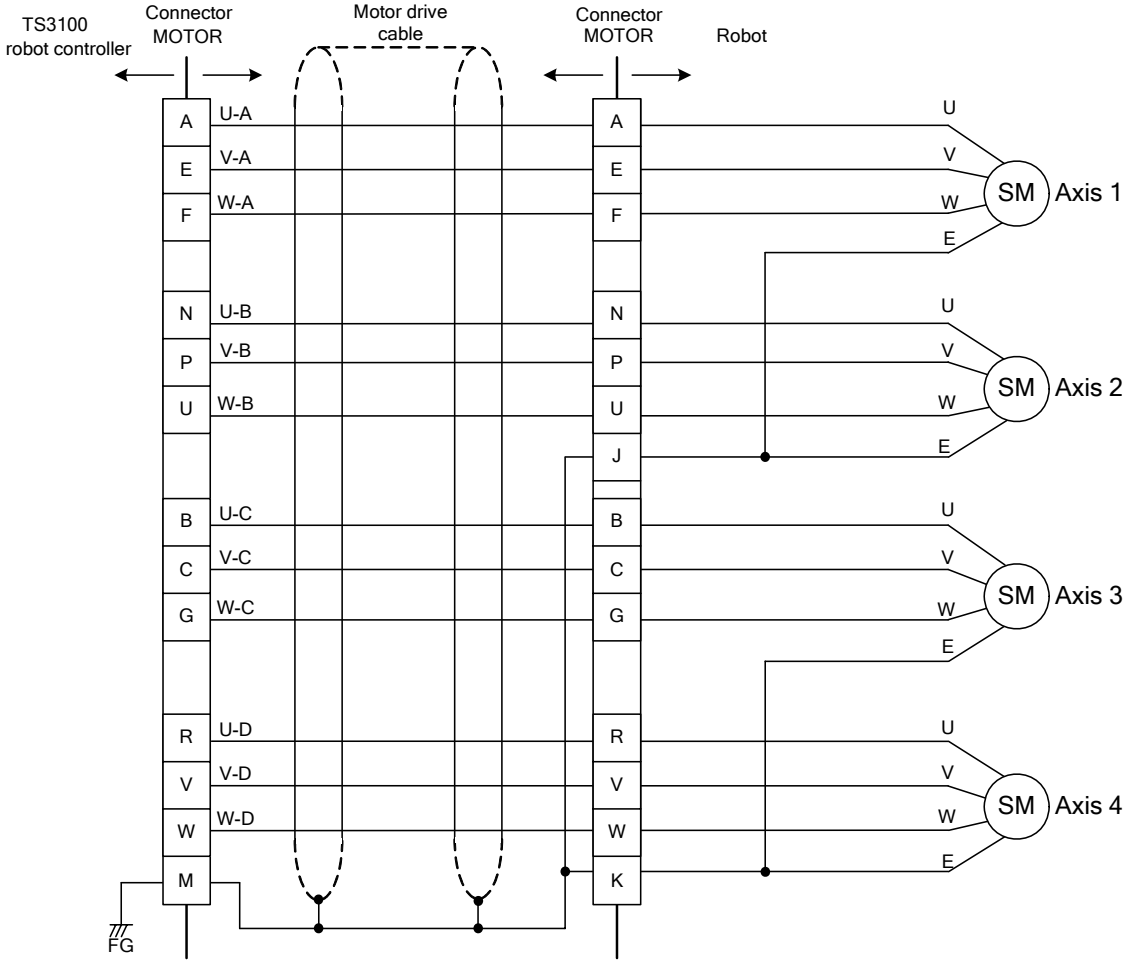


Fig. 3.1 Connection of motor drive cables (SCARA type robot)

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

3.1.2 Connecting Motor Drive Cable (6-axis Robot)

To connect the motors, use the attached cables.

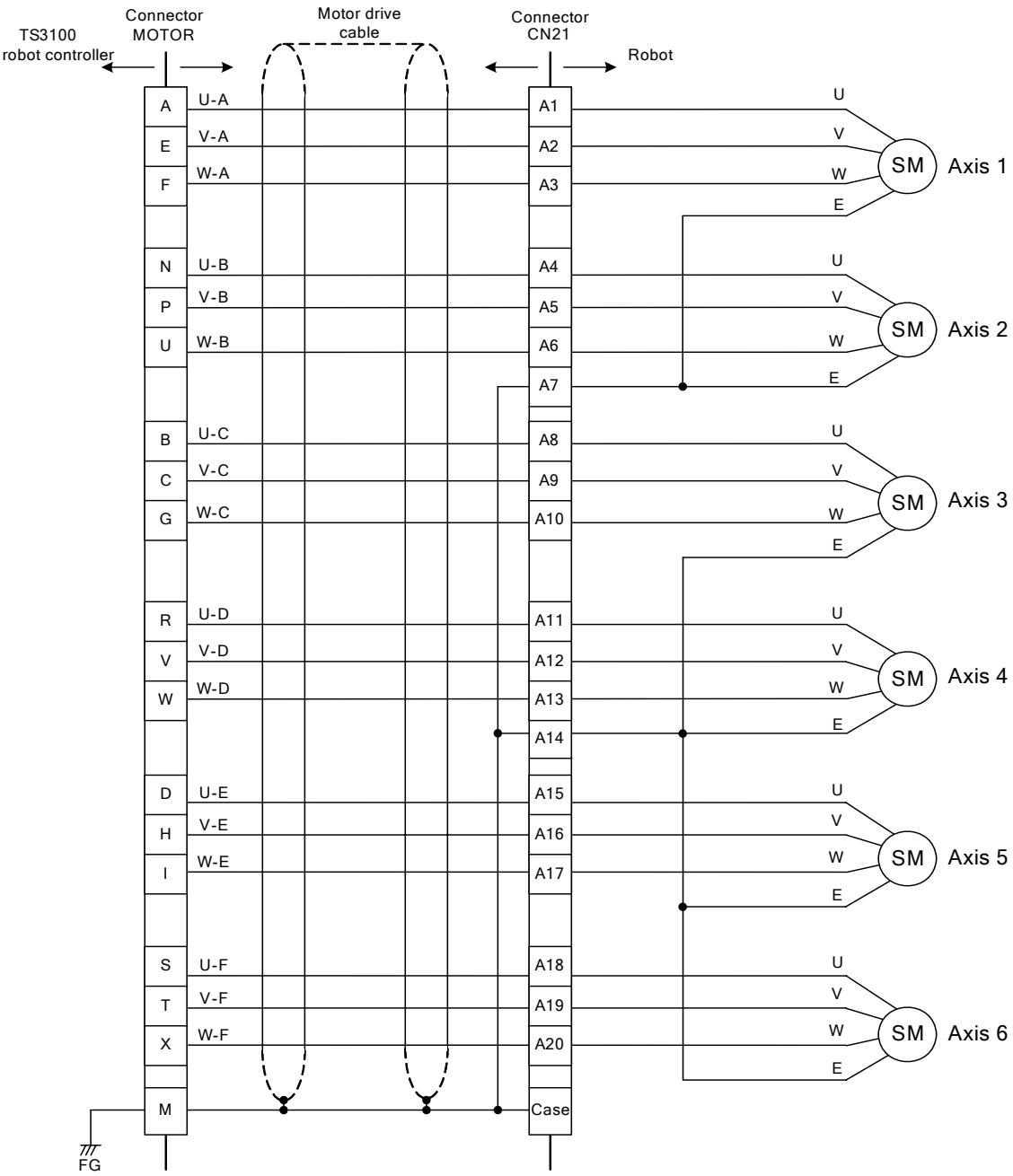


Fig. 3.2 Connection of motor drive cables (6-axis robot)

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

3.2 Connecting Encoder Cable

3.2.1 Connecting Encoder Cable (SCARA Type Robot)

To connect the encoders to the TS3100 digital servo printed board (X8GL), use the attached cables.

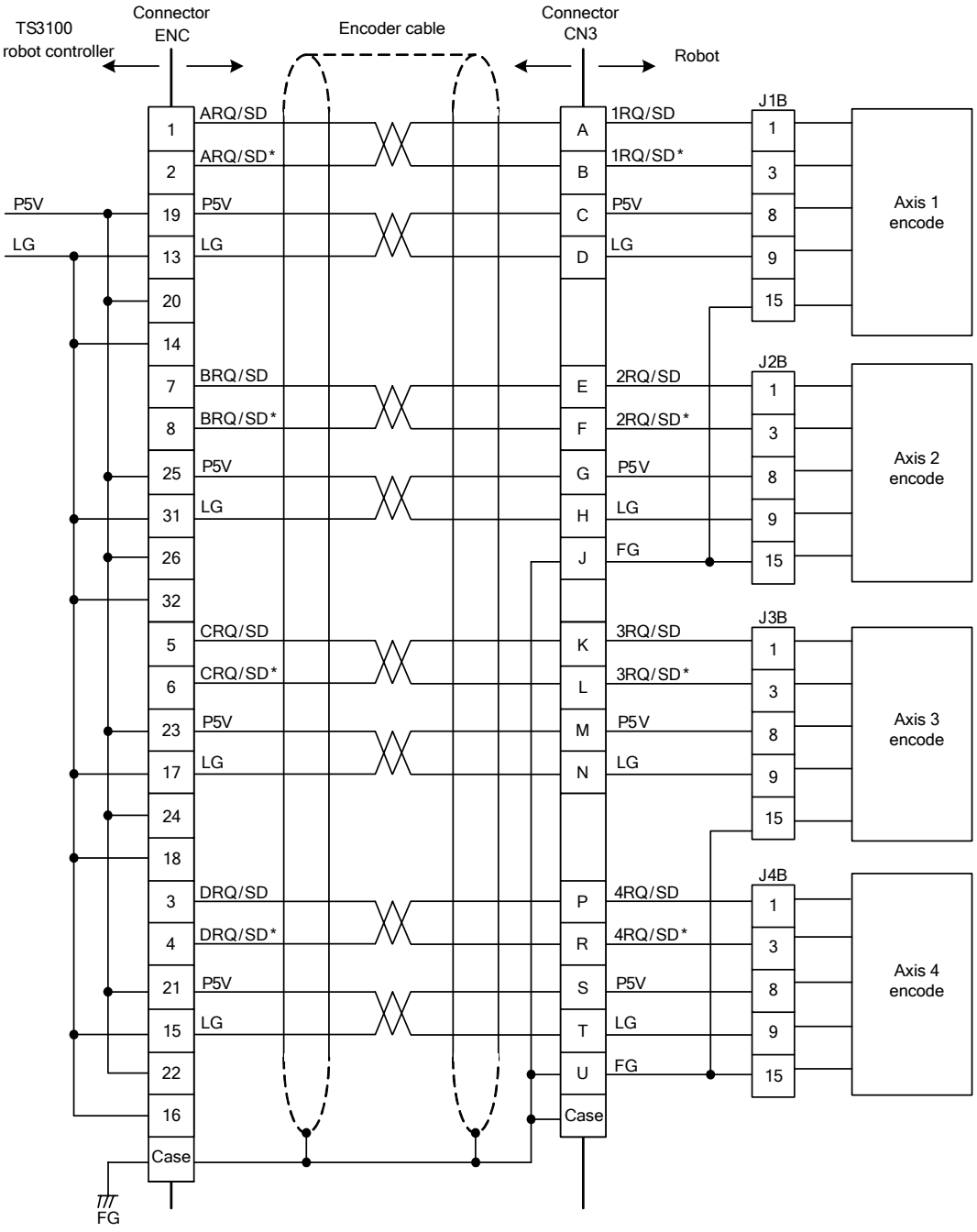


Fig. 3.3 Connection of encoder cables (SCARA type robot)

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

3.2.2 Connecting Encoder Cable (6-axis Robot)

To connect the encoder to the TS3100 digital servo printed board (X8GL), use the attached cables.

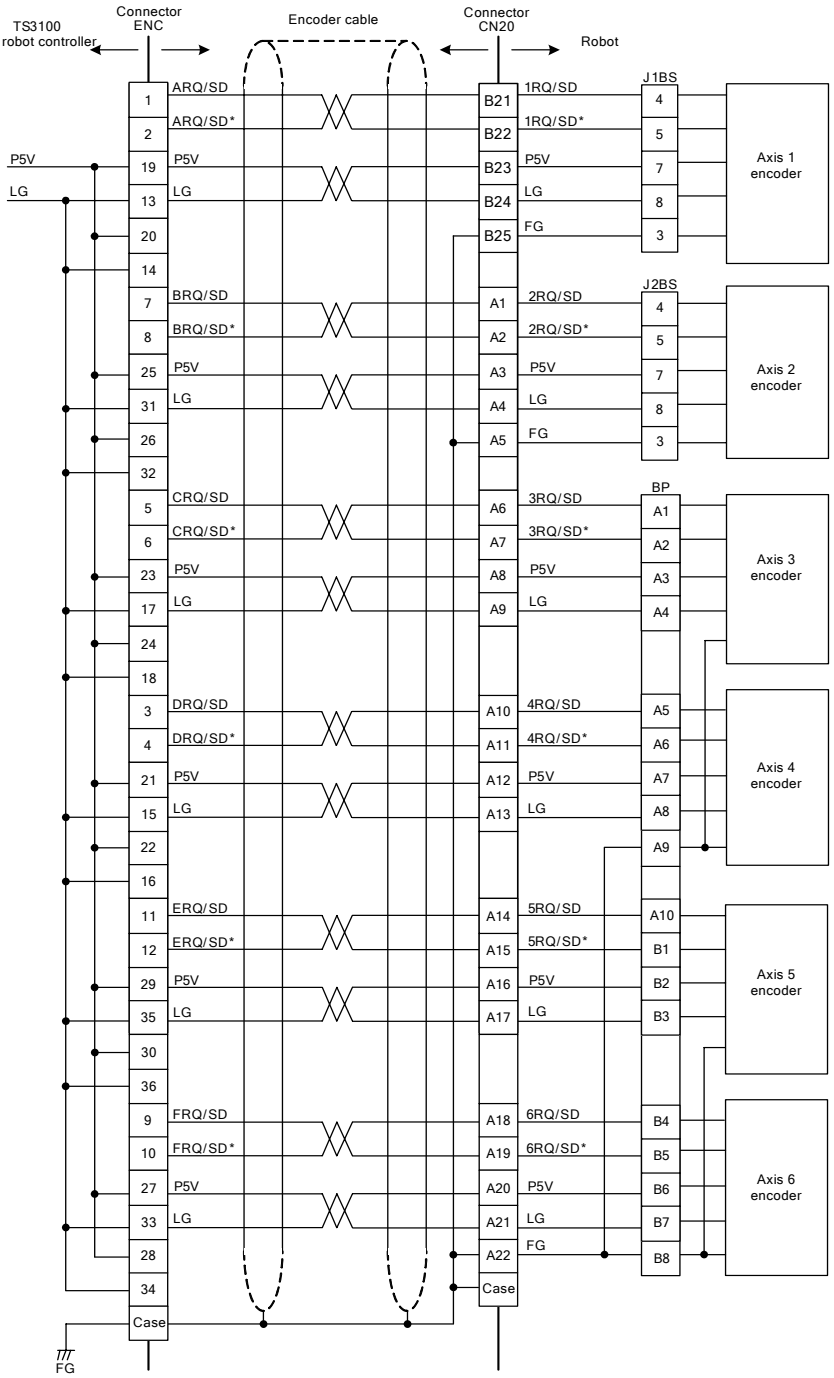


Fig. 3.4 Connection of encoder cable (6-axis robot)

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

3.3 Connecting Robot Control Signal Cable

3.3.1 Connecting Robot Control Signal Cable (SCARA Type Robot)

To connect the robot control signal cable, use the attached cables.
The I/O common comes in the two (2) types; Type N [X8GN (output sink type) is selected for the I/O printed board and the polarity is the same as in the SR7000 robot] and Type P [X8GI (output source type) is selected for the I/O printed board). After confirming the type of your controller, connect the robot control signal cable.

[Type N] (When X8GN printed board is used)

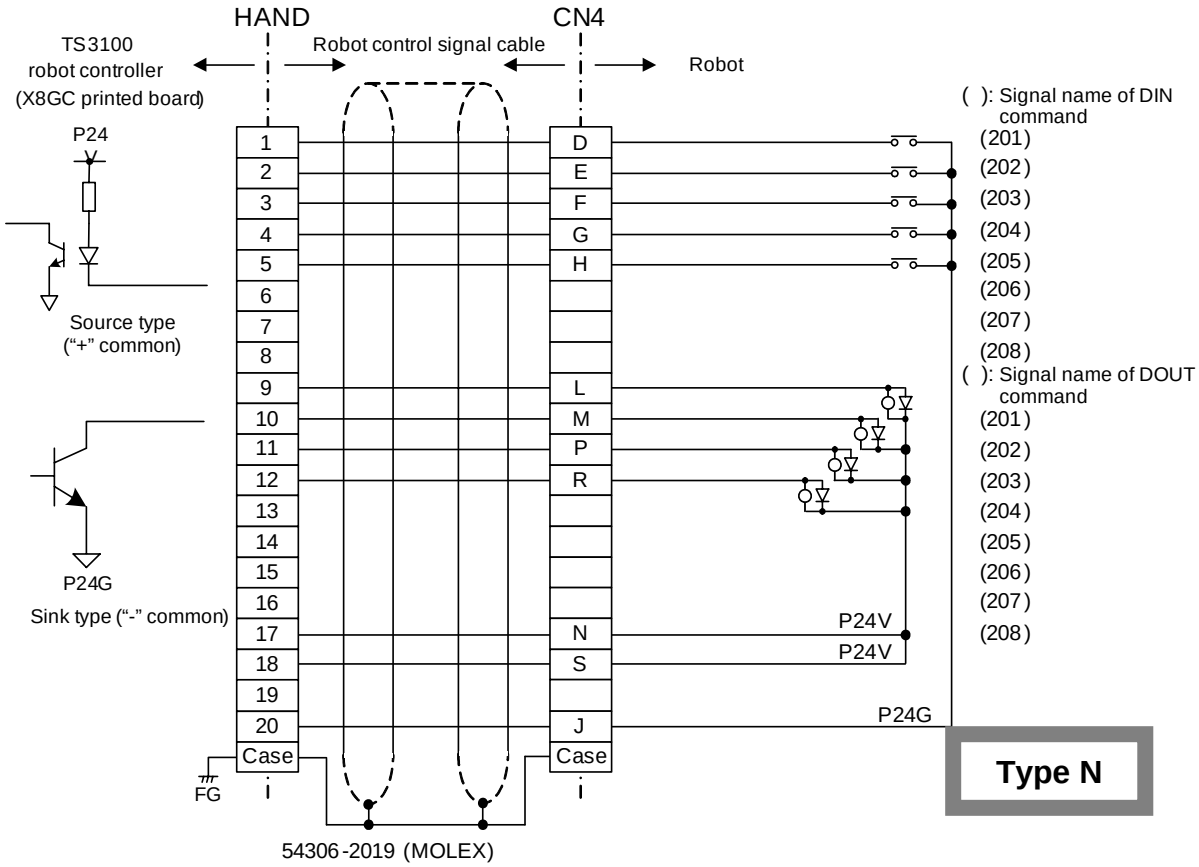


Fig. 3.5 Connection of robot control signal cable (Type N)

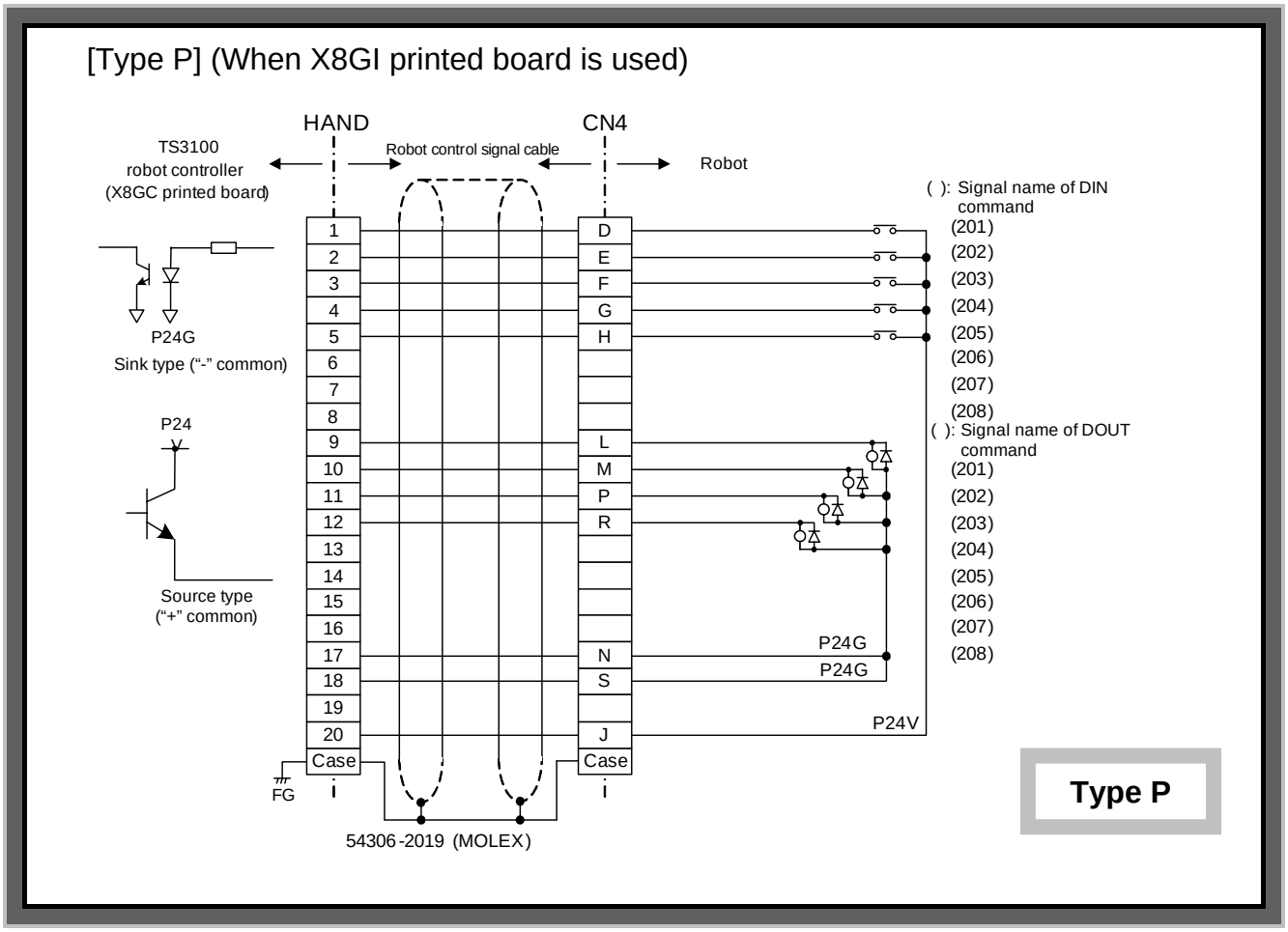


Fig. 3.6 Connection of robot control signal cable (Type P)

3.3.2 Connecting Robot Control Signal Cable (6-axis Robot)

[Type N] (When X8GN printed board is used)

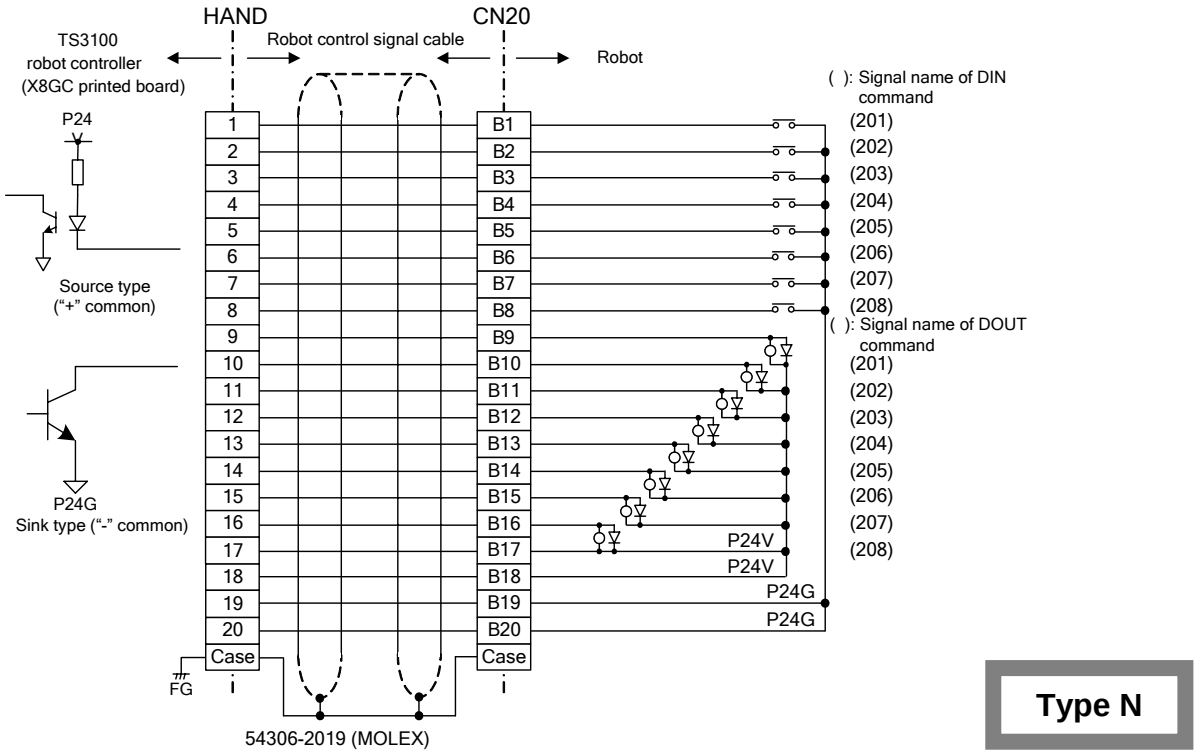


Fig. 3.7 Connection of robot control signal cables (Type N)

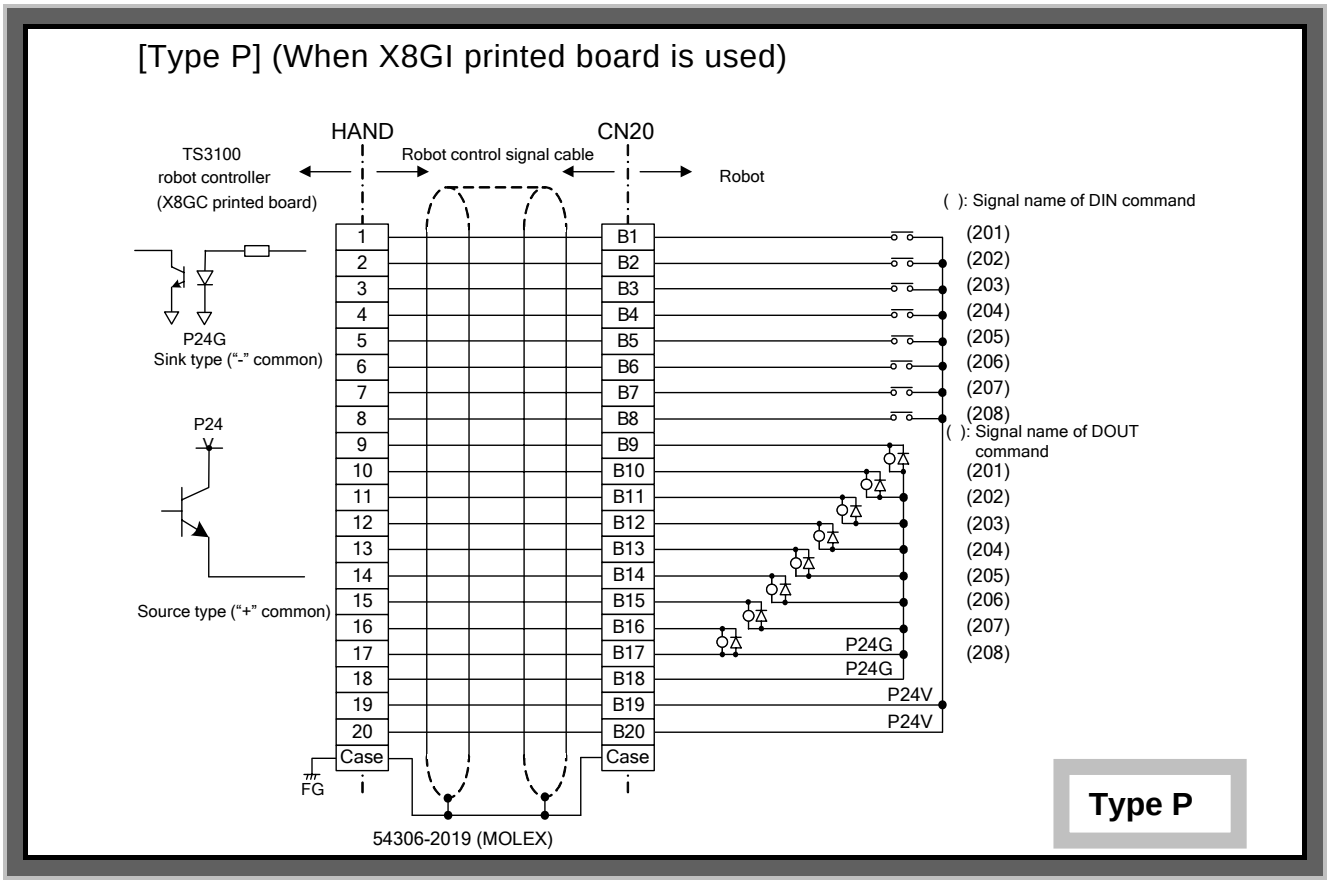


Fig. 3.8 Connection of robot control signal cables (Type P)

The robot control signal controls ON/OFF of the brake for securing the motor shaft, and the end effector such as hand operation.

The TS3100 controller is provided with eight (8) hand input signals and eight (8) hand output signals to control the end effector.

The specifications of the hand input signal are same as those of the digital input signal. Robot control signals are those for turning on or off the motor axis locking brake, and controlling the end effector through hand operation. The specifications of hand input signals are the same as those for digital input signals. The specifications of digital output signals are the same as those for digital output signals. For details of the circuit, see Para 4.5 and 4.8.

All of the hand output signals are turned off when the controller power has turned on or turned off. When designing the end effector, therefore, take careful precautions not to drop a part at power failure, etc.
The robot control signal can be controlled from the robot language program. In the robot language, the robot control signal is specified by the signal name assigned to each signal.
For the robot language, see the Robot Language Manual.
Additionally, the hand input and output signals can be controlled by the sequencer built in the TS3100. For details, see the Simple PLC Function Manual.

It is also possible to control the double solenoid device by combining two (2) hand output signals. When this happens, two (2) output signals bearing consecutive signal names are used to serve as a double solenoid. For the automatic operation, program using the robot language so that the two (2) output signals forming the double solenoid can be made exclusive. While the controller power is turned off or turned on, both output signals turn off.

The hand output signal can be turned on and off manually through the teach pendant on condition that each hand output signal which turns on and off is defined in the user parameter (USER. PAR) beforehand.
For the setting procedures, see the User Parameter Manual.

Note: Once the double solenoid is defined, using the user parameter, two (2) output signals are output exclusively by the hand output signal operation through the teach pendant. For the automatic operation, however, program using the robot language so that the two (2) output signals forming the double solenoid can be made exclusive. Also, even if the double solenoid is defined in advance, relevant two (2) 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 signals of (201, 202) and (203, 204) are output exclusively.
The hand output signal cannot be reset by the RESET SIG operation or RESET DOUT command.

! 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.

For further information on the robot control signal cable connection, see the Installation & Transport Manual.

4. Connecting External I/O Signal Cable

4.1 Connecting External Input Signal Cable (INPUT)

To connect the external input signal cable, use the attached connector [DHA-PC36-3G (connector), DHA-HPA36-3R (hood)].
The input common comes in the two (2) types; Type N [X8GN (output sink type) is selected for the I/O printed board and Type P [X8GI (output source type) is selected for the I/O printed board]. After confirming the type of your controller, connect the external input signal cables.
This connector is not included in the accessories. Therefore, please order one separately from Toshiba Machine or obtain one yourself.

[Type N] (When X8GN printed board is used)

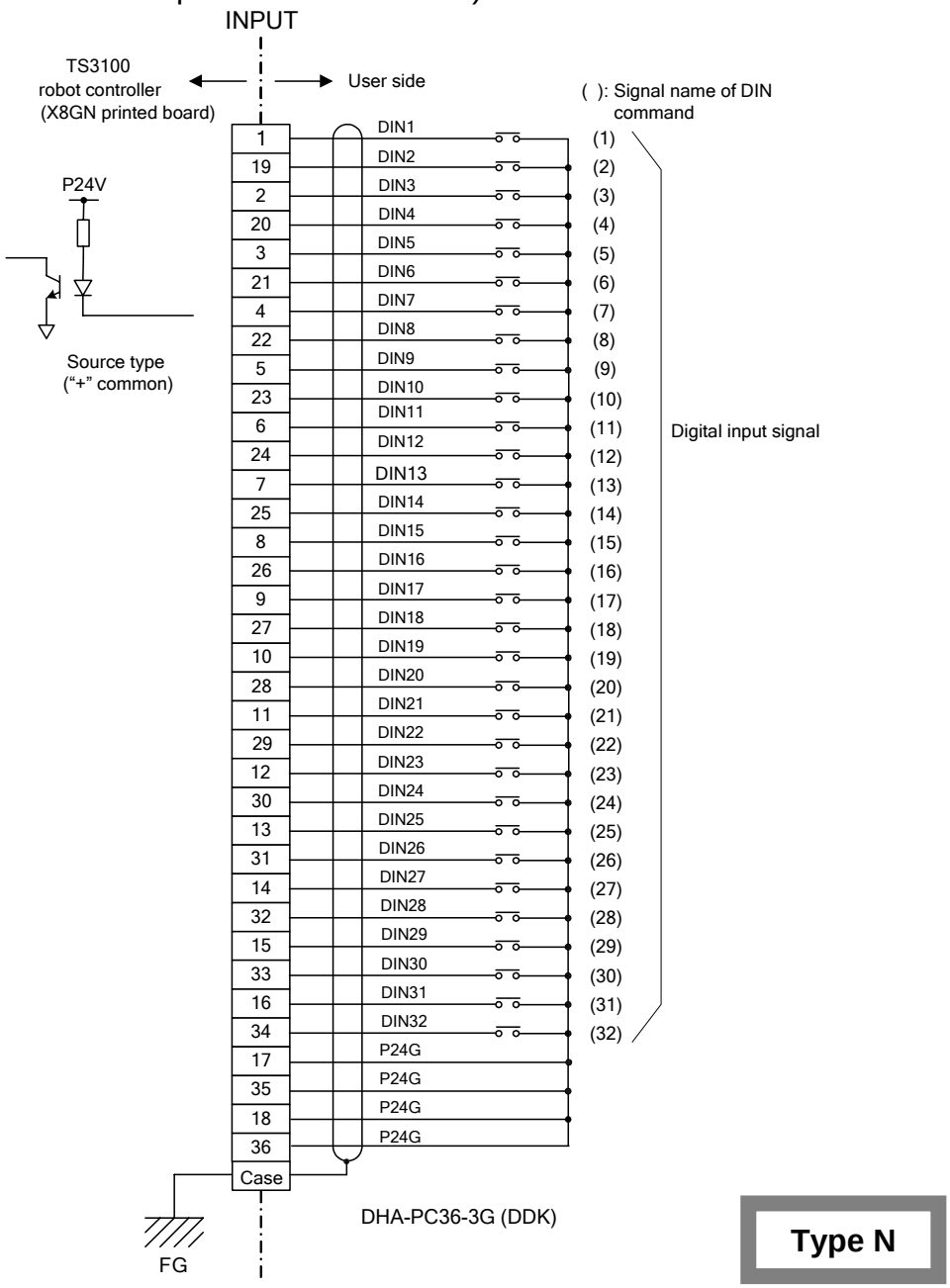


Fig. 4.1 Connection of external input signal cables (Type N)

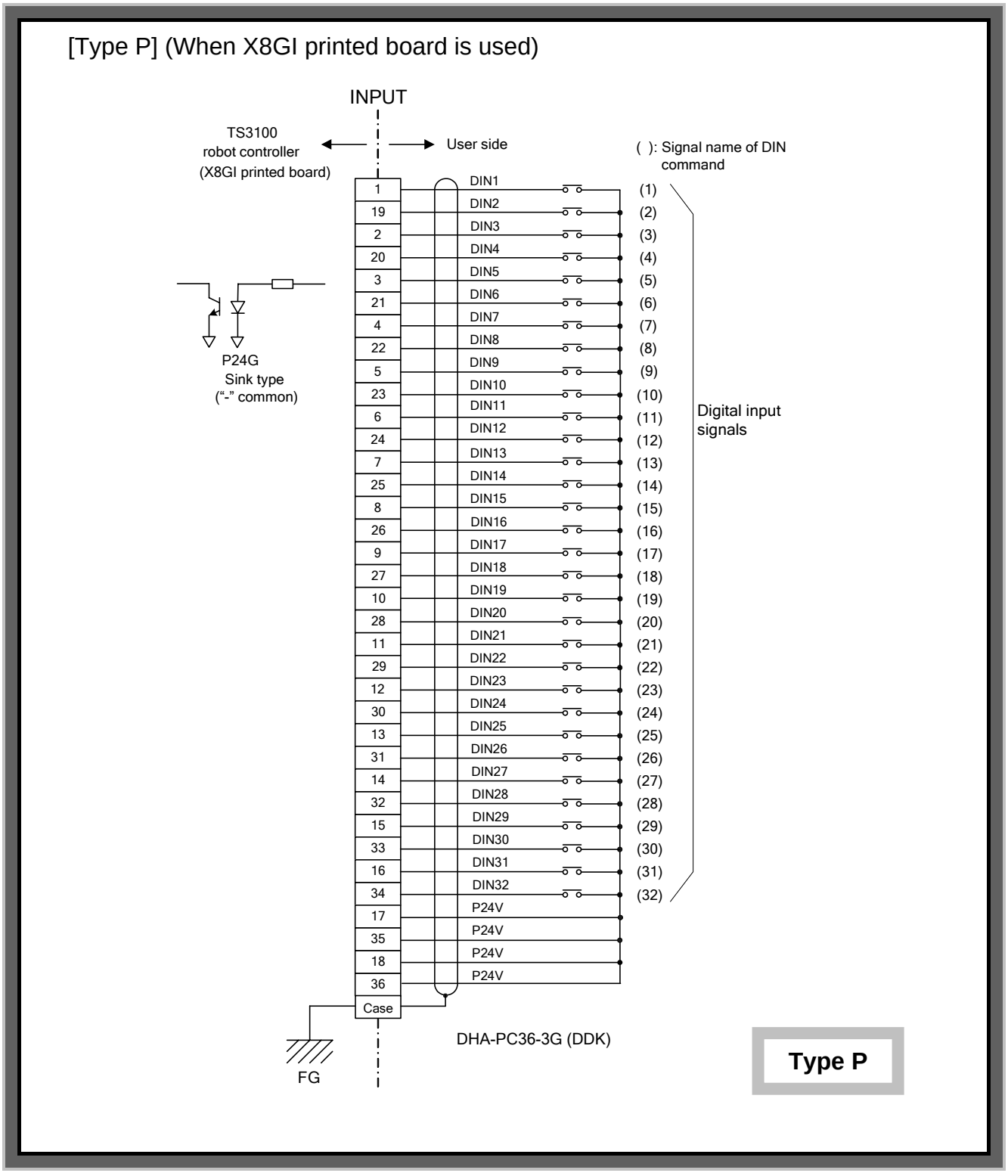


Fig. 4.2 Connection of external input signal cables (Type P)

As shown in Fig. 4.1 and Fig. 4.2 above, the digital input signals are non-voltage contact inputs or open collector inputs, all of which are normally open contact input. For the function, circuit to use etc., of each signal, see Para. 4.5.
Additionally, the external input signals can be controlled by the sequencer built in the TS3100. For details, see the Simple PLC Function Manual.

4.2 Connecting External Output Signal Cable (OUTPUT)

To connect the external output signal cable, use the attached connector [DHA-PC40-3G (connector), DHA-HPA40-3R (hood).
The output common comes in the two (2) types; Type N [X8GN (output sink type) is selected for the I/O printed board and Type P [X8GI (output source type) is selected for the I/O printed board]. After confirming the type of your controller, connect the external output signal cables.
This connector is not included in the accessories. Therefore, please order one separately from Toshiba Machine or obtain one yourself.

[Type N] (When X8GN printed board is used)

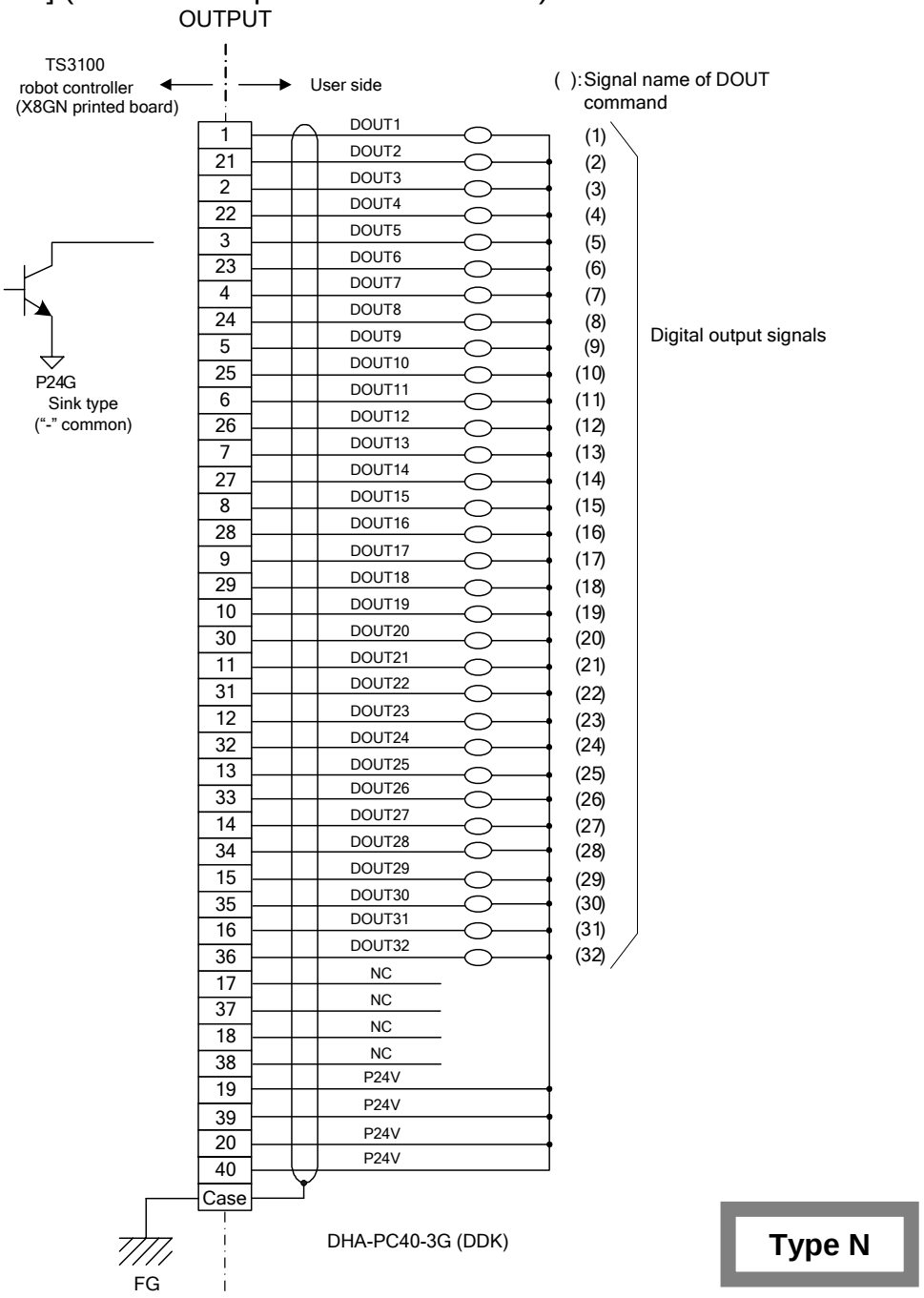


Fig. 4.3 Connection of external output signal cables (Type N)

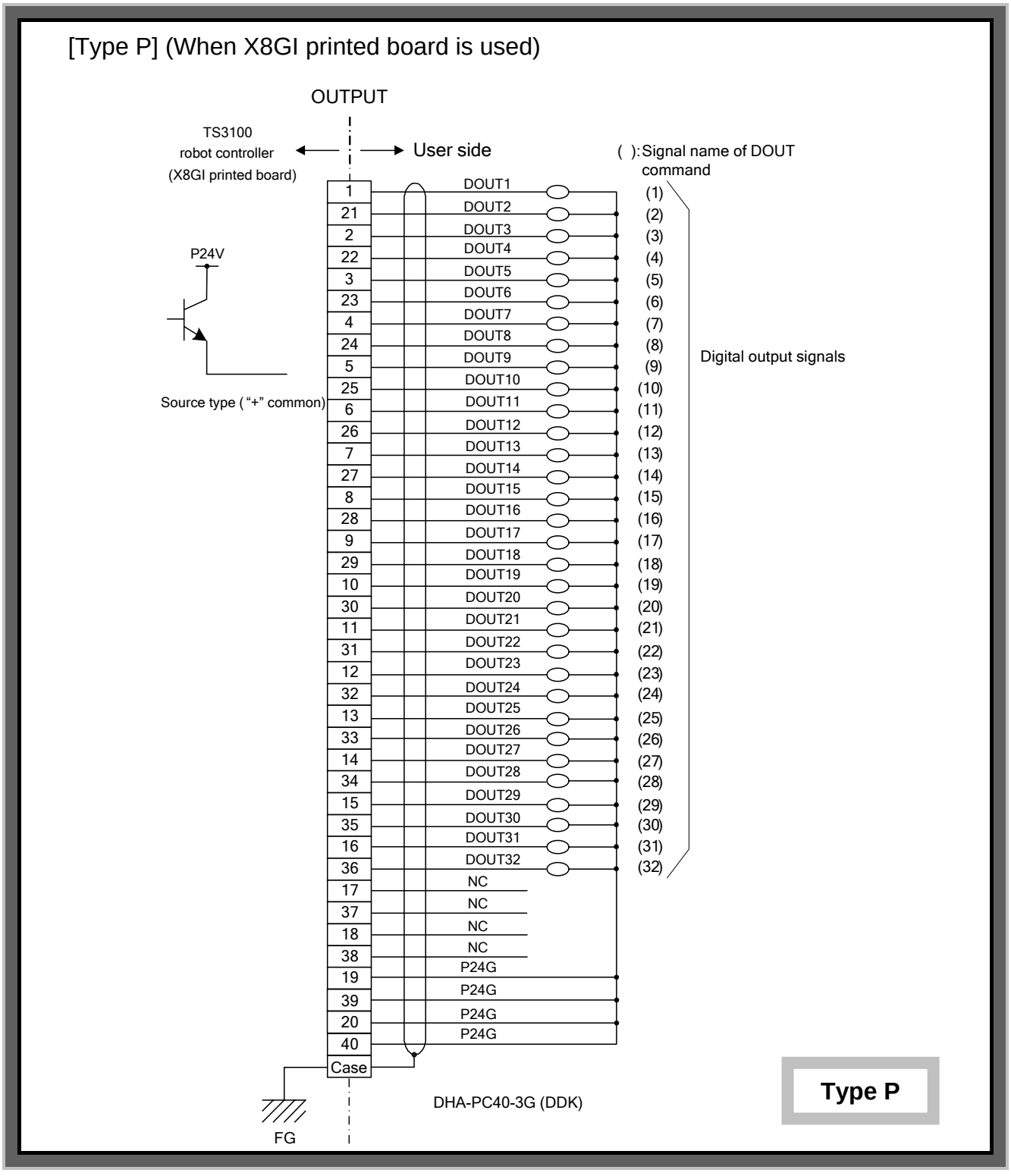


Fig. 4.4 Connection of external output signal cables (Type P)

As shown in Fig. 4.3 and Fig. 4.4 above, all sixteen (16) digital output signals are transistor outputs.
For the function, circuit to use etc., of each signal, see Para. 4.8.
Additionally, the external output signals can be controlled by the sequencer built in the TS3100. For details, see the Simple PLC Function Manual.

4.3 Connecting External I/O Signal Cable (SYSTEM)

To connect the external input/output signal cable, use the attached connector [10150-3000PE (connector), 10350-52A0-008 (hood)].
The I/O common comes in the two (2) types; Type N [X8GN (output sink type) is selected for the I/O printed board and Type P [X8GI (output source type) is selected for the I/O printed board). After confirming the type of your controller, connect the external I/O signal cables.

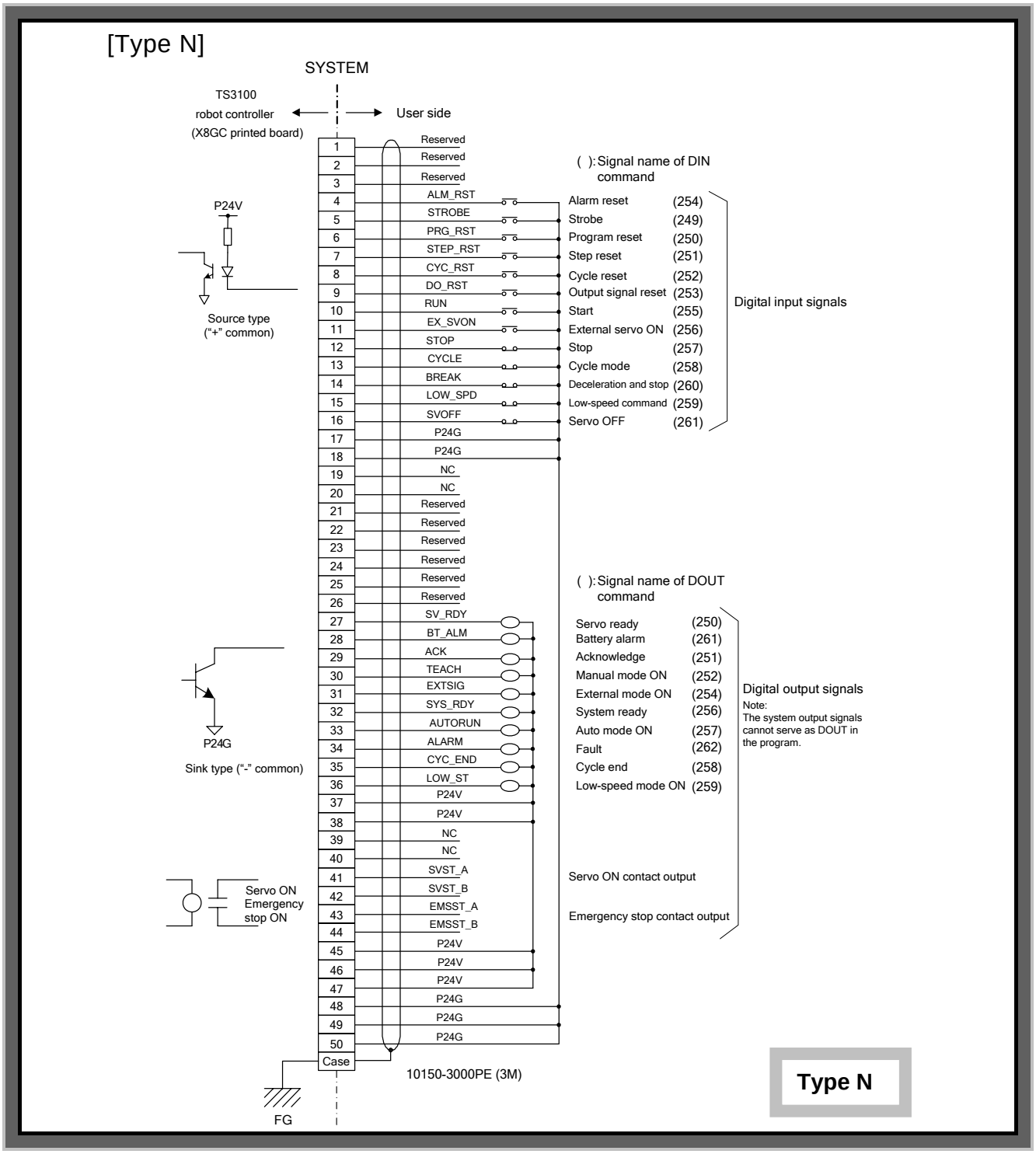


Fig. 4.5 Connection of external I/O signal cables (Type N)

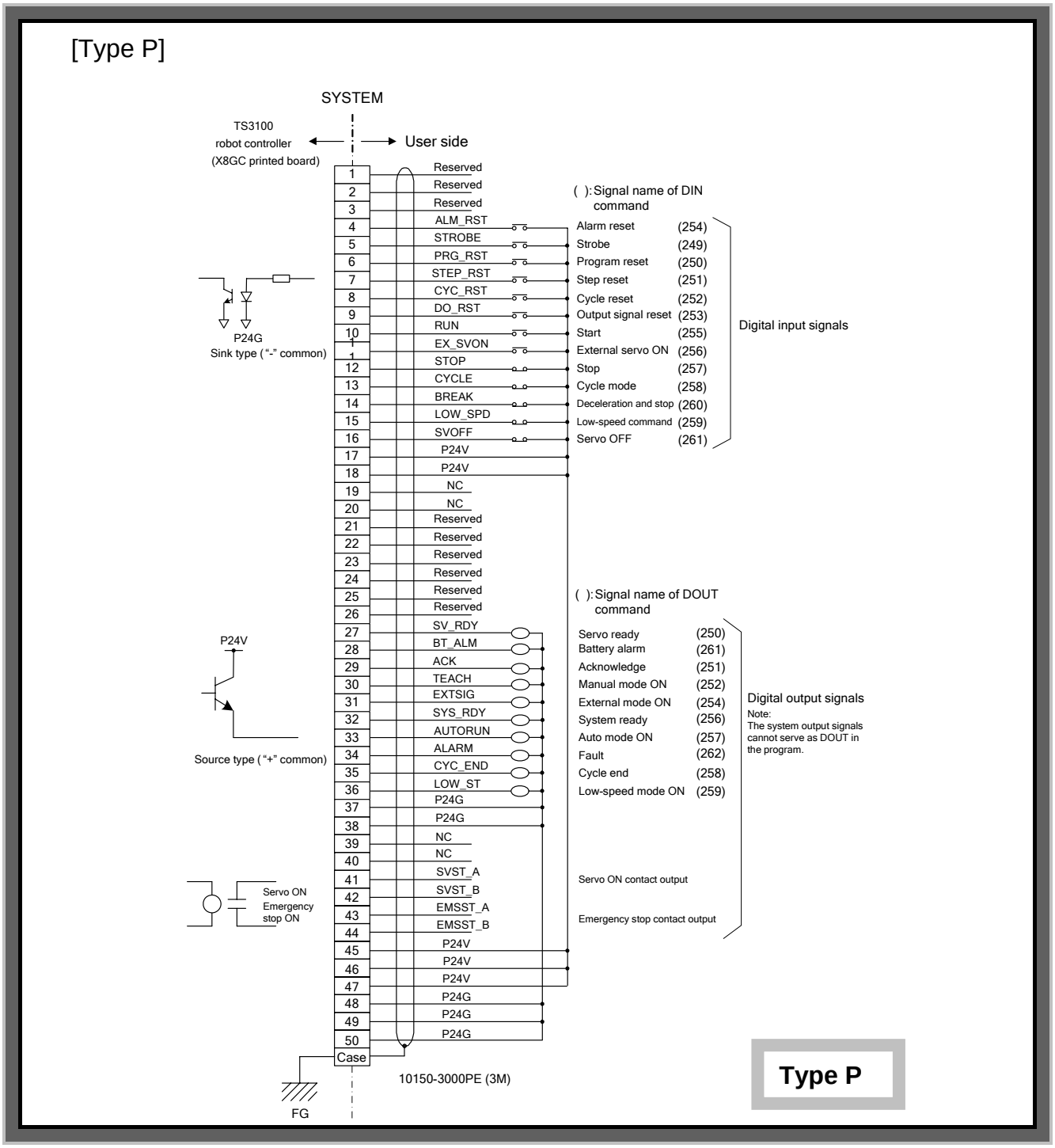


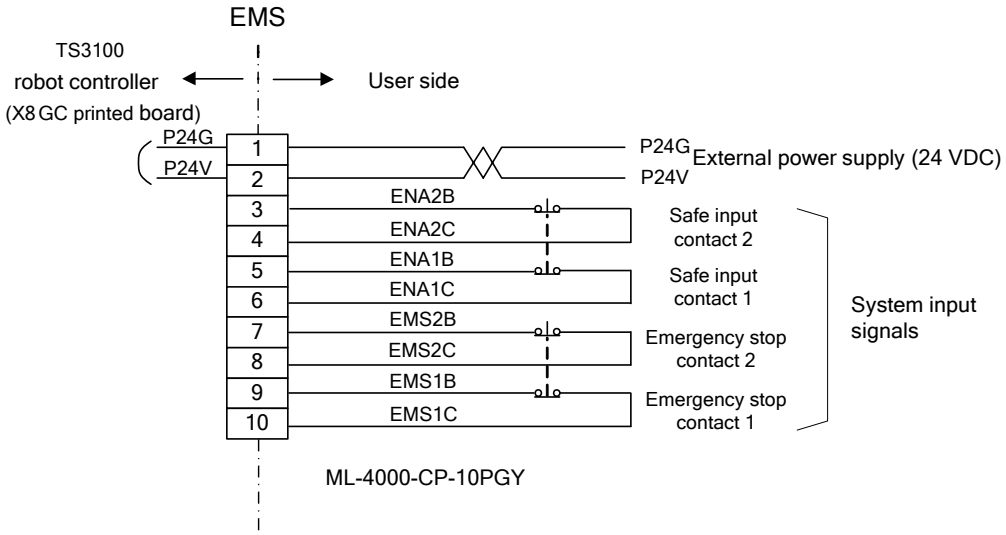
Fig. 4.6 Connection of external output signal cables (Type P)

As shown in Figs. 4.5 and 4.6, the system input signals are non-voltage contact input or open collector input. The system input signals "Stop", "Cycle mode", "Deceleration and stop", "Low-speed command", and "Servo OFF" are normally close contact input, and all others are normally open contact input.

The system output signals "Servo ON contact output" and "Emergency stop contact output" are non-voltage relay output, and all others are transistor output.
For the function, circuit to use etc., of each signal, see Para. 4.6 and 4.9.
Additionally, the external input/output signals can be controlled by the sequencer built in the TS3100. For details, see the Simple PLC Function Manual.

4.4 Safe Input Signal Cable (EMS)

The safe input signal cable is connected using the supplied connector "ML-4000-CP-10PGY (connector)".



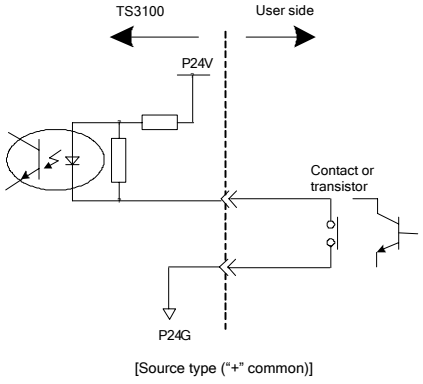
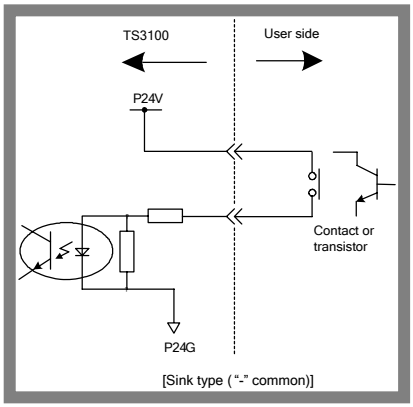
* The system input signals "Emergency stop contacts 1 and 2 (linked 2-contact configuration)" and "Safe input contacts 1 and 2 (linked 2-contact configuration)" are non-voltage contact input.
  For details on the signal functions and operating circuits, see Para 4.6. For the safety input cable attaching and detaching procedure, see Para 7.3.

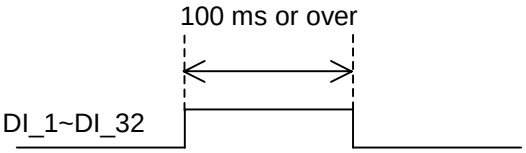
! CAUTION

The COM1, HOST, TCPRG, MEM, INPUT, and OUTPUT connectors of the TS3100 robot controller are attached with a connector cap, respectively.

Unless these connectors are used, be sure to attach the connector caps to prevent static electricity and damage.

4.5 Digital Input Signal

Designation	Digital input signal DI_1 ~ DI_32
Connector input terminal	Signals are assigned to INPUT-1 ~ 16 pins and 19 ~ 34 pins. (See Fig. 4.1 and 4.2.)
Function	Each signal status of DI_1 ~ DI_32 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_32) 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)	 [Source type ("+" common)]  [Sink type ("-" common)]
Signal	Input terminal — Signal judgment Open — OFF Short-circuit — ON
Specifications of non-voltage contact and transistor	• Non-voltage contact specifications Contact rating: 24 VDC, 10 mA or over Circuit current: Approx. 7 mA Minimum current: 24 VDC, 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. 

4.6 System Input Signal

In addition to a total of thirteen (13) signals which control STOP, CYCLE, etc., of the TS3100 robot controller from the external equipment, emergency stop contacts 1 and 2, and safe input contacts 1 and 2 are also available for the system input signal. 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. 4.5. (However, the four (4) signals of emergency stop contact 1 and emergency stop contact 2, and safe input contacts 1 and 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, each system input signal becomes valid or invalid by means of the master mode selector switch equipped on the control panel. Each signal ON mode is shown in Table 4.1 below.

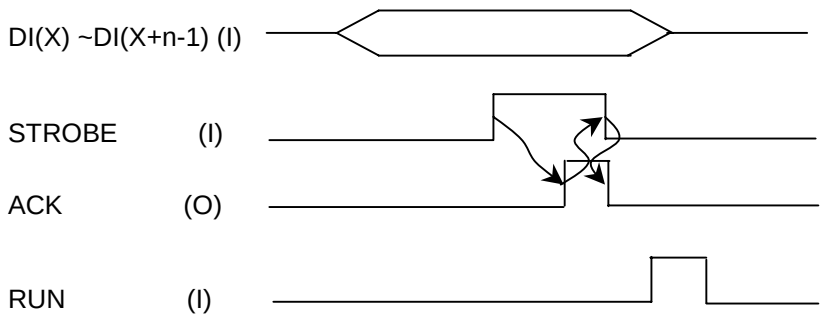
Table 4.1 List of system input signal ON modes

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

O : ON mode

Designation	STROBE (Strobe)
Input terminal	SYSTEM-5 pin
Signal name	249
Signal	

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

Function	Used to select an execution program for the TS3100 robot controller from the external equipment. The program number selected should use any successive "n" numbers (max. eight (8) numbers) of external digital input signal, which are coded. 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 ← Program Number (max. eight (8) bits) DI (X+n–1) ------ DI (X) ← External digital input signal * n = 1 ~ 8 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.
Signal timing	 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.
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 – 8)
  = 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 and 4.2.

  (Leading signal name in DIN command):
  Specify the leading number of input signals to be used. (Allowable range: 1 ~ 16, 101 ~ 164, 301 ~ 364)

  (Bit length):
  Specify the number of signals to be used. (Allowable range 1 ~ 8)

  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 program file name

Signal name in DIN command / Program file name (EXTRNSEL. SYS)	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 = 12, 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, use the EXTRNSEL. SYS file.

External select file "EXTRNSEL. SYS"
*** [00 - 0F] *****
= "PROG00"
= "PROG01"
= "PROG02"
= "PROG03"

= "PROG04"
= "PROG05"
= "PROG06"
= "PROG07"
= "PROG08"
= "PROG09"
= "PROG0A"
= "PROG0B"
= "PROG0C"
= "PROG0D"
= "PROG0E"
= "PROG0F"

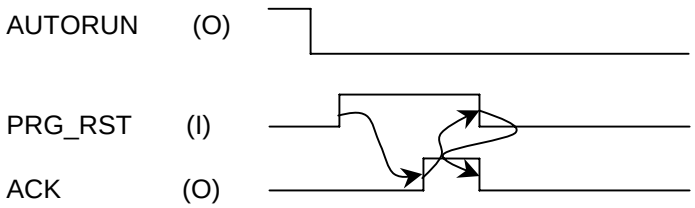
The initial setting is as shown above. Specify a file name you registered beforehand for the underlined of "PROG**".

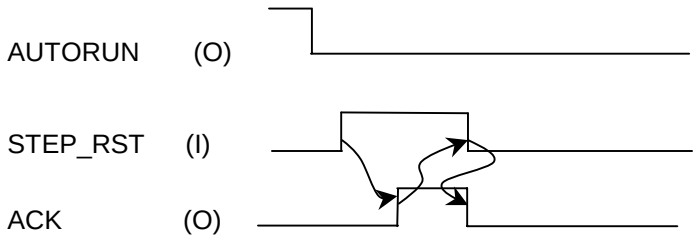
Example:
= "AAA"
= "BBB"
= "CCC"
= "DDD"

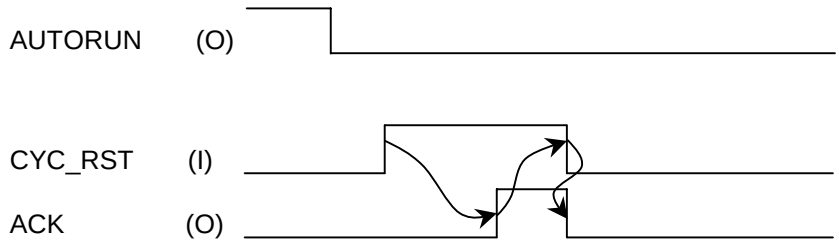
Specify the above program names in advance. (If the following steps are taken without registering the program names, a "Compile Error" occurs.) Then specify zero (0) for both bits 1 and 2 of DIN command, which are set by user parameter [U07] (assume that [U07] = 1 2) and input the STROBE signal. Program "AAA" is automatically selected now.

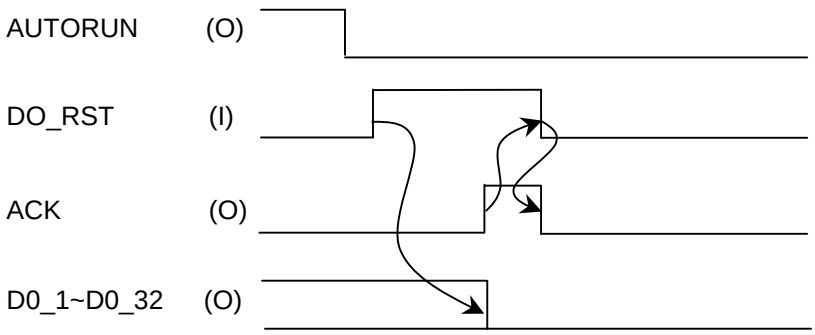
After the above parameter has been changed, save the data, turn the power off and on again. Otherwise, the parameter will not be operative.

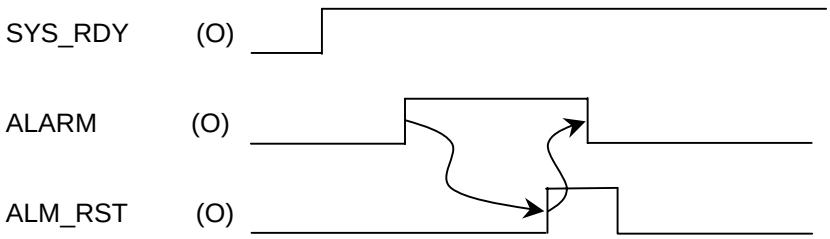
For the EXTRNSEL. SYS file, only the line described as "= File name" is effective and the other lines are regarded as the comment.

<table>
<tr><td>Designation</td><td>PRG_RST (Program reset)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-6 pin</td></tr>
<tr><td>Signal name</td><td>250</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</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>SYSTEM-7 pin</td></tr>
<tr><td>Signal name</td><td>251</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</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>

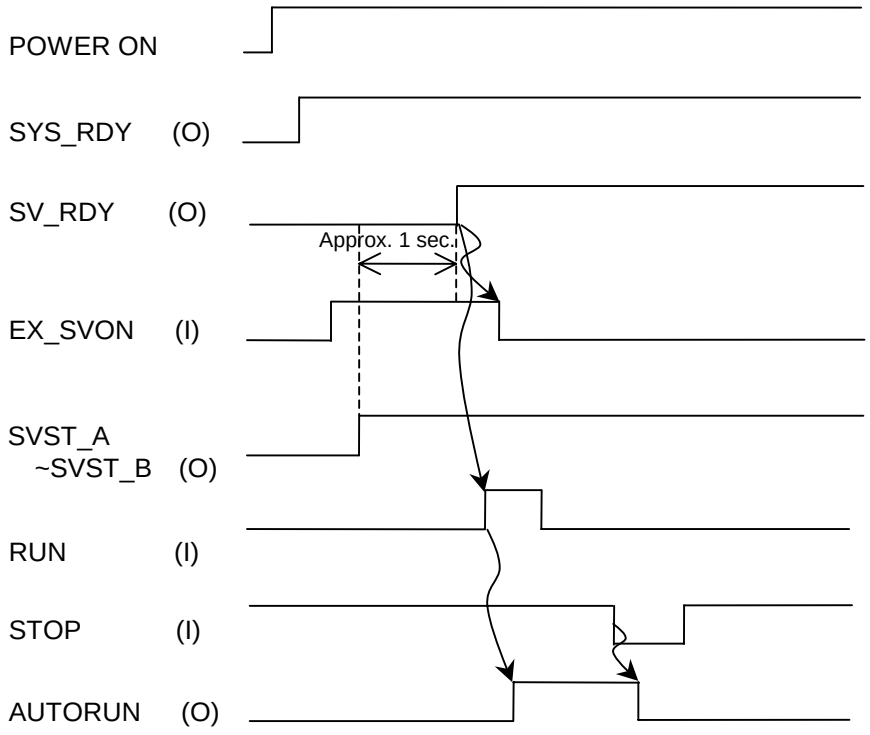
<table>
<tr><td>Designation</td><td>CYC_RST (Cycle reset)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-8 pin</td></tr>
<tr><td>Signal name</td><td>252</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</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>SYSTEM-9 pin</td></tr>
<tr><td>Signal name</td><td>253</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset digital output signals (DO_1 ~ DO_32) of the TS3100 robot controller from the external equipment.
(Extension I/O signals DO_101 (133) ~ DO_120 (152) are also reset.)
When reset, all signals of DO_1 ~ DO_32 turn 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>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>

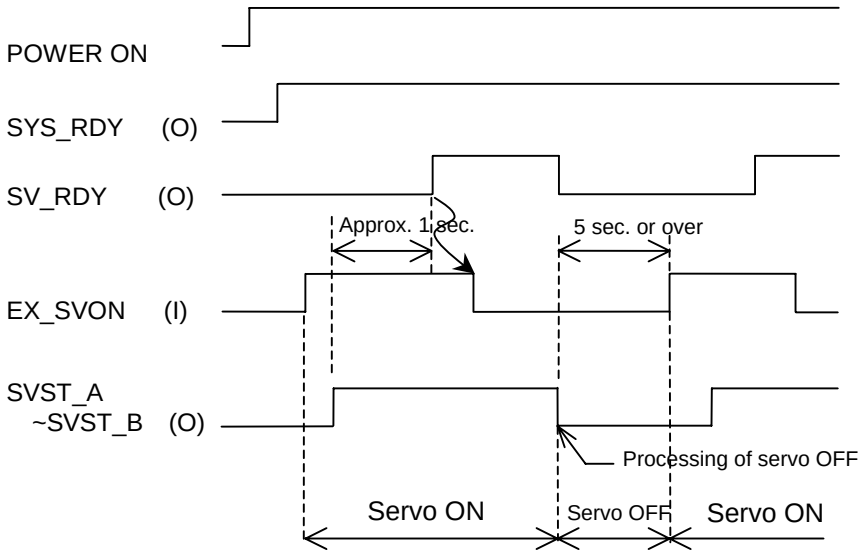
<table>
<tr><td>Designation</td><td>ALM_RST (Alarm reset)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-4 pin</td></tr>
<tr><td>Signal name</td><td>254</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</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 TS3100 robot controller was ready 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>

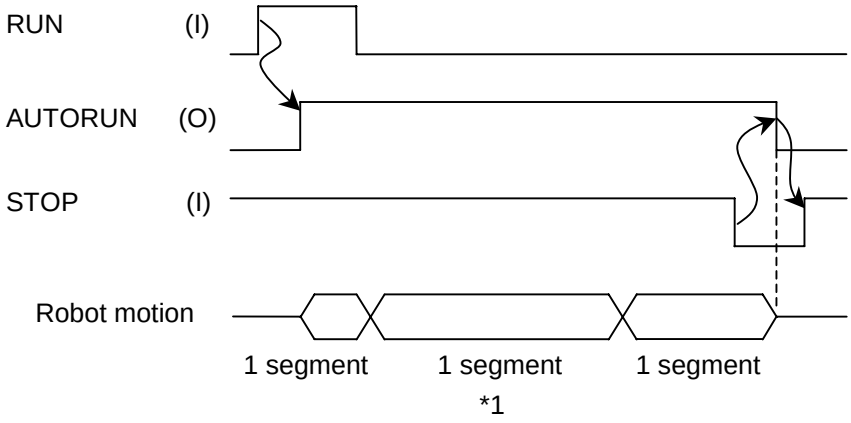
Designation	RUN (Start)
Input terminal	SYSTEM-10 pin
Signal name	255
Signal	
Function	Used to start a program registered in the TS3100 robot controller from the external equipment to execute an automatic cycle operation. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	

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

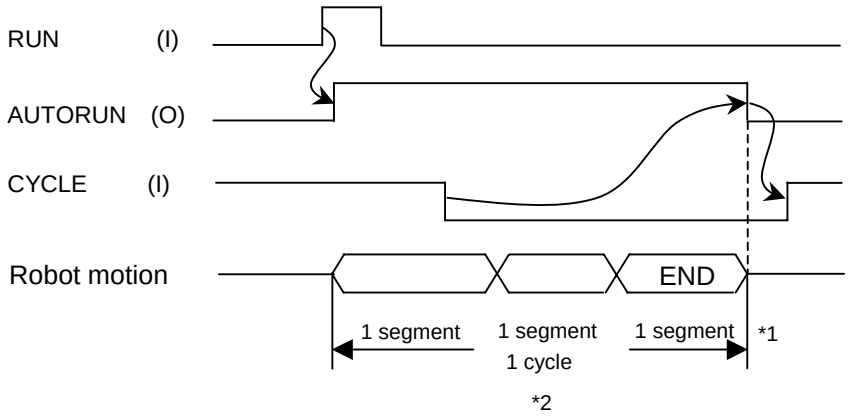


Cautions	After servo ON, automatic operation starts with the start of the RUN signal. It takes about one (1) second from the input of EX_SVON to the time when the robot is actually ready to work. Set ON the RUN signal only after the SV_RDY signal is ON. Even if the RUN signal is input before the SV_RDY signal is ON, it is neglected and the automatic operation will not be started.

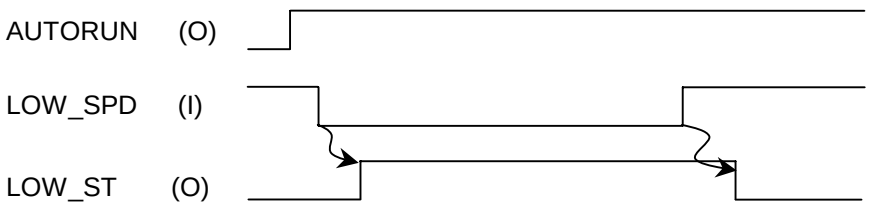
<table>
<tr><td>Designation</td><td>EX_SVON (External servo ON)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-11 pin</td></tr>
<tr><td>Signal name</td><td>256</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td></td><td>O</td></tr>
<tr><td>Short-circuit</td><td>O</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>1. It takes about one (1) second from the servo ON to the time when the robot is actually ready to work. Therefore, program so that the RUN signal, etc., can turn 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.</td></tr>
</table>

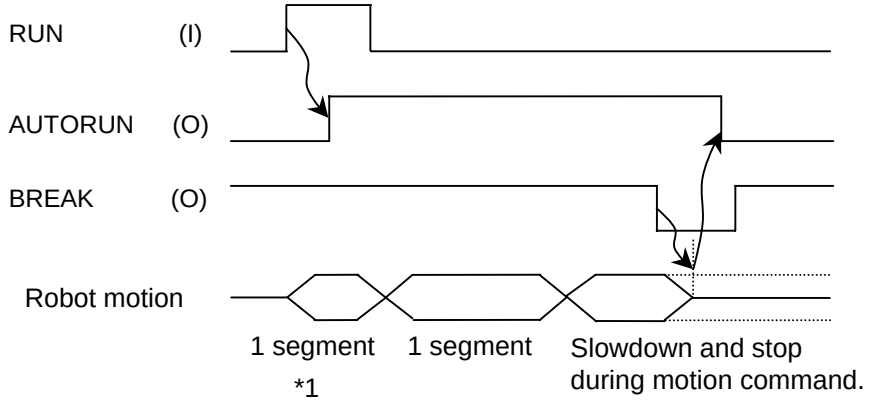
<table>
<tr><td>Designation</td><td>STOP (Stop)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-12 pin</td></tr>
<tr><td>Signal name</td><td>257</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td>O</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to stop executing a program registered in the TS3100 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 (0 V) input terminal SYSTEM-12.</td></tr>
</table>

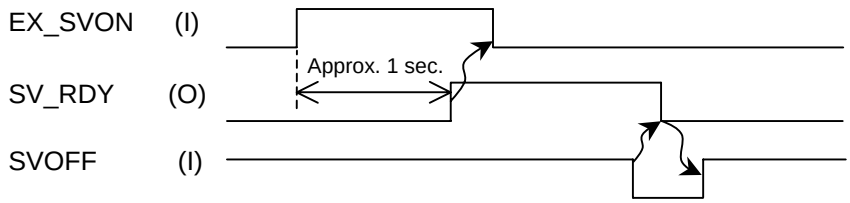
<table>
<tr><td>Designation</td><td>CYCLE (Cycle operation mode)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-13 pin</td></tr>
<tr><td>Signal name</td><td>258</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td>O</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 stop from the external equipment a program registered in the TS3100 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.</td></tr>
<tr><td>Signal timing</td><td> 

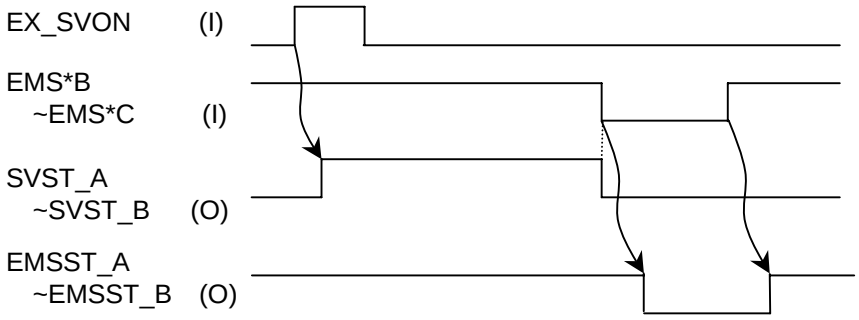
*1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment".
*2 Duration from the top of the main program to the END command is called "1 cycle".</td></tr>
<tr><td>Cautions</td><td>1. Unless this signal is used, short-circuit (0 V) input terminal SYSTEM-13 as necessary.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>LOW_SPD (Low speed command)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-15 pin</td></tr>
<tr><td>Signal name</td><td>259</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</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 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 override 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>1. If the speed override lower than the parameter set value is used, even if the LOW_SPD signal is made valid, the speed override value remains unchanged.
2. Unless this signal is used, short-circuit (0 V) input terminal SYSTEM-15.</td></tr>
</table>

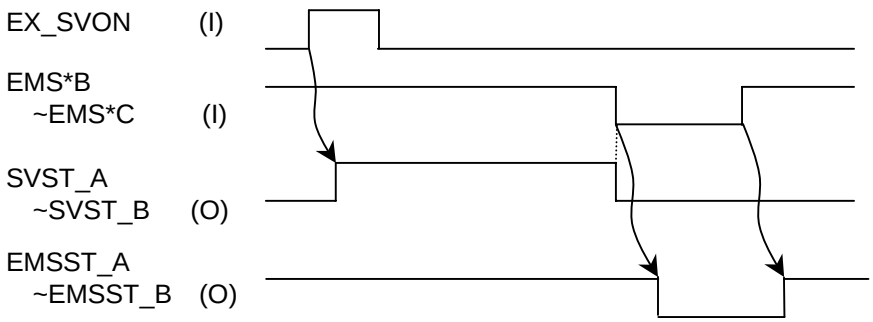
<table>
<tr><td>Designation</td><td>BREAK (Deceleration and stop)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-14 pin</td></tr>
<tr><td>Signal name</td><td>260</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td>O</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 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 (0 V) input terminal SYSTEM-14.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SVOFF (Servo OFF)</td></tr>
<tr><td>Input terminal</td><td>SYSTEM-16 pin</td></tr>
<tr><td>Signal name</td><td>261</td></tr>
<tr><td>Signal</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. While this signal is open, the servo power cannot be turned on in any mode.
2. Unless this signal is used, short-circuit (0 V) input terminal SYSTEM-16.</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 EMS-7 and EMS-8 (Emergency stop contact 2)
Between EMS-9 and EMS-10 (Emergency stop contact 1)</td></tr>
<tr><td>Signal</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>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 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>

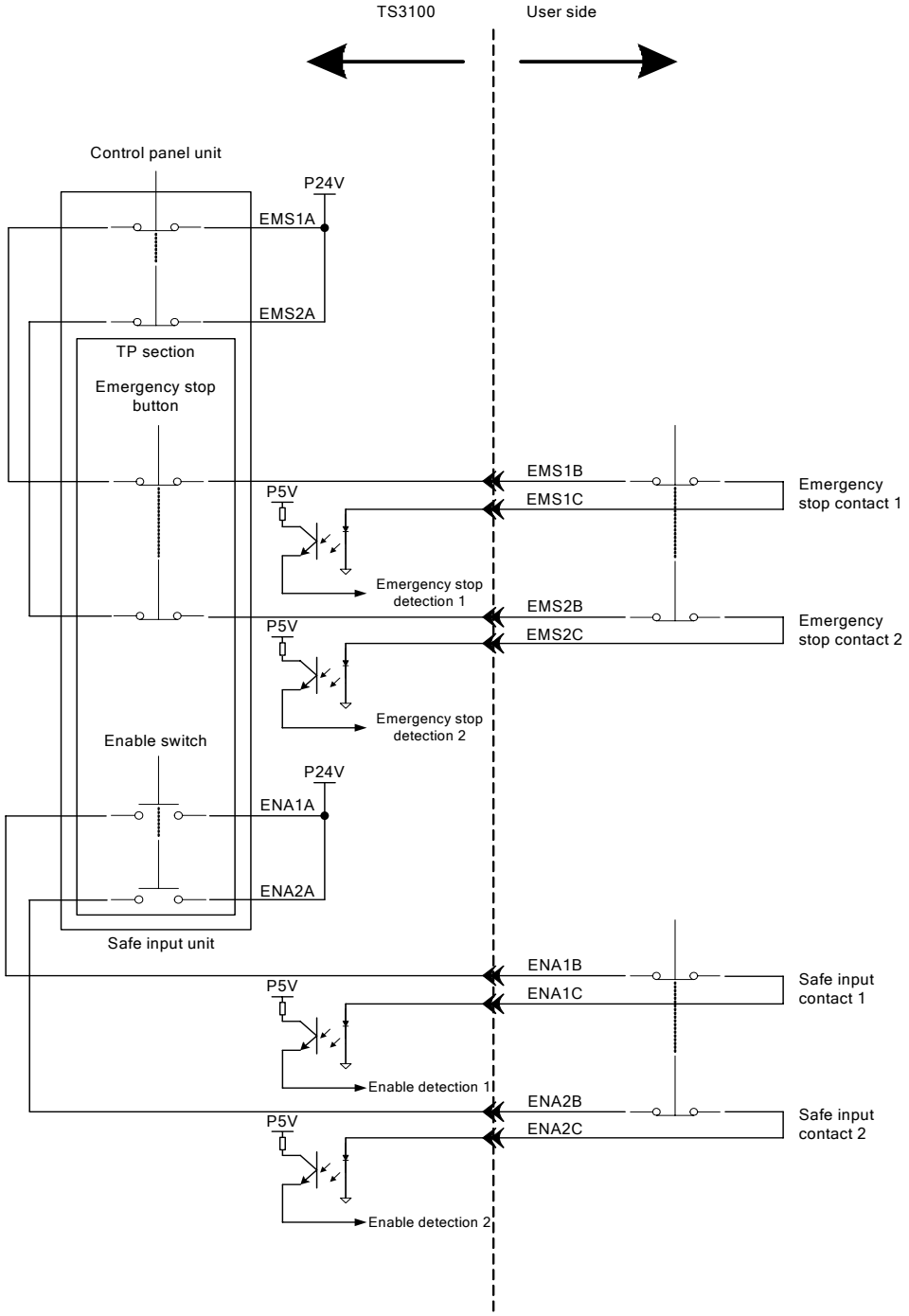
Cautions	1. While this signal is open, the servo power cannot be turned on in any mode. 2. EMS*B ~ EMS*CB are assumed to have two (2) normal close contacts interconnected, which should be turned on and off at the same time. If there is a delay in contact operation, the non-conformity detecting function of hardware works to effect an emergency stop. It is not possible, therefore, to short-circuit the one side and use the other side as the 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 "Emergency stop signal line" given below. 3. Unless this signal is used, short-circuit between EMS-7 and EMS-8, and between EMS-9 and EMS-10.

<table>
<tr><td>Designation</td><td>ENA*B ~ ENA*C (Safe input contacts 1 & 2)</td></tr>
<tr><td>Input terminal</td><td>Between EMS-3 and EMS-4 (Safe input contact 2)
Between EMS-5 and EMS-6 (Safe input contact 1)</td></tr>
<tr><td>Signal</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>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 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.
If the safety input contact is opened, a short-circuit occurs between the system output signals EMSST_A and EMSST_B.</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. ENA*B ~ ENA*C 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. It is not possible, therefore, to short-circuit the one side and use the other side as the emergency stop. When this happens, the system can be restored only by tuning off and on again the controller power. For details on the enable switch contact configuration, see "Emergency stop signal line" on the next page. 3. Unless this signal is used, short-circuit between EMS-3 and EMS-4, and between EMS-5 and EMS-6.

* Emergency stop signal line

The connection diagram of the emergency stop switch is shown below.



4.7 Jumper of Safety Measure Signal

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

System input signal cables	·····	SYSTEM-12	(STOP)
		SYSTEM-16	(SVOFF)
		SYSTEM-14	(BREAK)
		EMS-7, 8	(EMS2B ~ EMS2C)
		EMS-9, 10	(EMS1B ~ EMS1C)
		EMS-3, 4	(ENA2B ~ ENA2C)
		EMS-5, 6	(ENA1B ~ ENA1C)

For the connectors provided with the TS3100 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 connectors to the SYSTEM, EMS connectors on the controller side.
Unless the following signals are used as the system signals, jumper the cables also.

SYSTEM-15 (LOW_SPD)
SYSTEM-13 (CYCLE)

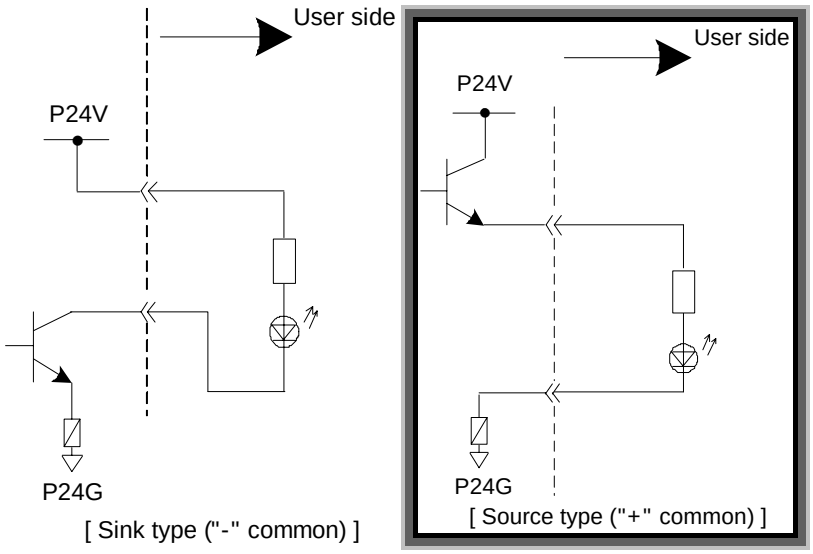
Jumper of connectors

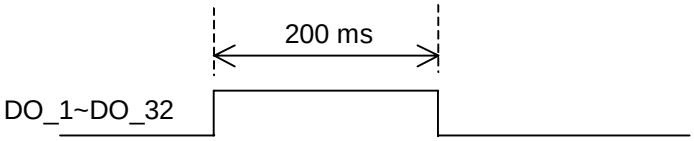
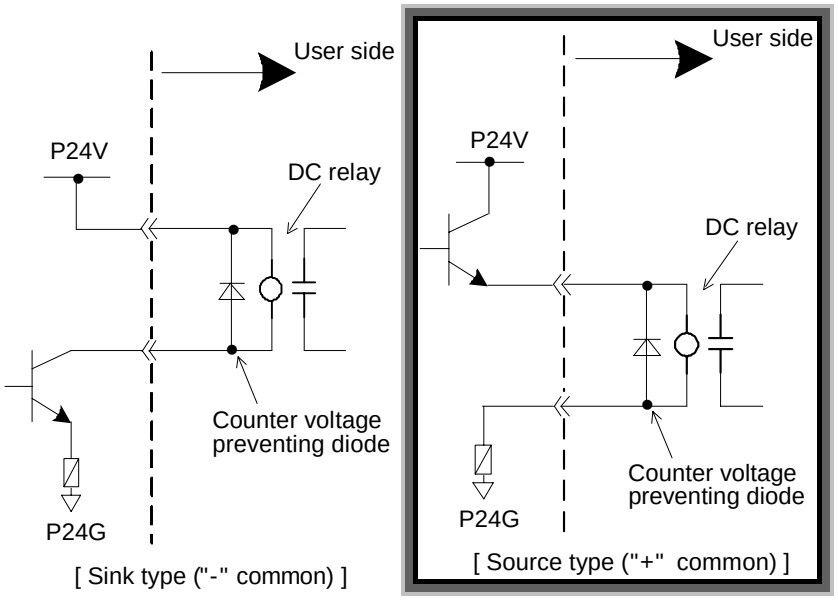
SYSTEM		EMS	
12-17(18)	14-17(18)	3-4	5-6
16-17(18)	(13-17(18))	7-8	9-10
(15-17(18))	-		

! CAUTION

1. Unless the signals of SVOFF and emergency stop contacts 1 and 2, and safe input contacts 1 and 2 are jumpered, the controller servo power cannot be turned on.
2. Unless the CYCLE signal is jumpered, the controller enters the cycle operation mode.
3. Unless the LOW_SPD signal is jumpered, the low speed is selected for the robot speed during automatic operation.
4. Unless the signals of STOP and BREAK are jumpered, automatic operation of the robot is not possible.

4.8 Digital Output Signal

Designation	Digital output signal DO_1 ~ DO_32
Connector output terminal	Signals DO_1 ~ DO_32 are assigned to OUTPUT-1 ~ 16 pins and 21 ~ 36 pins. (See Fig. 4.3 and 4.4.)
Function	ON/OFF of signals DO_1 ~ DO_32 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 VDC Rated current: 100 mA (max.) **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.

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

4.9 System Output Signal

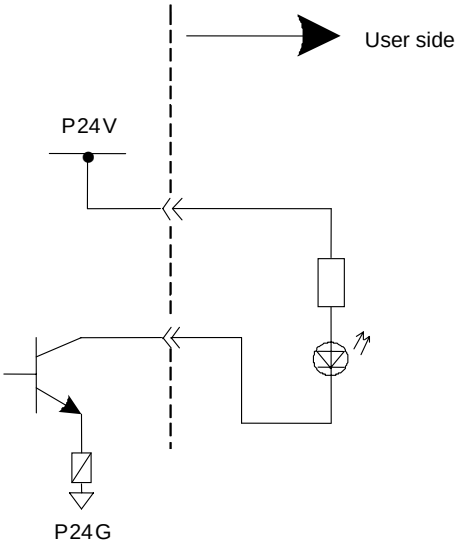
A total of twelve (12) system output signals are available. Of them, ten (10) signals are used to output the run status of the TS3100 robot controller and the remaining two (2) signals are output via relay contact.
The two (2) relay output signals are SVST_A ~ SVST_B and EMSST_A ~ EMSST_B. The former 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

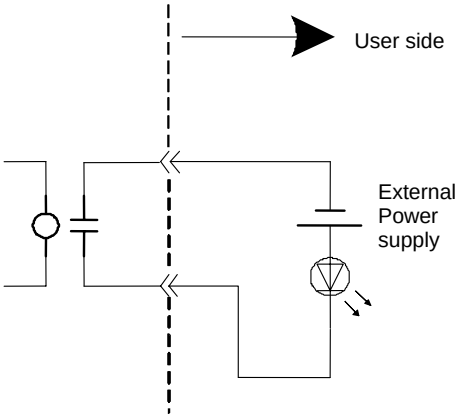
- Output circuit structure
  When Type N is selected (when X8GN printed board is used)

(1) Transistor output



[Sink type ("-" common)]

(2) Relay contact output

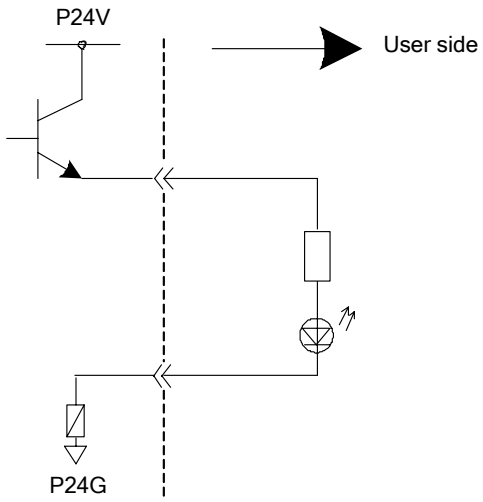


* The above figure exemplifies a normal open contact output structure.
The servo ON contact output is of a normal open contact type and the emergency stop contact output is of a normal close contact type. Take utmost care when using.

Type N

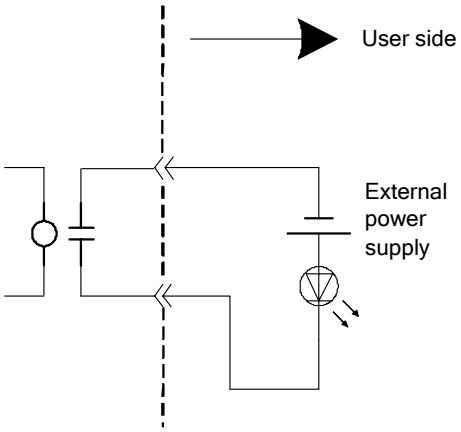
When Type P is selected (when X8GI printed board is used)

(1) Transistor output



[Source type ("+" common)]

(2) Relay contact output



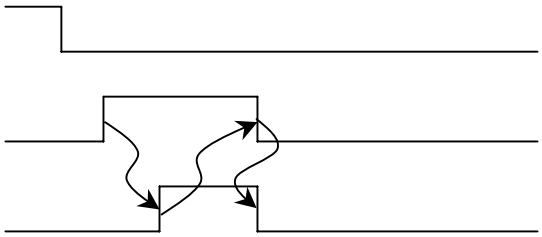
* The above figure exemplifies a normal open contact output structure.
The servo ON contact output is of a normal open contact type and the emergency stop contact output is of a normal close contact type. Take utmost care when using.

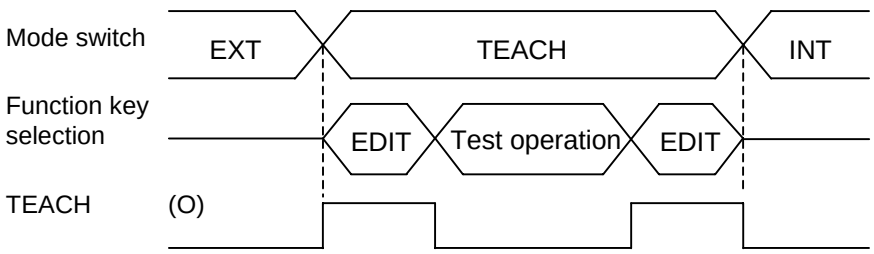
Type P

- Transistor specification
  Rated voltage: 24 VDC
  Rated current: 100 mA max.

- Relay contact specification
  Maximum rating: 125 VAC, 0.5 A / 60 VDC, 1.0 A

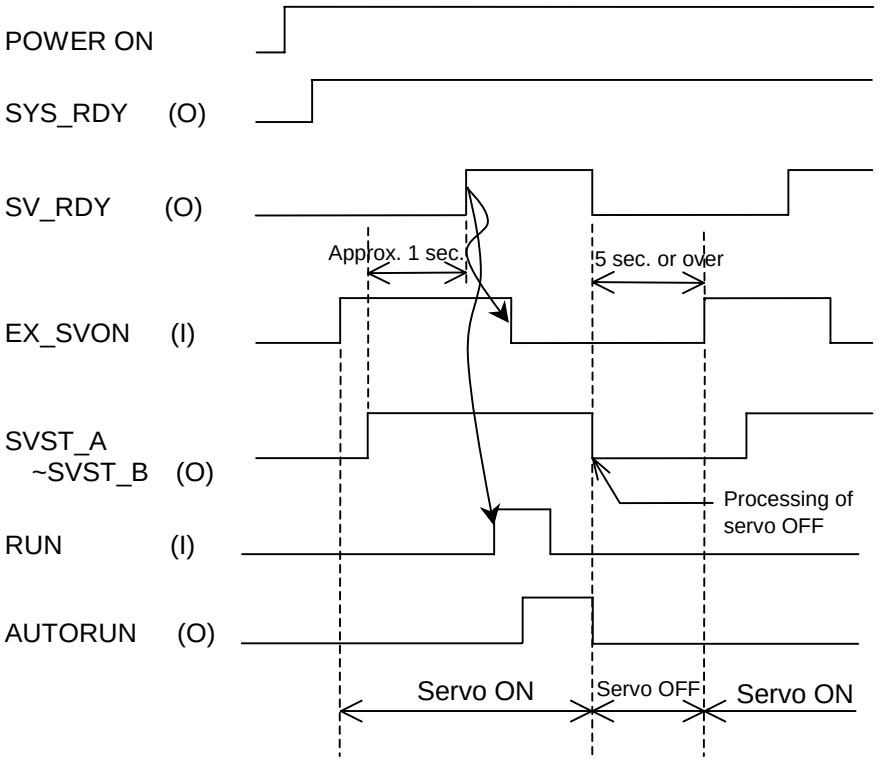
! **CAUTION**	If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.

<table>
<tr><td>Designation</td><td>ACK (Acknowledge)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-29 pin</td></tr>
<tr><td>Signal name</td><td>251</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>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.</td></tr>
<tr><td>Signal timing</td><td>AUTORUN (O)
Program selection (I)
STROBE, PRG_RST, etc.
ACK (O)
  </td></tr>
<tr><td>Cautions</td><td>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.</td></tr>
</table>

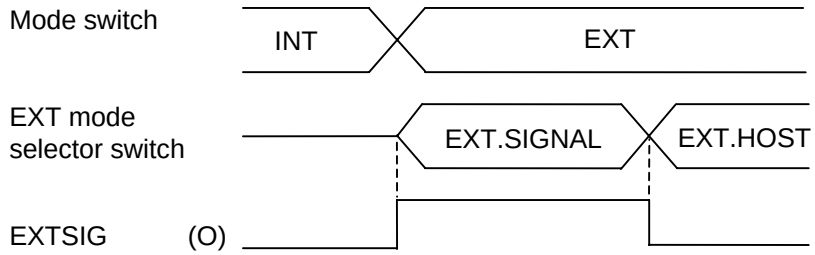
<table>
<tr><td>Designation</td><td>TEACH (Manual mode ON)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-30 pin</td></tr>
<tr><td>Signal name</td><td>252</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><td>Signal judgment
Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on when the MODE switch of the TS3100 robot controller is set to "TEACH" and the test operation mode is not selected.
During the output of this signal, the robot arm can be guided through the teach pendant.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

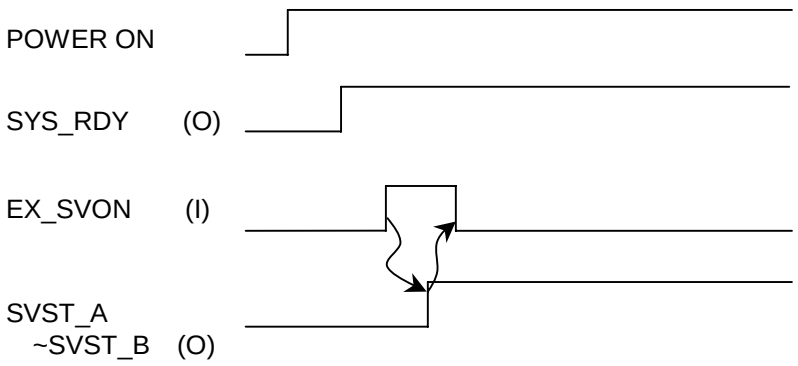
Designation	SV_RDY (Servo ready)
Output terminal	SYSTEM-27 pin
Signal name	250
Signal	

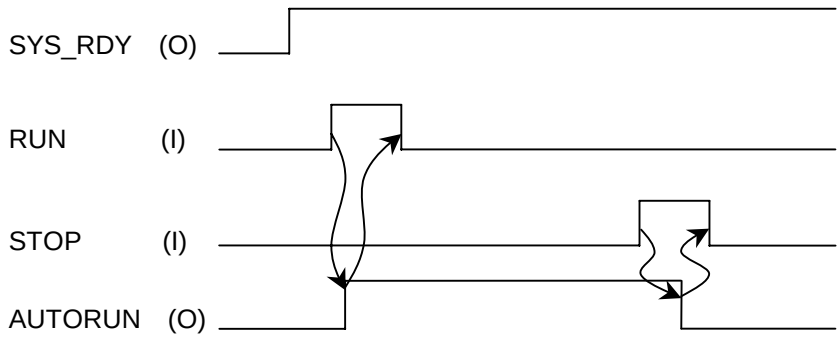
Output terminal \ Signal judgment	ON	OFF
High	O	
Low		O

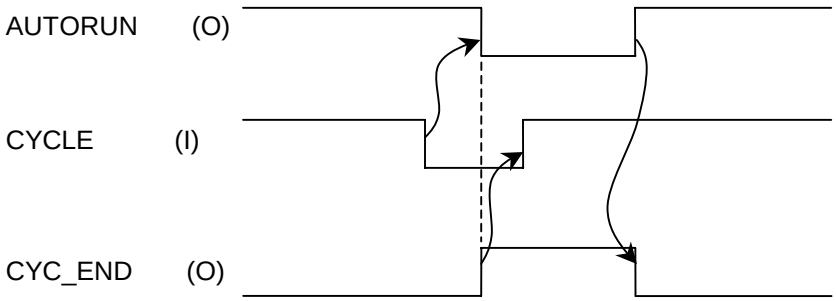
Function	This signal indicates that the servo power of the TS3100 robot controller has turned on with the robot ready for starting an operation. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	

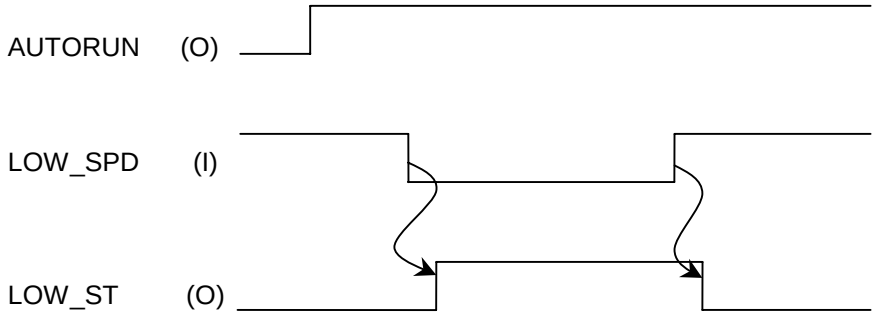
Cautions	1. Program so that the RUN signal can be turned on only after the SV_RDY signal turns on. 2. To prevent an internal damage, the servo cannot be turned on about 4.5 seconds after it is turned off. To turn the servo on again, wait at least five (5) seconds after the SVST_A ~ SVST_B signal turns off.

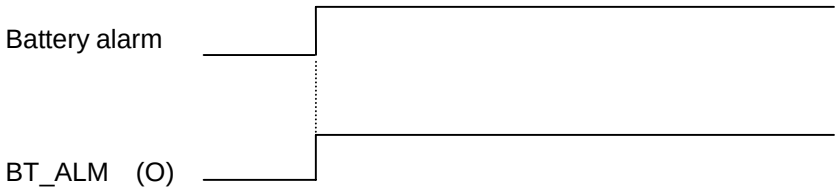
<table>
<tr><td>Designation</td><td>EXTSIG (External mode ON)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-31 pin</td></tr>
<tr><td>Signal name</td><td>254</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on while the TS3100 robot controller is in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>When the EXT mode is selected by means of the MODE switch and the EXT. SIGNAL mode is selected by means of the EXT mode selector switch, all system input signals become operative.</td></tr>
</table>

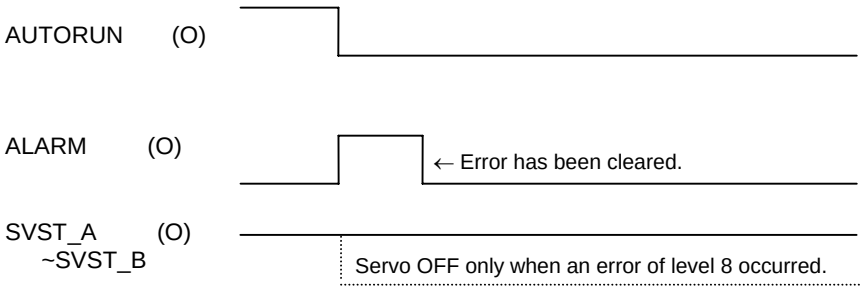
Designation	SYS_RDY (System ready)
Output terminal	SYSTEM-32 pin
Signal name	256
Signal	<table><tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr><tr><td>High</td><td>O</td><td></td></tr><tr><td>Low</td><td></td><td>O</td></tr></table>
Function	This signal turns on when the robot 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.
Signal timing	
Cautions	

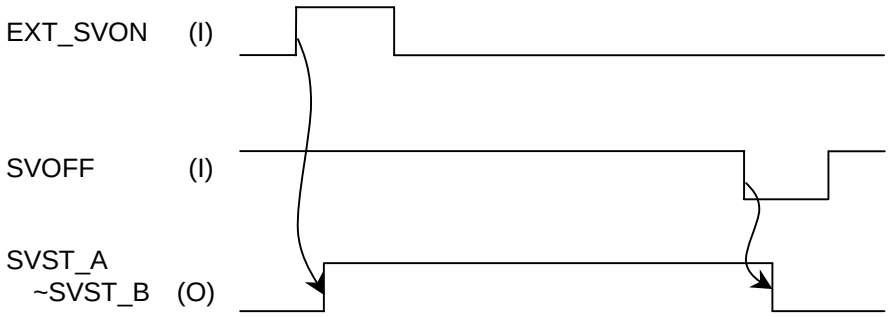
<table>
<tr><td>Designation</td><td>AUTORUN (Auto mode ON)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-33 pin</td></tr>
<tr><td>Signal name</td><td>257</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>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 INT or EXT (EXT. SIGNAL, EXT. HOST) mode is selected by means of the MODE switch of the TS3100 robot controller.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>This signal will not turn on while the TEACH mode is selected by means of the MODE switch of the TS3100 robot controller.</td></tr>
</table>

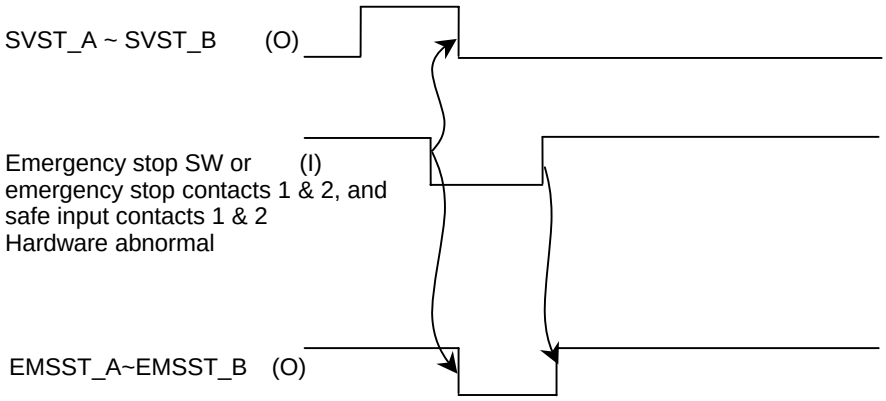
<table>
<tr><td>Designation</td><td>CYC_END (Cycle end)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-35 pin</td></tr>
<tr><td>Signal name</td><td>258</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</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>

Designation	LOW_ST (Low speed mode ON)
Output terminal	SYSTEM-36 pin
Signal name	259
Signal	<table><tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr><tr><td>High</td><td>O</td><td></td></tr><tr><td>Low</td><td></td><td>O</td></tr></table>
Function	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.
Signal timing	
Cautions	

<table>
<tr><td>Designation</td><td>BT_ALM (Battery alarm)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-28 pin</td></tr>
<tr><td>Signal name</td><td>261</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</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 6 and battery level in the main control board (X8GC).
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>

<table>
<tr><td>Designation</td><td>ALARM (Fault)</td></tr>
<tr><td>Output terminal</td><td>SYSTEM-34 pin</td></tr>
<tr><td>Signal name</td><td>262</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment
Output terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on if an error of level 2, 4 or 8 has occurred in the robot or TS3100 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.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

<table>
<tr><td>Designation</td><td>SVST_A ~ SVST_B (Servo ON contact output)</td></tr>
<tr><td>Output terminal</td><td>Between SYSTEM-41 pin and SYSTEM-42 pin (contact output)</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>Open</td><td>Short-circuit</td></tr>
<tr><td>OFF</td><td>O</td><td></td></tr>
<tr><td>ON</td><td></td><td>O</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 VAC (max.), 0.5 A (max.) / 60 VDC (max.), 1 A (max.).
It takes about one (1) second from the servo ON to the time when the robot is actually ready to work.</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 SYSTEM-43 pin and SYSTEM-44 pin (contact output)</td></tr>
<tr><td>Signal</td><td>
<table>
<tr><th>Signal judgment / Output terminal</th><th>Open</th><th>Short-circuit</th></tr>
<tr><td>OFF</td><td></td><td>O</td></tr>
<tr><td>ON</td><td>O</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 and 2", and safe input contacts 1 and 2 are ON or when the hardware abnormal(*), 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 VAC (max.), 0.5 A (max.) / 60 VDC (max.), 1 A (max.).
(*) Hardware abnormal
・Servo Amp error (X8GL)
・IPM error
・PW Over Volt
・Servo Power Volt Low
・Volt Overheat
・P24V/24VDC Regulator error
・EI/O Fuse Broken
・Bus timeout error
・Instantaneous power failure
・AC Alarm</td></tr>
</table>

4.10 Fabricating External I/O Signal Cable

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

a. Connectors CN5 and CN6 for the TS3100 robot controller should be either the connectors attached to the controller or equivalent connectors.
For INPUT and OUTPUT, prepare the following connector.

Connector name	Type of connector	Maker
SYSTEM	10150-3000PE (connector) 10350-52A0-008 (hood)	Sumitomo 3M
INPUT	DHA-PC36-3G (connector) DHA-HPA36-3R (hood)	DDK
OUTPUT	DHA-PC40-3G (connector) DHA-HPA40-3R (hood)	DDK

b. Select the cables which meet the following specifications.

- Core wires : AWG#24 ~ #30 (SYSTEM), AWG#28, #30 (INPUT/OUTPUT)
- Cable outer diameter : Max. ϕ16.0 mm (SYSTEM), Max. ϕ7.2 mm (INPUT), ϕ7.4 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 SYSTEM, 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 in Chapter 15.

4.11 Attaching and Detaching External I/O Signal Cable

Before attaching or detaching an external I/O signal cable to or from the TS3100 robot controller, be sure to turn off the POWER switch equipped on the front side of the controller, or the main power in the user's control panel.

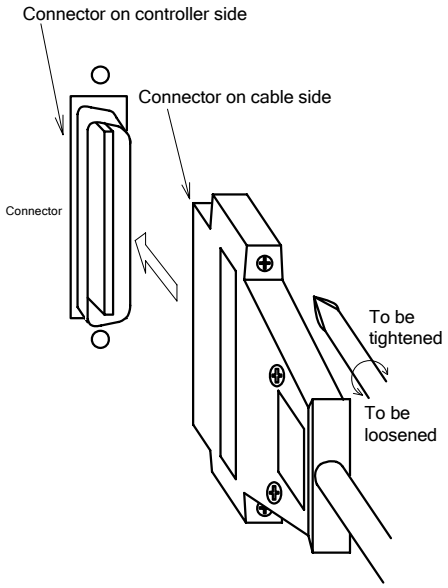


Fig. 4.7 Attaching and detaching external I/O signal cable (SYSTEM)

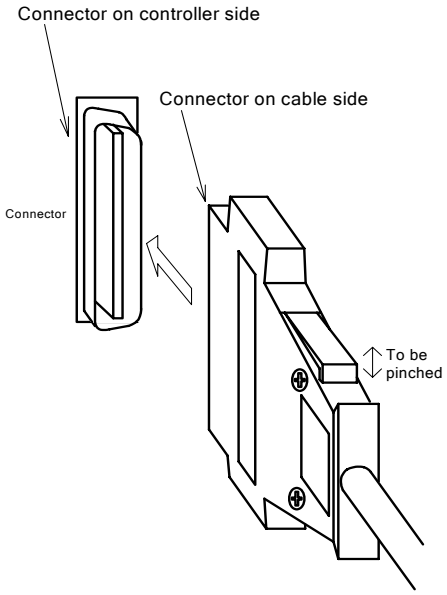


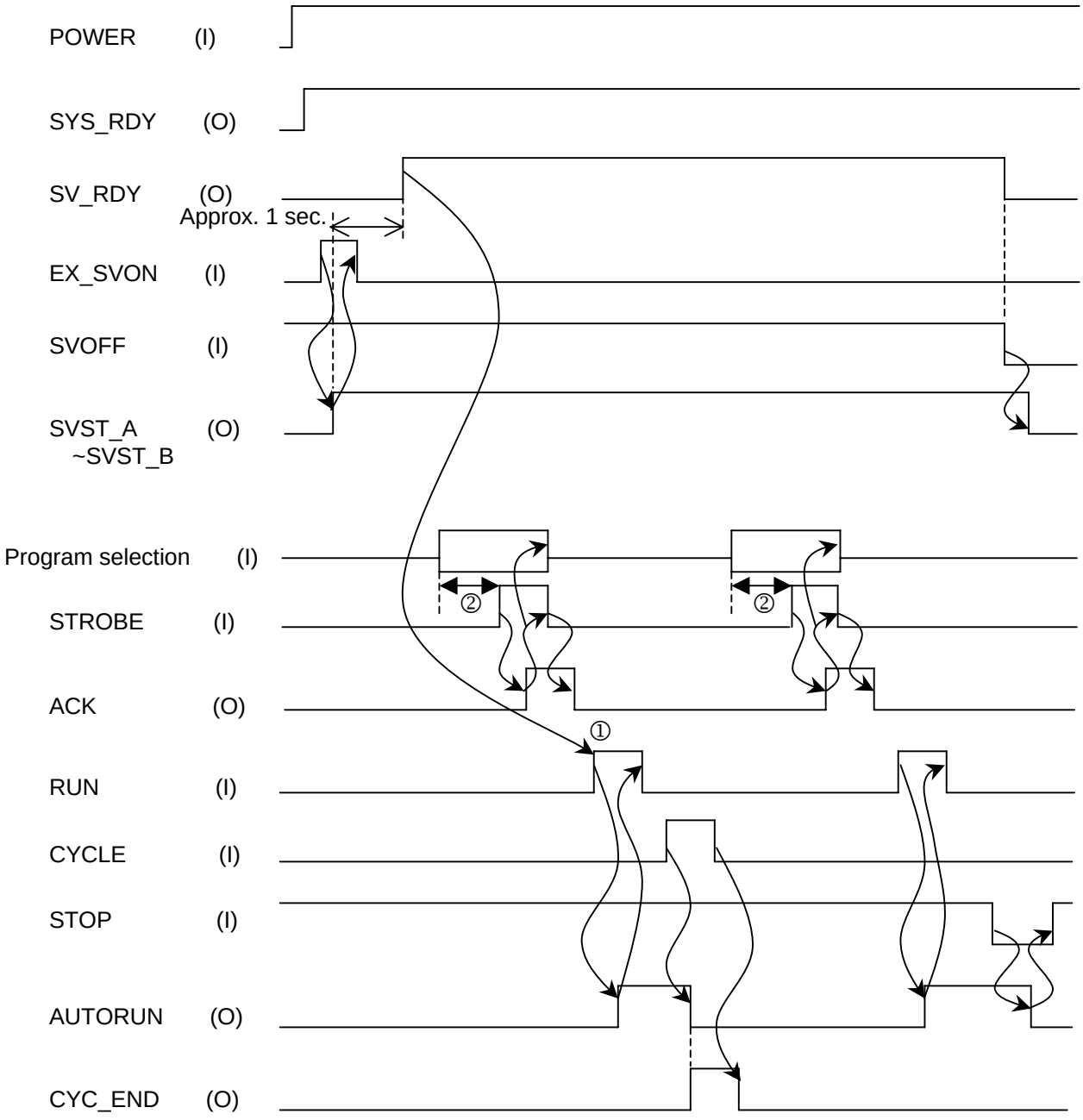
Fig. 4.8 Attaching and detaching external I/O signal cable (INPUT/OUTPUT)

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 Fig. 4.7 (SYSTEM).
The INPUT and OUTPUT connectors have a one-touch lock system, and so check that they are locked securely.
To disconnect the cable, loosen the lock screws, then pull out the connector, as shown in Fig. 4.7 (SYSTEM).
Unlock the INPUT and OUTPUT connectors, and then pull out the connectors.
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.

4.12 Example of Controller Operation, Using External Signals

(1) Normal operation sequence

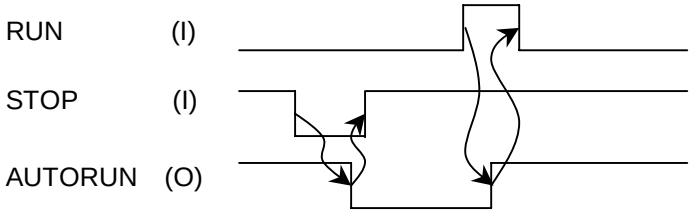


① Set ON the RUN signal only after the SV_RDY signal is ON.

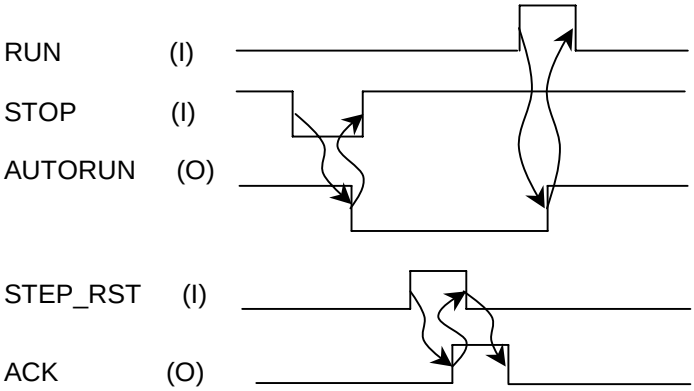
② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

(2) Example of restarting the stopped robot

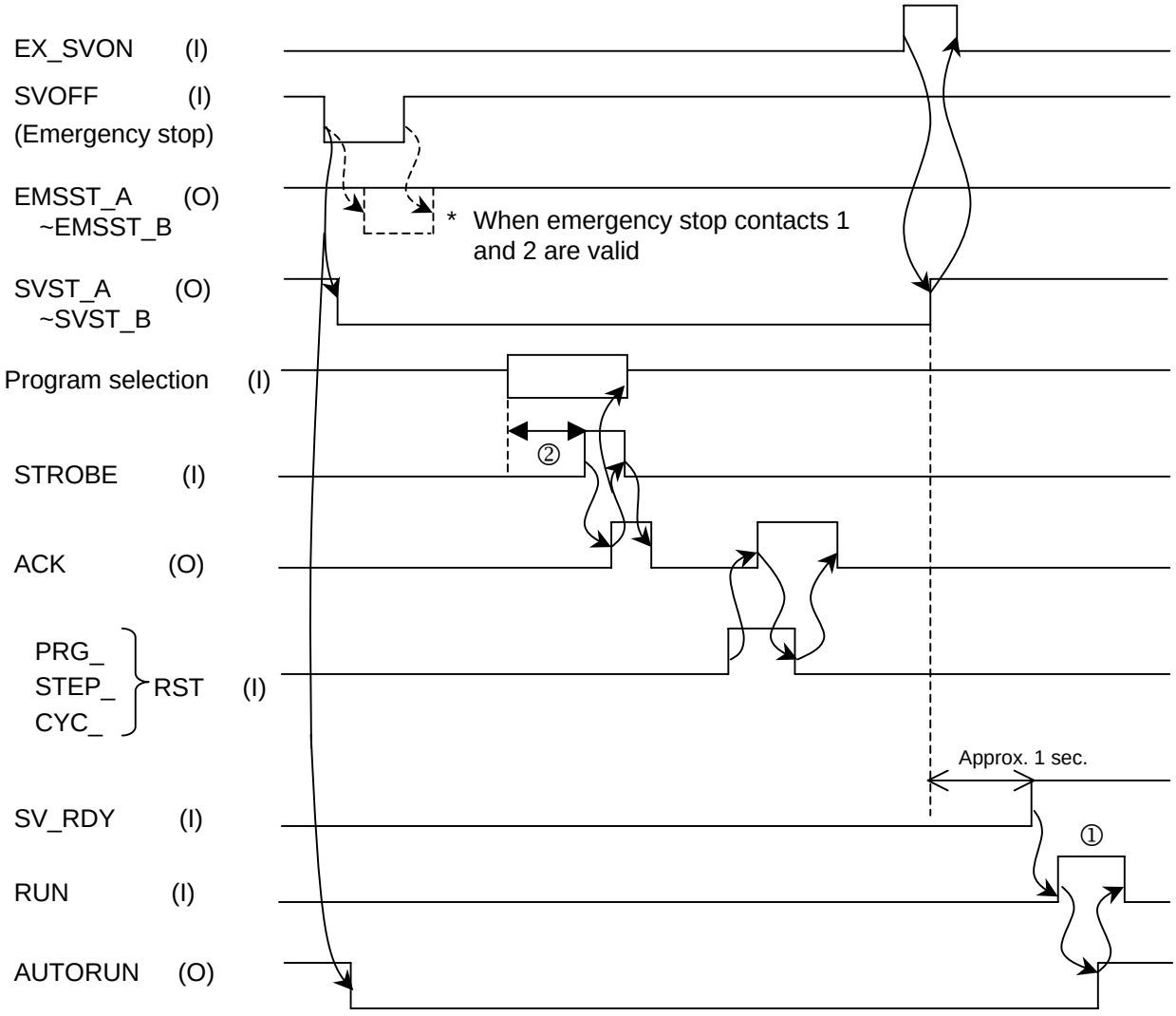
Restart after stop (to resume the operation)



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 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)

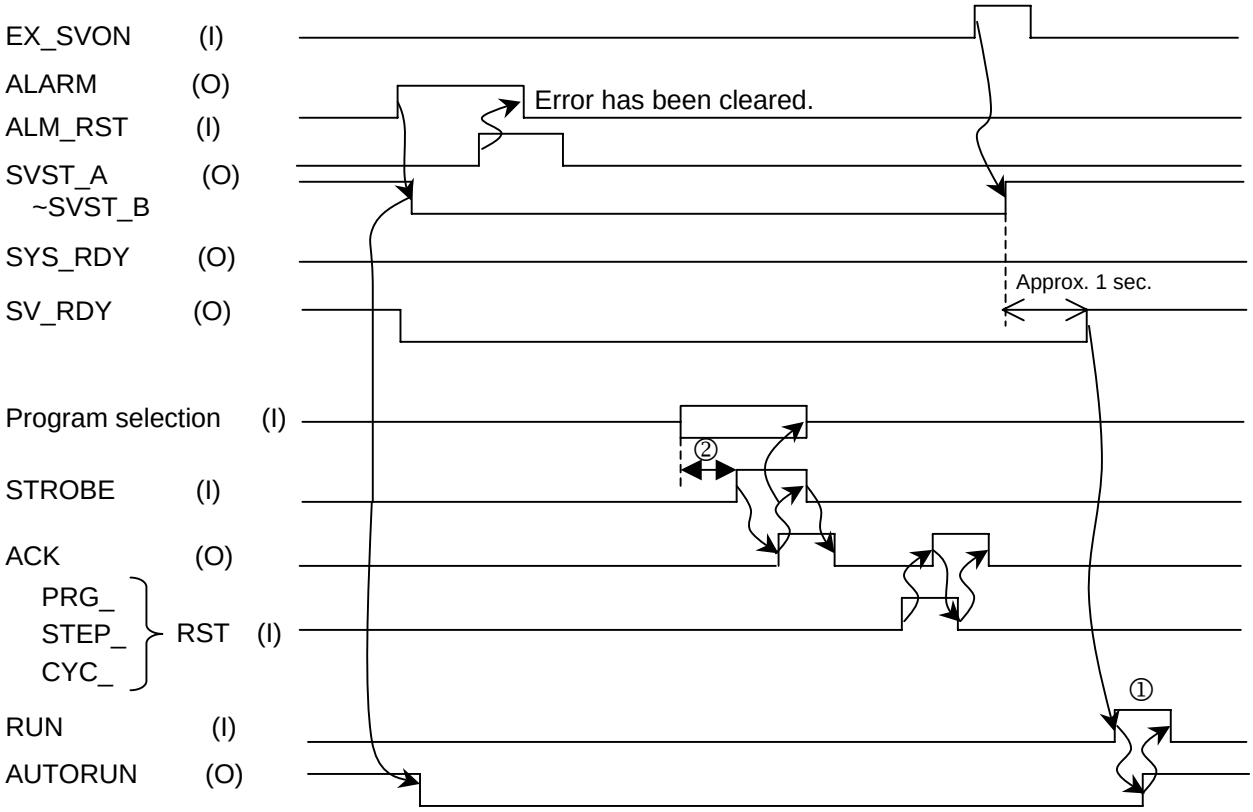
Note 1: Signals EMSST_A ~ EMSST_B (emergency stop contact output) turn on when the emergency stop contacts 1 and 2 become valid.

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.

(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 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.

5. Connecting Serial Signal Cable

5.1 Connecting Serial I/O Signal Cables COM1, HOST, and TCPRG

The TS3100 robot controller is provided with three (3) channels of RS-232C serial I/O signals COM1, HOST, and TCPRG. For the connection, see the figure below. It is recommended to use commercially available cables.
Connection of the RS-232C may differ with the communicating device. Before use, therefore, confirm the signals of the communicating device and the connection of commercially available cables.

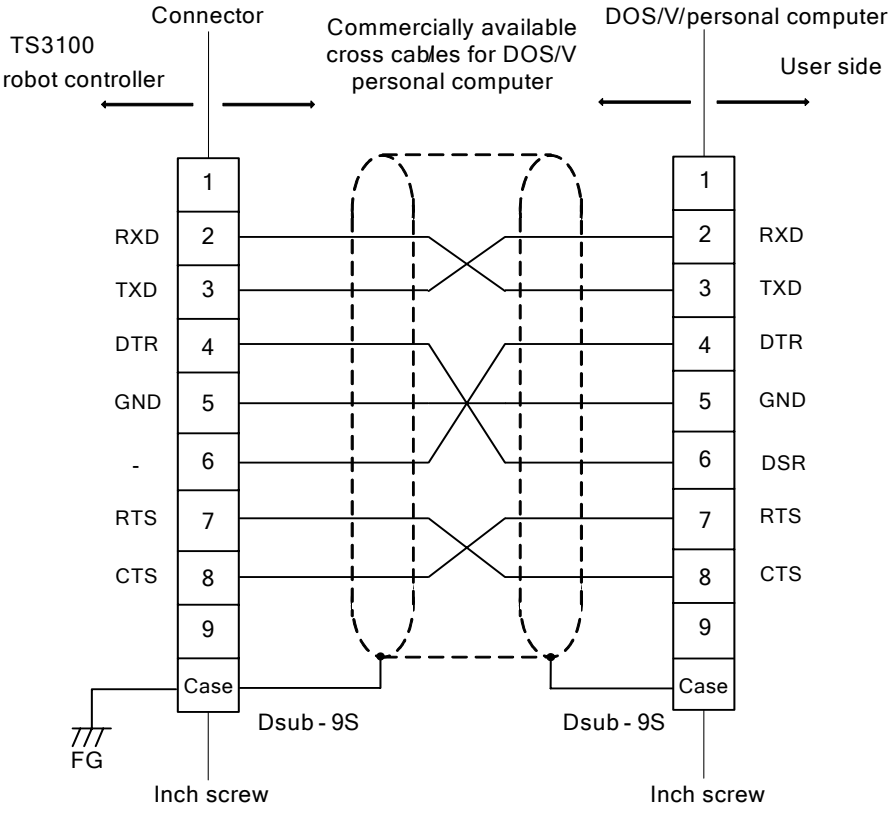


Fig. 5.1 Connection of serial I/O signals COM1, HOST, and TCPRG

5.2 Attaching and Detaching Serial I/O Signal Cables COM1, HOST, and TCPRG

Before attaching or detaching the serial I/O signal cables from the TS3100 robot controller, be sure turn off the "POWER" switch on the controller front panel or the main power on the customer's control panel.

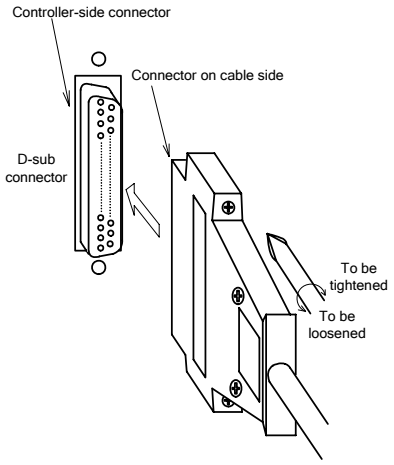


Fig. 5.2 Attaching and detaching extension I/O signal cable

As shown in Fig. 5.2, to connect the serial output signal cable, completely insert the cable-side connector into the controller-side connector and then tighten the lock screws on both sides of the connector with a screwdriver.
To remove the cable, perform the connection procedure in reverse by loosening the lock screws, and then pulling out the connector. Be sure to grasp the connector and not the wire section when disconnecting. If the wire section is pulled out without holding onto the connector, excessive force could be applied to the cable and damage it.

! **CAUTION**	When attaching or detaching the cable, be sure to grasp the connector and not the wire section.

! **CAUTION**	The COM1, HOST, and TCPRG connectors of the TS3100 robot controller are attached with a connector cap, respectively. Unless these connectors are used, be sure to attach the connector caps to prevent static electricity and damage.

6. Connecting TP (Teach Pendant) Cable

Connecting TP cable

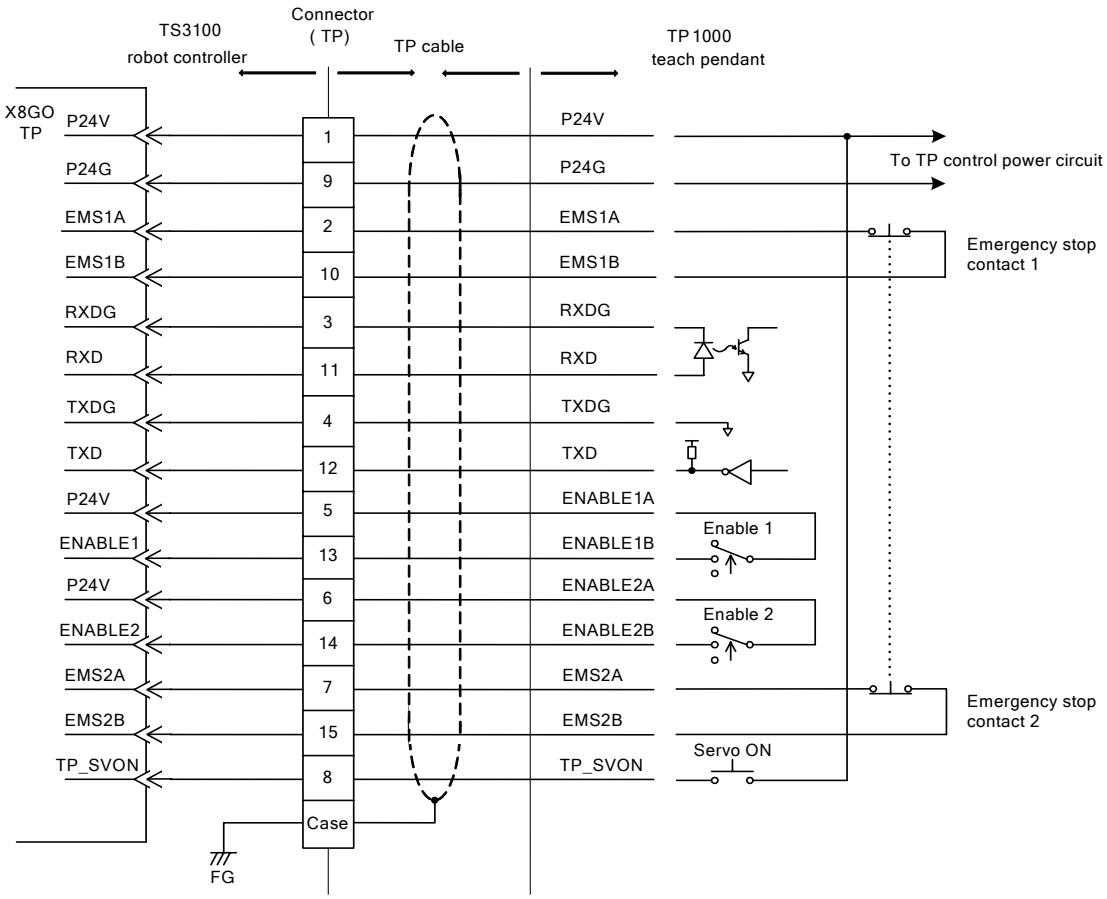


Fig. 6.1 Connection of TP1000 teach pendant I/O signals

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 connector to connector TP on the front panel of the controller.

When connecting the teach pendant, remove this dummy connector first. (The attaching and detaching procedures are the same as in Para. 5.2. For details, see Para. 5.2.)

The dummy connector can be removed while the POWER switch is set ON or OFF. If the dummy connector is removed while the servo power is turned on, however, the servo power is turned off automatically. (While the dummy connector or teach pendant is not connected, safety measures are effected to prevent the servo power from actuating.)
The TP disconnect switch is provided as an option on the lower left side of the TP connector (when seen from the controller front side). When the dummy connector or teach pendant connector is disconnected while pressing this switch, the controller servo power remains on. Change the connector while pressing the TP disconnect switch continuously.

If the TP disconnect switch is kept pressed for long hours, however, the safety device works to turn off the servo power (i.e., emergency stop contact output is ON). The time for attaching or detaching the connector should be thirty (30) seconds or less.

! **CAUTION**	Unless the TP cable or dummy connector is connected with the TP connector of the TS3100 robot controller, the servo power cannot be turned on.

! **CAUTION**	NEVER keep pressing the TP disconnect switch intentionally.

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 TS3100 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).

7. Connecting EXT–I/O Cable

7.1 Connecting EXT–I/O Cable

The EXT–I/O cable is used to connect the TR48DIOCN/TR48DIOC module (option) or Toshiba Machine's designated remote I/O module (option) serving as the slave station.
To supply the controller internal power to the TR48DIOCN/TR48DIOC module, the EXT–I/O cable is connected with P24V (24 V) and P24G (0 V) (when external power (24 VDC) is supplied to controller).
When using power (24 VDC) supplied by the controller, an external power supply from the connector "EMS" is required. Select the optimum external power supply according to the customer's system specifications (power supply capacity).

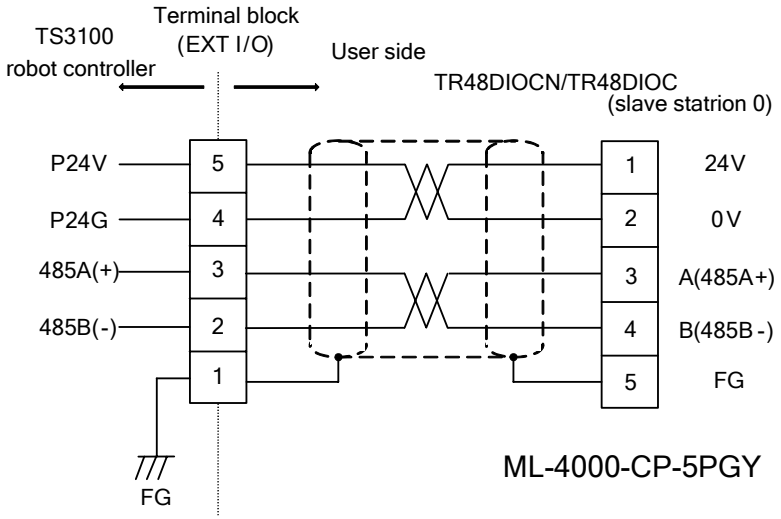


Fig. 7.1 Connection of RS-485 cable

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

- Core wires : 0.3 ~ 0.75 mm^2 twisted wires
- Twisted pair : Required.
- Cable outer diameter : Max. 7 mm
- Shield : Batch braided shield
- Cable length : 10 m or less in total
  (When the external power is supplied to the remote I/O module and only the RS-485 communication cable is extended, the total cable length can be 400 m or less.)

- Characteristic impedance : 100 Ω
- Others : For RS-485 250 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/TR48DIOC modules for I/O extension, be sure to branch from the terminal block of slave station 0, as shown in Fig. 7.2. (For the I/O extension, up to two (2) TR48DIOCN/TR48DIOC modules can be connected.)

For details on the TR48DIOCN/TR48DIOC module, see the Simple PLC Function Manual.

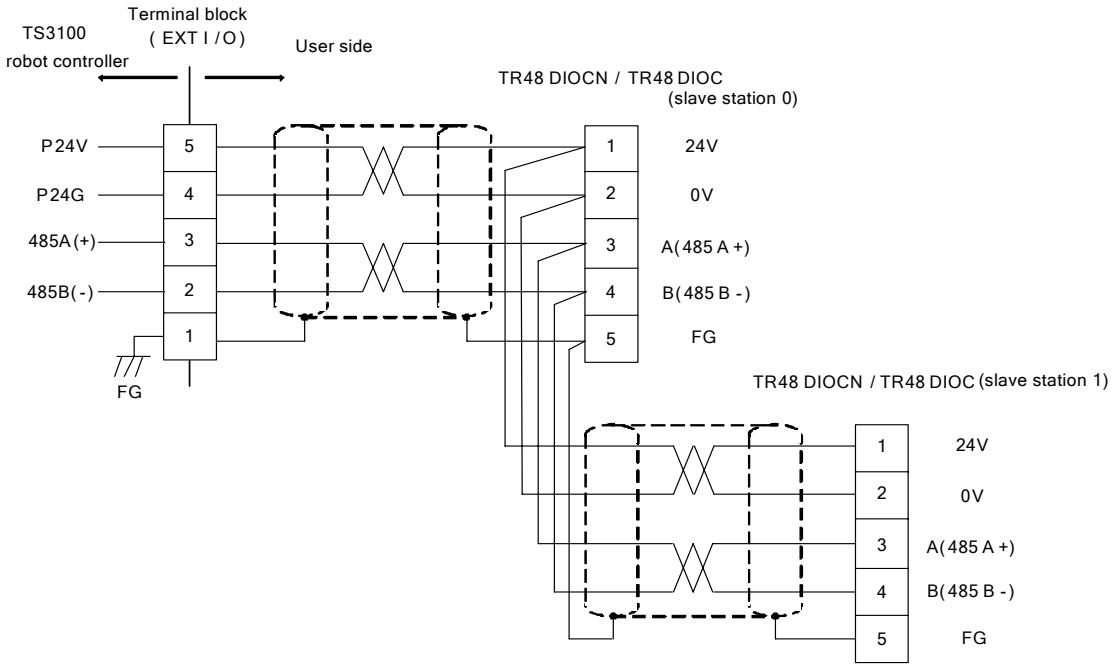


Fig. 7.2 Connection when relaying EXT–I/O cable

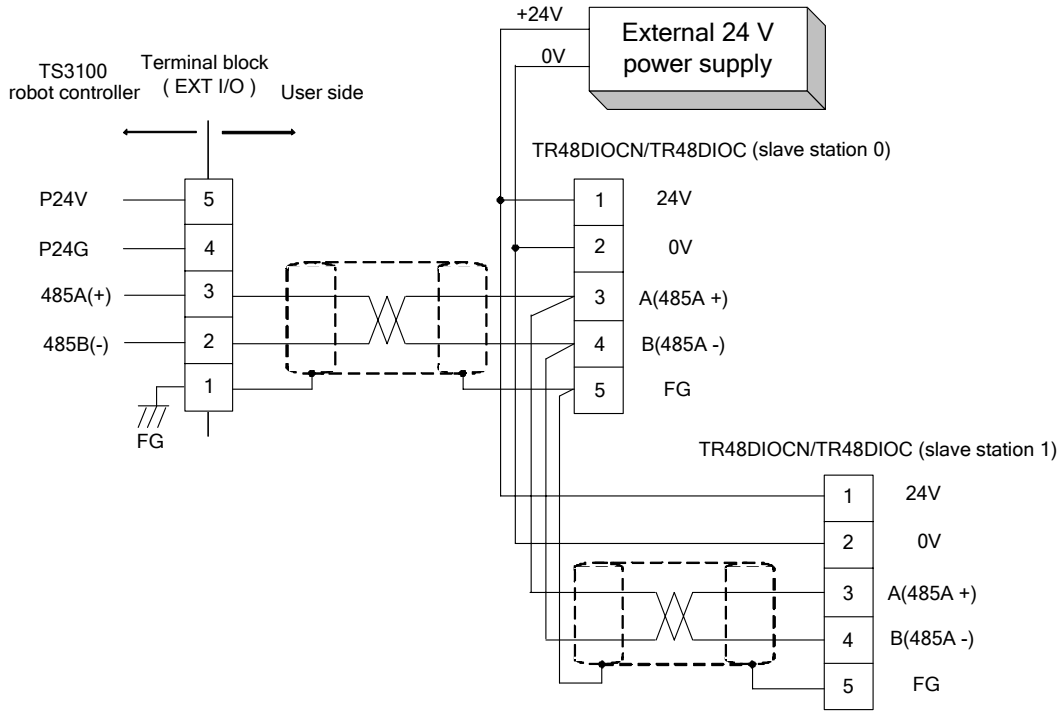


Fig. 7.3 Connection of EXT–I/O cable when external power supply is used

7.2 EXT–I/O Communication

If the number of digital I/Os is insufficient for the system, up to two (2) TR48DIOCN/TR48DIOC modules [option; twenty-eight (28) inputs and twenty (20) outputs] can be connected as the I/O function extension unit. When the TS3100 robot controller is assigned to the master station and the TR48DIOCN/TR48DIOC module to the slave station, inputs and outputs can be controlled via the RS-485 serial communication.
In addition to the TR48DIOCN/TR48DIOC module, a remote I/O module designated by Toshiba Machine, which can serve as the slave station, can be used also.

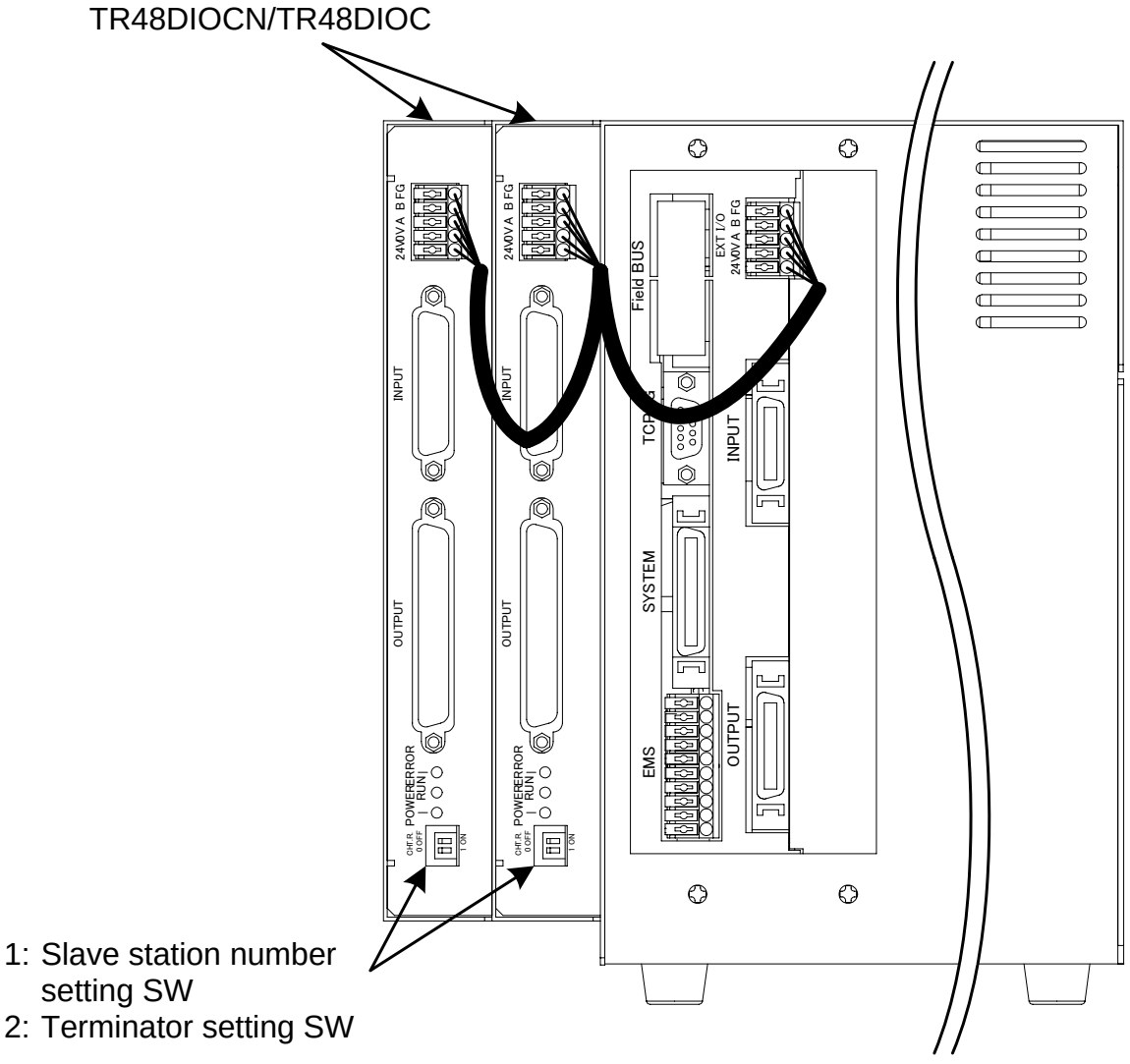


Fig. 7.4 Connection of TR48DIOCN/TR48DIOC module

- User parameter setting procedures

  * To designate the slave station number of the TS3100, 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.

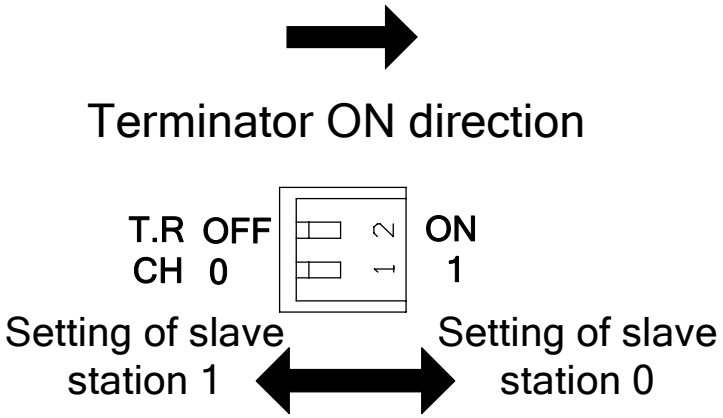
    If you wish to use both stations 0 and 1 TR48DIOCN/TR48DIOC module), for instance, change the underlined bit corresponding to station 0 to "1".
    = 1 28 20
    = 0 28 20

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

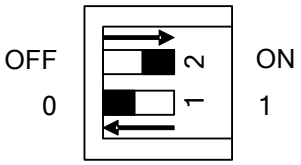
    If you wish to use both stations 0 and 1 (i.e., two (2) TR48DIOCN/TR48DIOC modules), specify as follows and perform the same operation as above to make the parameter valid.
    = 1 28 20
    = 1 28 20

- Station number and terminator setting

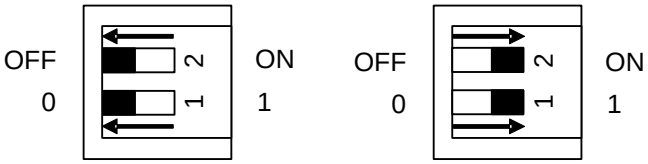
  The switches (2 pins) provided on the front upper side of the TR48DIOCN/TR48DIOC module represent pin 1 (upper) for slave station number setting and pin 2 (lower) for terminator setting.



Ex.1 When adding one (1) TR48DIOCN/TR48DIOC



Ex.2 When adding two (2) TR48DIOCN/TR48DIOC



The slave station setting is already described above. Specify the slave station of TR48DIOCN/TR48DIOC to be used, according to the station number set in USER. PAR.

For the terminator, when only one (1) TR48DIOCN/TR48DIOC module is used, set ON the terminator setting switch equipped on the module.
When two (2) TR48DIOCN/TR48DIOC modules are used, see Fig. 7.4 for example. As the TR48DIOCN/TR48DIOC module on the extreme left side as viewed from the controller rear 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 TR48DIOCN/TR48DIOC module should remain OFF.

When using the TR48DIOCN/TR48DIOC module, careful precautions should be taken on the following matters.

[1] Make sure that the slave station number set in "USER.PAR" coincides with the station number setting of the TR48DIOCN/TR48DIOC module.

[2] When the TR48DIOCN/TR48DIOC module or modules are connected, set ON the terminator setting switch equipped on the TR48DIOCN/TR48DIOC

module which is located on the extreme right side in terms of cable wiring when seen from the controller.

Be sure to execute Items [1] and [2] above, irrespective of the presence or absence of external power supply. 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 TR48DIOCN/TR48DIOC module are illuminated.

7.3 Attaching and Detaching EXT–I/O Cable

For the EXT–I/O cable, use the cable attached to the TR48DIOCN/TR48DIOC module, or a cable which meets the specifications.
Before attaching or detaching the EXT–I/O cable to or from the TS3100 robot controller, be sure to turn off the POWER switch equipped on the rear side of the controller, or the main power in the user's control panel.

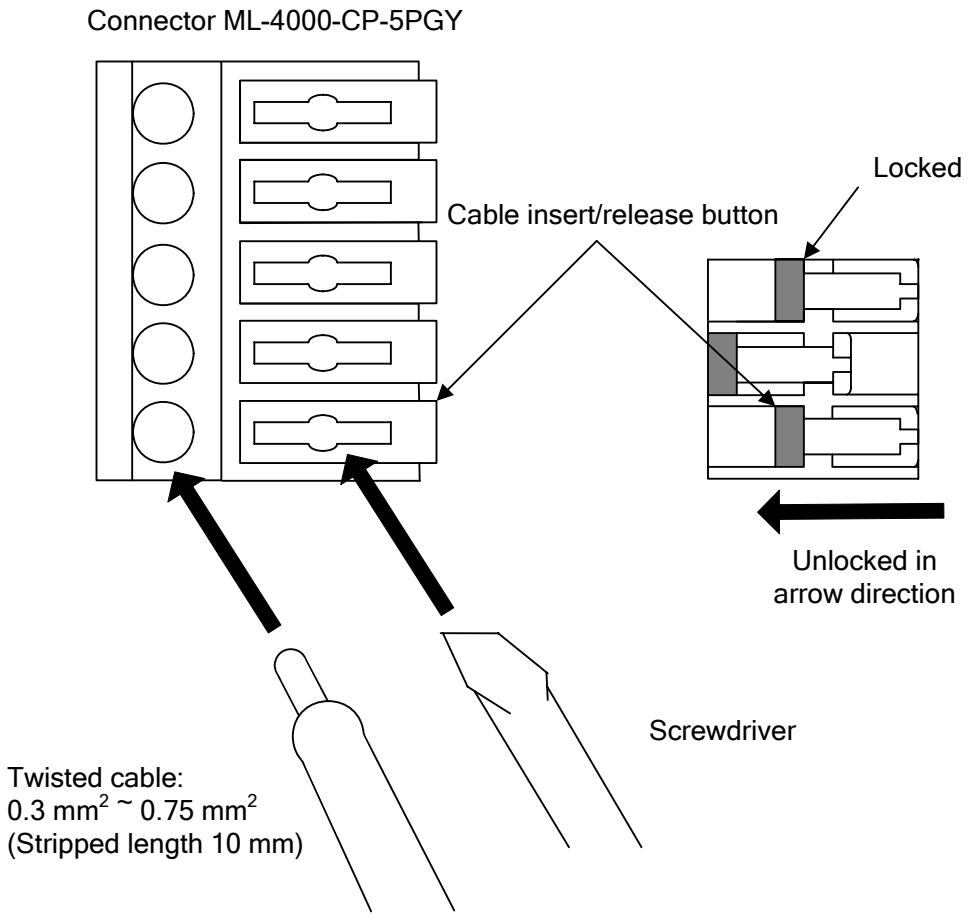


Fig. 7.5 Attaching and detaching EXT–I/O cable

To connect the EXT-I/O cable, use the attached connectors.
As shown in Fig. 7.5, when the cable insert/release button of the connector is pressed in by a flat-head screwdriver, the cable insert/release button is locked, and the cable can be attached or detached. After the cable is firmly pressed in, pull up the cable insert/release button 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 detach a cable, use a screwdriver to press in the cable insert/release button so that the cable insert/release button is locked, and then pull out the cable.

8. Connecting Extension I/O Signal Cable (Option)

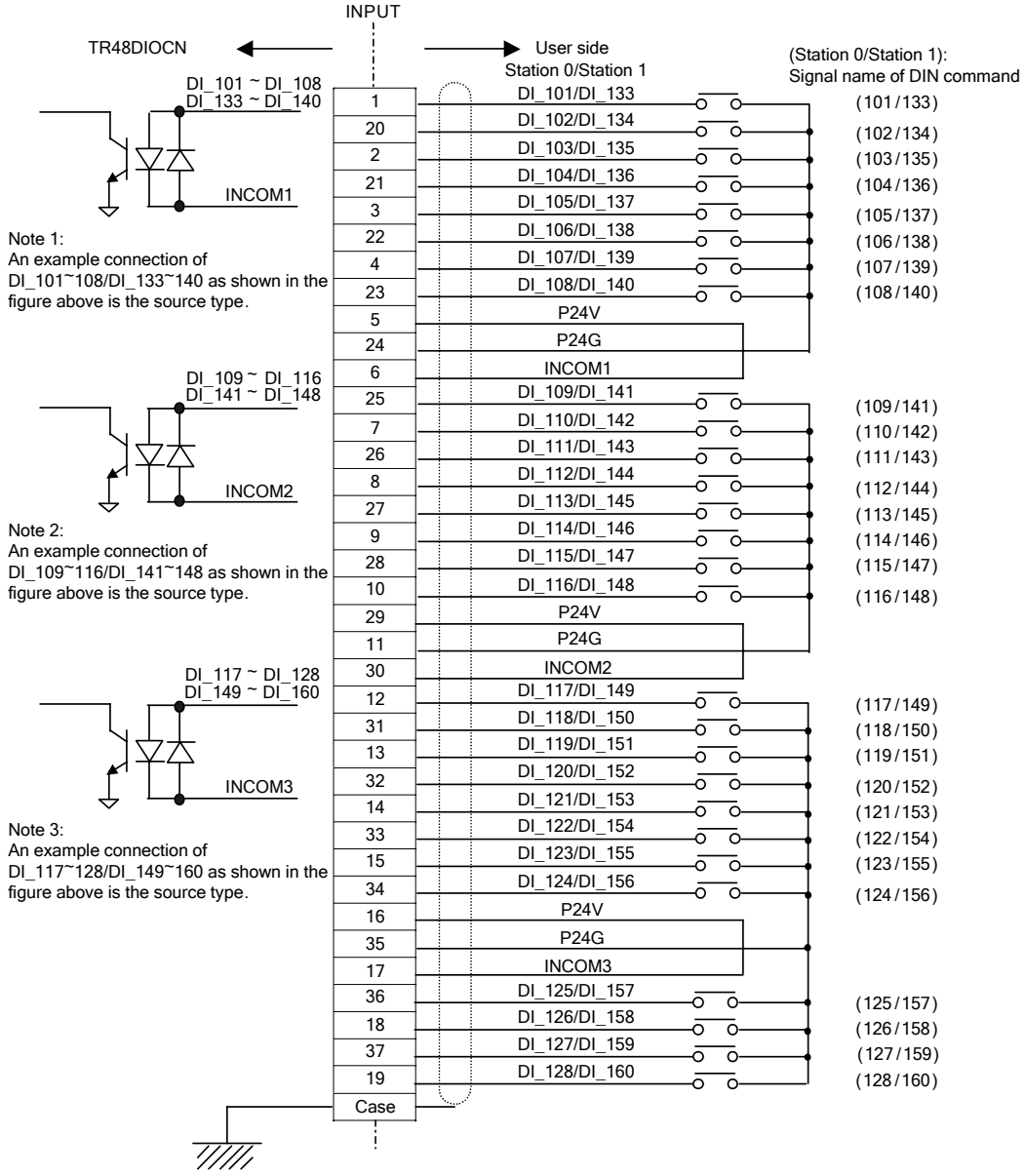
The TR48DIOCN and TR48DIOC modules are available to serve as the extension I/O modules exclusive to the TS3100 robot controller.
They are provided with twenty-eight (28) inputs and twenty (20) outputs, respectively.
For the TS3100 robot controller, up to two (2) stations can be extended.
The output specifications (source type or sink type) differ between the TR48DIOCN and TR48DIOC modules.
After confirming the type of your extension I/O module, connect the extension I/O signal cables.

8.1 TR48DIOCN

The output specifications of the TR48DIOCN are the same as those of the sink type. For the input specifications, a bidirectional photocoupler is used in the input circuit, and it is possible to change over the source type or sink type by the selection of INCOM*.

8.1.1 Connecting Extension Input Signal Cable

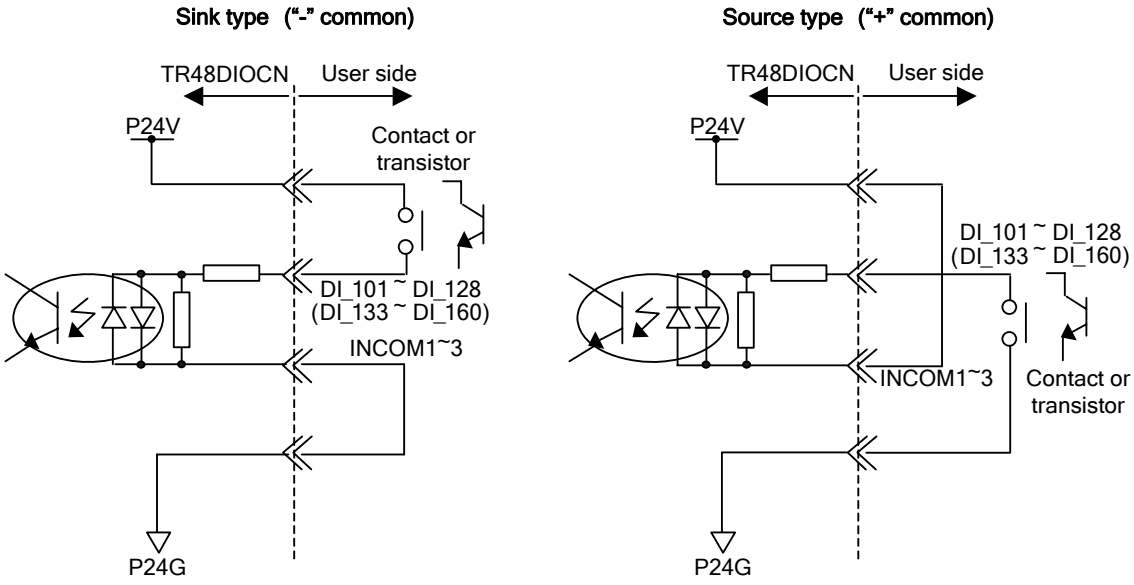
To connect the extension input signal cable, use the connector attached to the TR48DIOCN module [XM2A–3701 (plug type connector), XM2S–3711 (connector cover)]. Connect the inputs of the TR48DIOCN (DI_101 ~ 128 (station 0) and DI_133 ~ 160 (station 1) to connector INPUT provided on the module surface.


INPUT
TR48DIOCN
User side
Station 0/Station 1
(Station 0/Station 1):
Signal name of DIN command
DI_101 ~ DI_108
DI_133 ~ DI_140
INCOM1
Note 1:
An example connection of
DI_101~108/DI_133~140 as shown in the
figure above is the source type.
DI_109 ~ DI_116
DI_141 ~ DI_148
INCOM2
Note 2:
An example connection of
DI_109~116/DI_141~148 as shown in the
figure above is the source type.
DI_117 ~ DI_128
DI_149 ~ DI_160
INCOM3
Note 3:
An example connection of
DI_117~128/DI_149~160 as shown in the
figure above is the source type.
1 DI_101/DI_133 (101/133)
20 DI_102/DI_134 (102/134)
2 DI_103/DI_135 (103/135)
21 DI_104/DI_136 (104/136)
3 DI_105/DI_137 (105/137)
22 DI_106/DI_138 (106/138)
4 DI_107/DI_139 (107/139)
23 DI_108/DI_140 (108/140)
5 P24V
24 P24G
6 INCOM1
25 DI_109/DI_141 (109/141)
7 DI_110/DI_142 (110/142)
26 DI_111/DI_143 (111/143)
8 DI_112/DI_144 (112/144)
27 DI_113/DI_145 (113/145)
9 DI_114/DI_146 (114/146)
28 DI_115/DI_147 (115/147)
10 DI_116/DI_148 (116/148)
29 P24V
11 P24G
30 INCOM2
12 DI_117/DI_149 (117/149)
31 DI_118/DI_150 (118/150)
13 DI_119/DI_151 (119/151)
32 DI_120/DI_152 (120/152)
14 DI_121/DI_153 (121/153)
33 DI_122/DI_154 (122/154)
15 DI_123/DI_155 (123/155)
34 DI_124/DI_156 (124/156)
16 P24V
35 P24G
17 INCOM3
36 DI_125/DI_157 (125/157)
18 DI_126/DI_158 (126/158)
37 DI_127/DI_159 (127/159)
19 DI_128/DI_160 (128/160)
Case

The specifications of the extension input signal are as follows:

- Type of input:
  Non-voltage contact input or transistor open collector input

- Example of application circuit and structure of input circuit

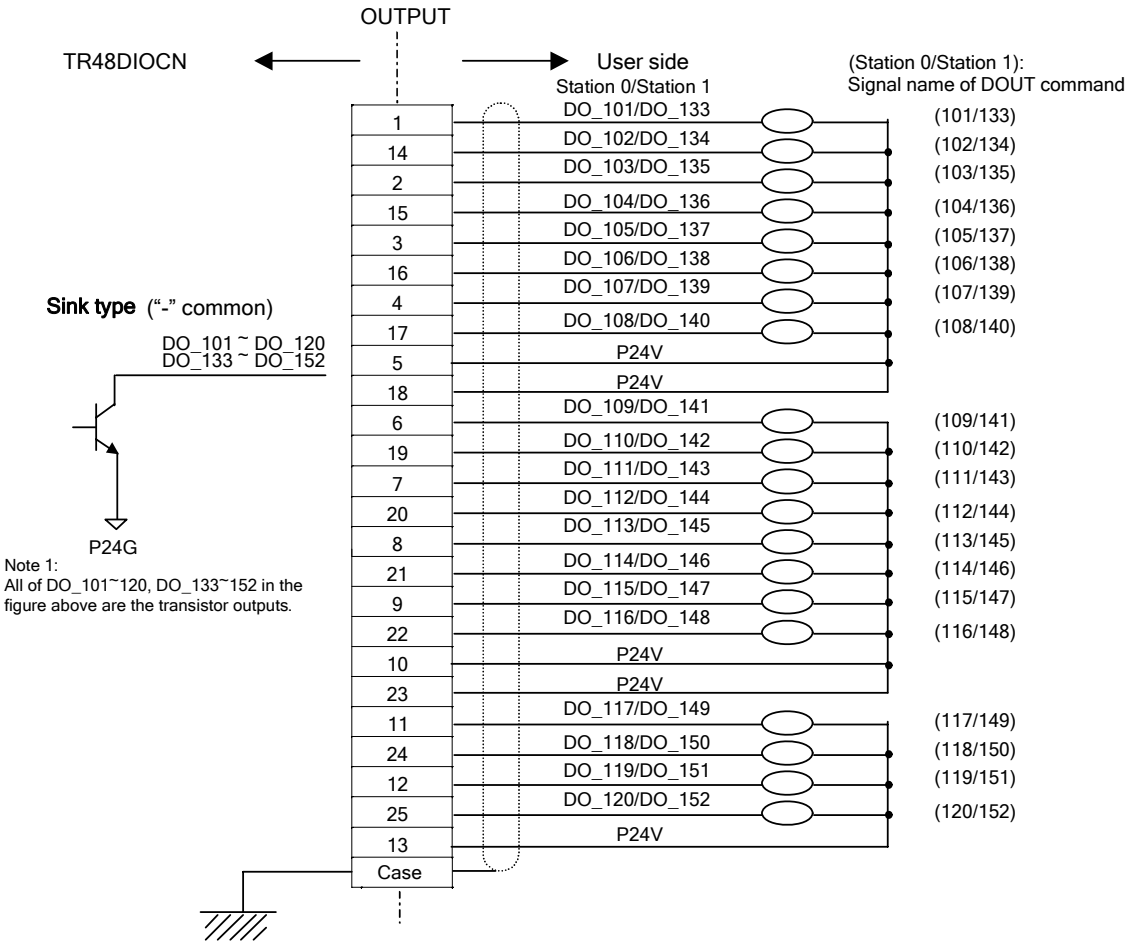


- Non-voltage contact/transistor specifications

Non-voltage contact specifications		Transistor specifications	
Contact rating	24 VDC, 10 mA or over	Voltage between collector and emitter	30 V or over
Circuit current	Approx. 7 mA	Current between collector and emitter	10 mA
Minimum current	24 VDC, 1 mA	Circuit current	Approx. 7 mA
Connected impedance	100 Ω or less	Leak current between collector and emitter	100 μA

8.1.2 Connecting Extension Output Signal Cable

To connect the extension output signal cable, use the connector attached to the TR48DIOCN module [XM2A–2501 (plug type connector), XM2S–2511 (connector cover)]. Connect the outputs of the TR48DIOCN (DO_101 ~ 120 (station 0) and DO_133 ~ 152 (station 1) to connector OUTPUT provided on the module surface.



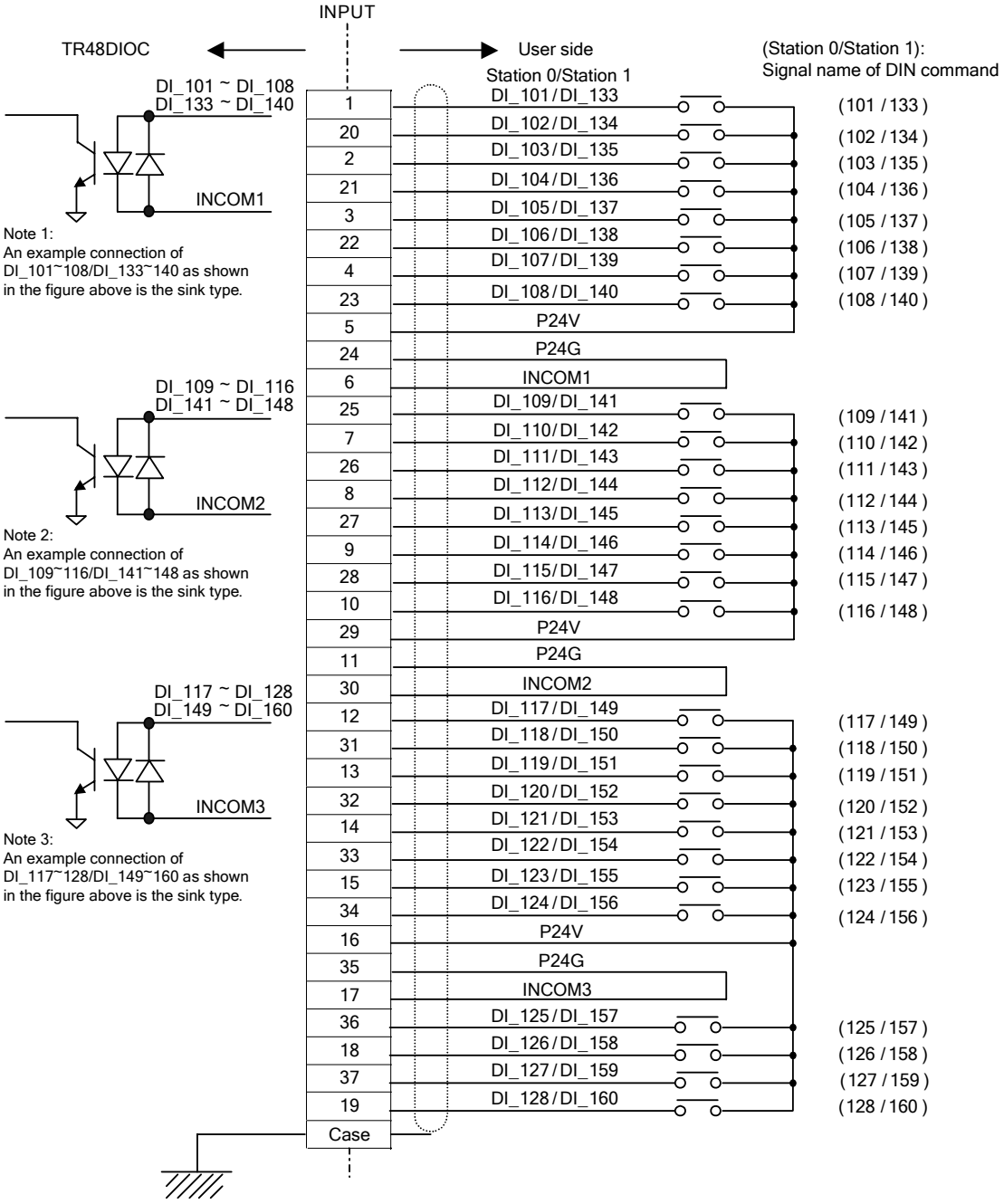
The specifications of the extension output signal are the same as those of the digital output signal (i.e., sink type) which are described in Para. 4.8.

8.2 TR48DIOC

The output specifications of the TR48DIOC differ from those of the source type. The polarity is the same as the output polarity of I/O printed board X8GI of this controller.
For the input specifications, a bidirectional photocoupler is used in the input circuit, and it is possible to change over the source type or sink type by the selection of INCOM*.

8.2.1 Connecting Extension Input Signal Cable

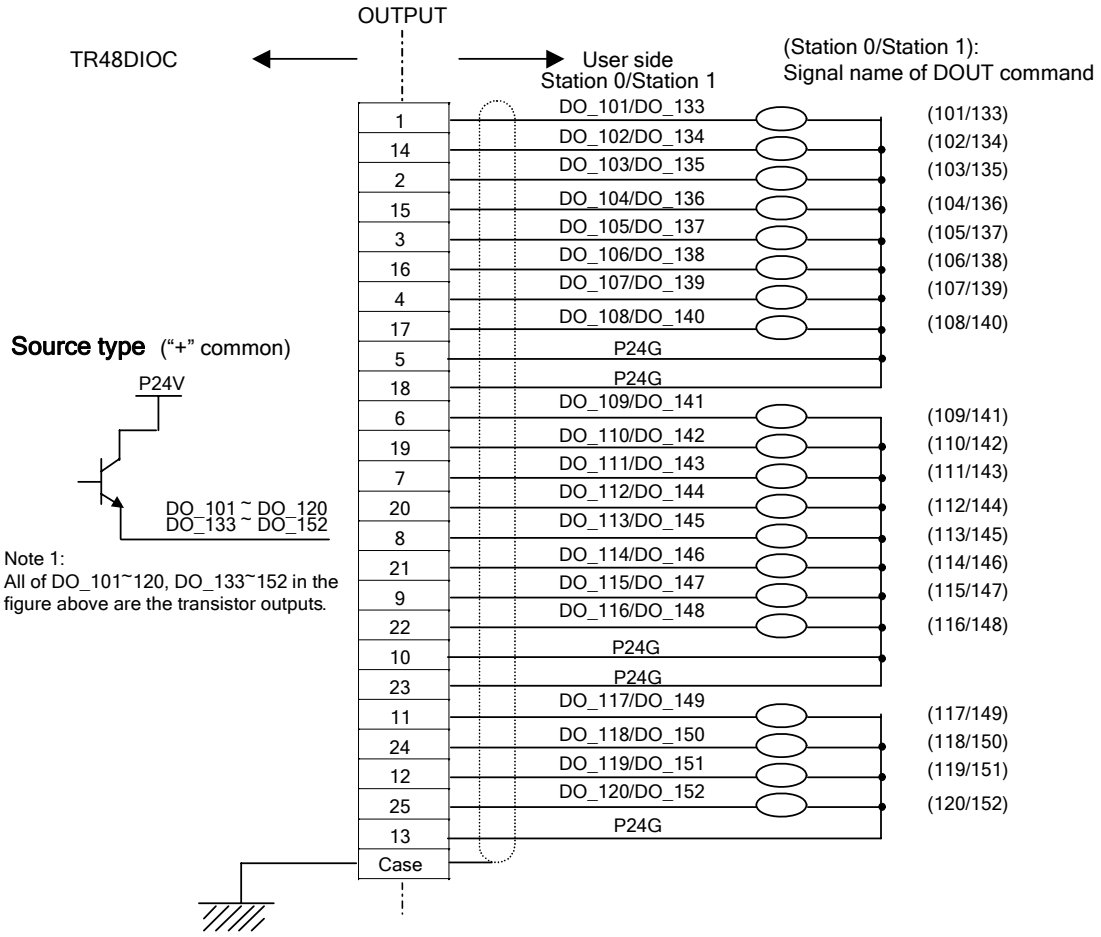
To connect the extension input signal cable, use the connector attached to the TR48DIOC module [XM2A–3701 (plug type connector), XM2S–3711 (connector cover)]. Connect the inputs of the TR48DIOC (DI_101 ~ 128 (station 0) and DI_133 ~ 160 (station 1) to connector INPUT provided on the module surface.



The specifications of the TR48DIOC extension input signal are the same as those of the TR48DIOCN extension input signal. For details, see Para. 8.1.1.

8.2.2 Connecting Extension Output Signal Cable

To connect the extension output signal cable, use the connector attached to the TR48DIOC module [XM2A–2501 (plug type connector), XM2S–2511 (connector cover)]. Connect the outputs of the TR48DIOC (DO_101 ~ 120 (station 0) and DO_133 ~ 152 (station 1) to connector OUTPUT provided on the module surface.



The specifications of the extension output signal are the same as those of the digital output signal (i.e., source type) which are described in Para. 4.8.

- Electric rating

Electric rating		Cautions
Rated voltage	24 VDC	Select the optimum external power supply according to the user's system specifications (power supply capacity). 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. NEVER use an external power supply. Otherwise, the system will malfunction.
Rated current	100 mA (max.)	

8.3 Fabricating Extension I/O Signal Cable

Follow the procedure below when fabricating an extension I/O signal cable.

a. Either use the TR48DIOCN/TR48DIOC supplied connector, or obtain the same model connector separately. An equivalent connector (D-sub connector) by another manufacturer can also be used.

Connector name	Type of connector	Maker
INPUT	XM2A-3701 (plug type) XM2S-3711 (connector cover)	OMRON
OUTPUT	XM2A-2501 (plug type) XM2S-2511 (connector cover)	OMRON

b. Select a cable that matches the specifications below.
   - Core wires: 0.18 ~ 0.32 mm^2 twisted wires
   - Cable outer diameter: Max. 10.5 mm (INPUT), 9 mm (OUTPUT)
   - Shield: Batch shield
   - Cable length: 30 m or less

Never use cables that differ from the specifications. This can cause melting due to a short-circuit or overheating of the wire cores, and also malfunctioning of the robot due to the intrusion of noise.

c. The INPUT and OUTPUT2 connectors are solder cap type connectors that are joined by soldering the wires. For details about the procedure for joining the wires to the connector and applying the shielding, see Appendix in Chapter 15.

8.4 Attaching and Detaching Extension I/O Signal Cable

For attaching and detaching the extension I/O signal cable, see Para. 5.2.

9. Connecting Trigger Input Signal Cable (TRIG)

The TS3100 robot controller is provided with eight (8) trigger inputs as standard. Though a filter of 0.22 ms (calculated value) is normally provided for the inputs, only a filter of 2.2 µs (calculated value) is provided for the high-speed inputs. To prevent mis-operation, input a signal without chattering and less noise.
For the input specifications, a bidirectional photocoupler is used in the input circuit, and it is possible to change over the source type or sink type by the selection of COM.
To connect the trigger input signal cable, use the connector [XM2D–1501 (socket type connector), XM2S–1511 (connector cover)] attached to the X8GL printed board.

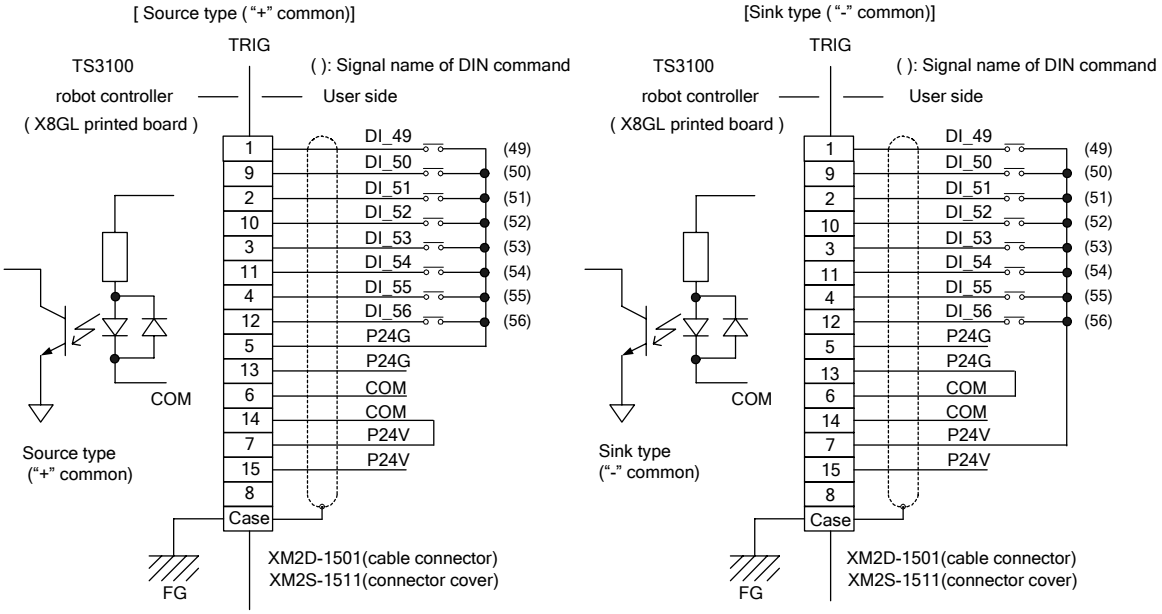


Fig. 9.1 Connection of trigger input signal cable

The specifications of the trigger input signal are the same as in the TR48DIOCN/TR48DIOC modules. For details, see Para. 8.1.1.
When this input signal is used as the conveyor synchronous start trigger input function, it cannot serve as the high-speed input function.

9.1 Fabricating Trigger Input Signal Cable

When fabricating the high-speed input signal cable, follow the fabrication procedures given below.

a. Use the connectors attached to the controller or the same type connectors. Equivalent connectors (D-sub connector) made by other maker can also be used.

Connector name	Type of connector	Maker
TRIG	XM2D-1501 (socket type) XM2S-1511 (connector cover)	OMRON

b. Select cables which meet the following specifications.

- Cable wires: 0.18 ~ 0.32 mm^2 twisted wires
- Cable outer diameter: Max. 10.5 mm (INPUT), 9 mm (OUTPUT)
- Shield: Batch shield
- Cable length: 30 m or less

Never use cables that differ from the specifications. This can cause melting due to a short-circuit or overheating of the wire cores, and also malfunctioning of the robot due to the intrusion of noise.

c. The TRIG connector is solder cap type connector that is joined by soldering the wires. For details about the procedure for joining the wires to the connector and applying the shielding, see Appendix in Chapter 15.

9.2 Attaching and Detaching Trigger Input Signal Cable

For attaching and detaching the high-speed input signal cable, see Para. 5.2.

10. Connecting Conveyor Synchronization Signal Cable (CONV)

The standard TS3100 includes a two-channel conveyor synchronization encoder input.
Use an encoder having an output circuit with RS-422 differential output (line driver) and A and B phase signals with a 90-degree phase.
Use the supplied connectors (54306-1419 (connector), 54331-0141 (hood)) to connect the encoder signal cable. Use shielded twisted-pair cables. Connect the cables in a pair as shown below.
If the cables are connected incorrectly, anti-noise performance will be reduced, and this could cause a malfunction.
For details on the conveyor synchronization function, see the Conveyor Synchronous Function Instruction Manual.

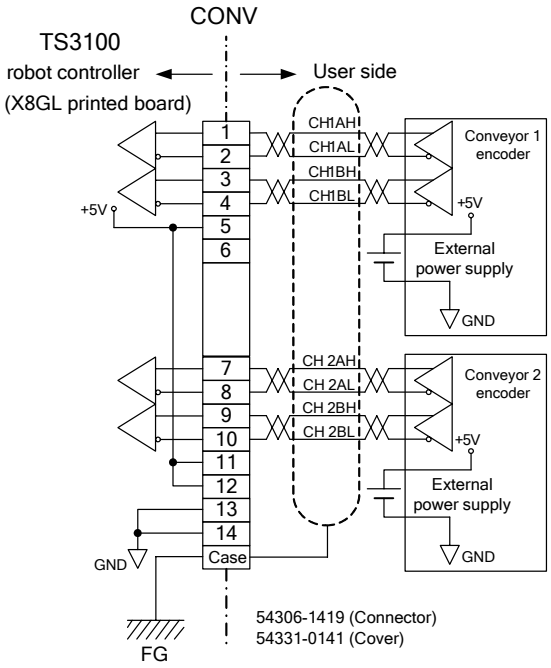


Fig. 10.1 Connection Between Incremental Encoders (when using external power supply)

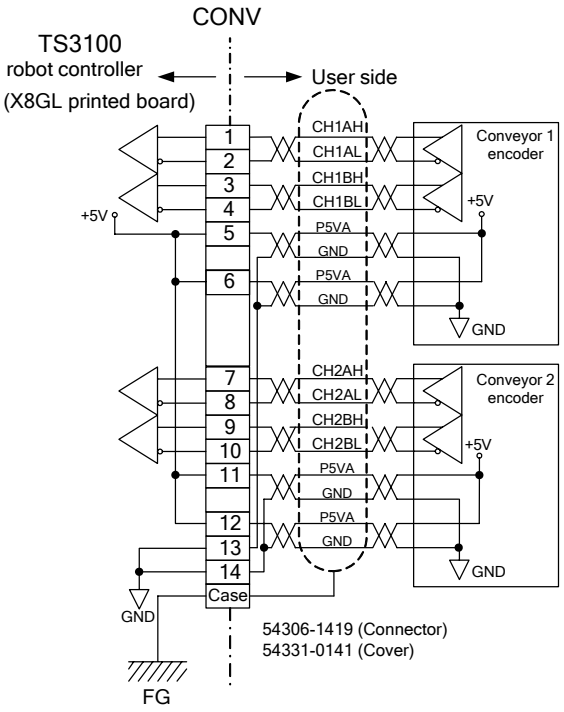


Fig. 10.2 Connection Between Incremental Encoders (when using internal power supply)

10.1 Fabricating Incremental Encoder Input Signal Cable

When fabricating an incremental encoder input signal cable, follow the fabrication procedures below.

a. Use the supplied connector.

Connector name	Type of connector	Maker
CONV	54306-1419 (connector) 54331-0141 (hood)	MOLEX

b. Select a cable that matches the specifications below.

- Core wires: 0.2 ~ 0.52 mm^2 twisted wires
- Cable diameter: Max. 8.5 mm
- Shield: Batch shield

Never use cables that differ from the specifications. This can cause melting due to a short-circuit or overheating of the wire cores, and also malfunctioning of the robot due to the intrusion of noise.

c. The CONV connector is a solder cap type connector that is joined by soldering the wires. For details about the procedure for joining the wires to the connector and applying the shielding, see the Appendix in Chapter 15.

10.2 Attaching and Detaching Incremental Encoder Input Signal Cables

For the procedure for attaching and detaching incremental encoder input signal cables, see Para 4.11.

11. LAN Signal Cable "LAN"

The standard TS3100 has a one-channel LAN port.
In this function, TCP/IP protocol can be used to enable communication on the same local area network with computers and visual equipment on the Ethernet. This allows program creation and editing, debugging start support, and maintenance using the computer programmer TSPC.
If a hub is used to connect to external equipment, connect using a straight cable. Use a cross cable when connecting a computer directly to controller. Some equipment has an automatic recognition function so that either a straight cable or cross cable can be used, and so check the specifications of the equipment that is used.
For details on the LAN communication function, see the Communication Manual.

Communication specifications

a. Interface: 10BASE-T
b. Communication system: TCP
c. Communication speed: 10 Mbps
d. Maximum packet size: 512 bits/packet
e. Number of simultaneous connectable ports: 4
f. Internal connector (X8GC): RJ-45 (shielded)
g. Appliations: IP0 → Simple protocol communication (host computer)
IP1/IP2 → Non-protocol communication (external equipment)
IP3 → Exclusive communication (dedicated equipment)

12. Memory Cable "MEM"

The standard TS3100 has a one-channel USB port.
A commercial USB memory device can be used to transfer and save various parameters and to back up programs and other data. For the USB memory usage procedure, see the Operator's Manual.

13. Robot Control Signal Cable "BRK"

This cable is used to turn on and off the robot motor brake.
It is also possible to turn on and off the robot motor brake, irrespective of the control of the controller.

[Connector and contact on the external user side]

- Type of connector: 1–1827864-6* made by Tyco Electronics
- Type of contact: 1827589-2* made by Tyco Electronics

13.1 Connecting Motor Brake Signal Cable (SCRARA Type Robot)

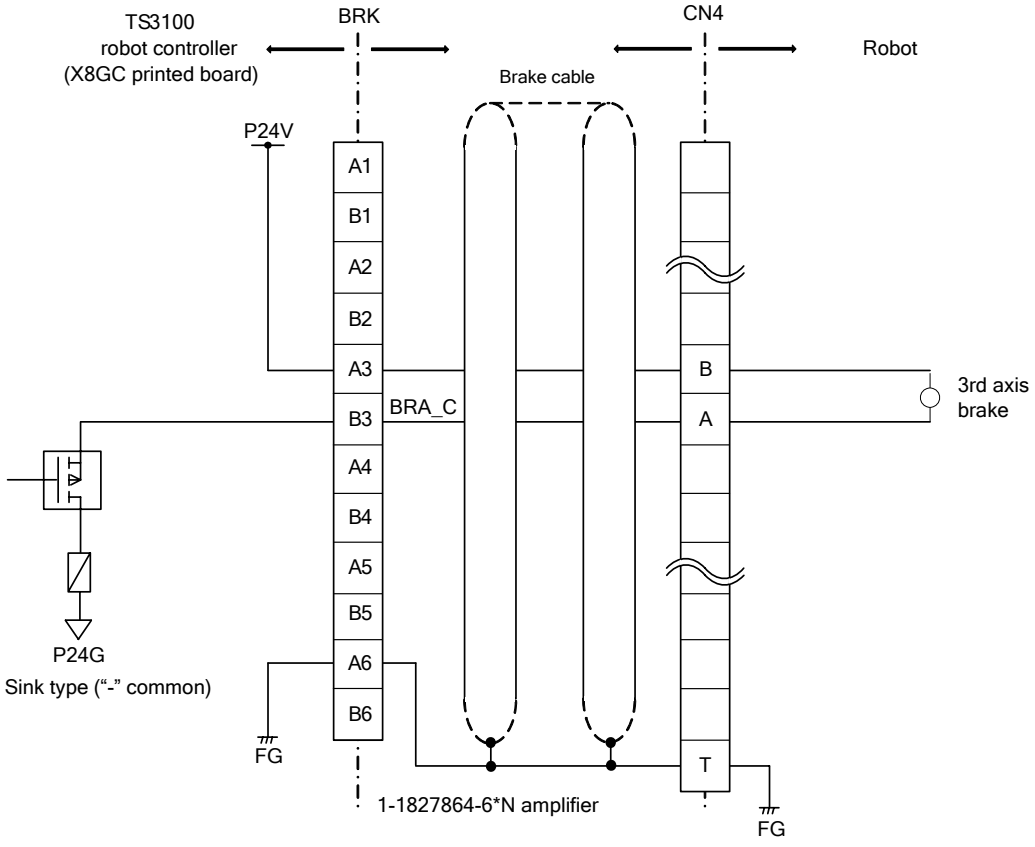


Fig. 13.1 Connecting motor brake signal cable

13.2 Connecting Motor Brake Signal Cable (6-axis Robot)

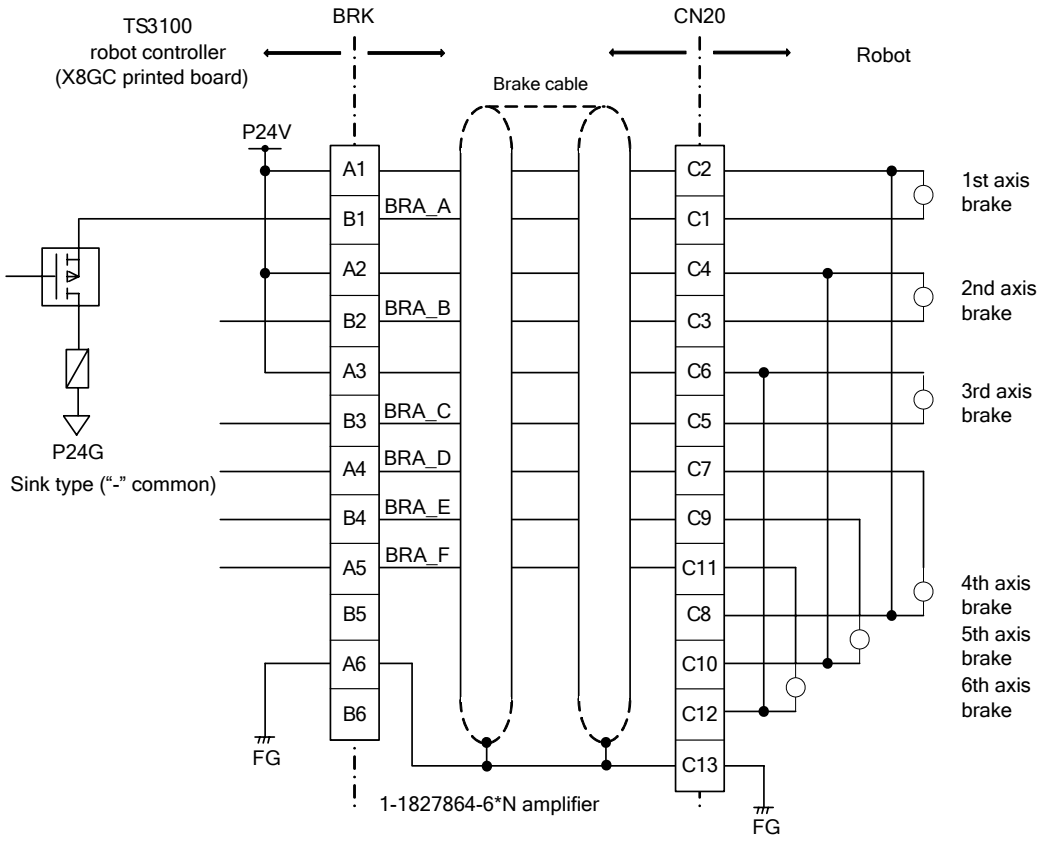


Fig. 13.2 Connecting motor brake signal cable

14. Connecting External I/O Power Supply Cable (EMS)

The external I/O power supply cable is connected in the same way as the safety input signal cable, and the supplied connector (ML-4000-CP-10PGY (connector)) is used. The power supply (P24 V) is supplied from the "EMS" connector on the controller rear panel.

I/O that uses an external power supply (24 VDC) are shown below. Be sure to connect an external power supply (24 VDC).

- External input/output
- External operation input/output
- Extension input/output
- Hand input/output

Note that trigger input and brake output uses the power supply (24 VDC) in the controller.

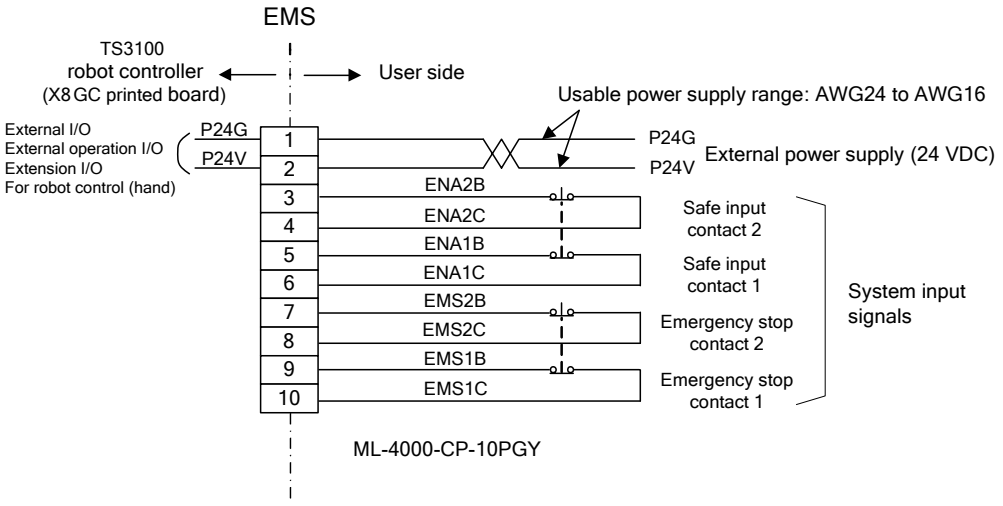


Fig. 14 Connecting external power supply

The "EMS" connector supports cables in the AWG24 to AWG16 range.
Select the optimum external power supply according to the customer's system specifications (power supply capacity).
For the external I/O power supply cable attaching and detaching procedure, see Para 7.3.

! **CAUTION**	Be sure to always supply external power (24 VDC). Otherwise, the safety protection signals will not be enabled, and servo power supply of the controller cannot be turned on.

15. Appendixes

15.1 System Signal Table

Name	I/O	Function	Signal judgment
STROBE	I	Selects an execution program file from the external equipment.	ON: Short-circuit OFF: Open
PRG_RST	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	I	Resets a program currently stopped to step 1. The value of each variable remains unchanged.	ON: Short-circuit OFF: Open
CYC_RST	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	I	Batch-resets the digital output signals (DOUT1 ~ 32, DOUT101 ~ 120, DOUT133 ~ 152).	ON: Short-circuit OFF: Open
ALM_RST	I	Cancels an alarm which has occurred while the robot controller was able to work.	ON: Short-circuit OFF: Open
RUN	I	Starts a program currently stopped to execute an automatic operation.	ON: Short-circuit OFF: Open
EX_SVON	I	Turns on the servo power.	ON: Short-circuit OFF: Open
STOP	I	Stops a program during automatic operation.	ON: Open OFF: Short-circuit
CYCLE	I	Stops a program currently executed in automatic operation after one (1) cycle has finished.	ON: Open OFF: Short-circuit
LOW_SPD	I	Reduces the robot operating speed in automatic operation.	ON: Open OFF: Short-circuit
BREAK	I	Slows down and stops the ongoing robot operation.	ON: Open OFF: Short-circuit
SVOFF	I	Turns off the servo power.	ON: Open OFF: Short-circuit

Name	I/O	Function	Signal judgment
EMS*B ~ EMS*C	I	Emergency-stops the robot.	ON: Open OFF: Short-circuit
ENA*B ~ ENA*C	I	Emergency-stops the robot.	ON: Open OFF: Short-circuit
ACK	O	Serves as a response signal to input signals STROBE, PRG_RST, STEP_RST, CYC_RST and DO_RST.	ON: High OFF: Low
TEACH	O	This signal is output when the robot arm can be guided through the teach pendant.	ON: High OFF: Low
SV_RDY	O	This signal is output when the servo power is turned on and the robot is ready to start.	ON: High OFF: Low
EXTSIG	O	This signal is output when the EXT. SIGNAL mode is selected by means of the MODE switch.	ON: High OFF: Low
SYS_RDY	O	System ready signal	ON: High OFF: Low
AUTORUN	O	This signal is output while the program is executed in automatic operation.	ON: High OFF: Low
CYC_END	O	This is the output signal for verifying that the program has stopped by the CYCLE signal input.	ON: High OFF: Low
LOW_ST	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	O	Battery voltage level error output for backup power supply.	ON: High OFF: Low
ALARM	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

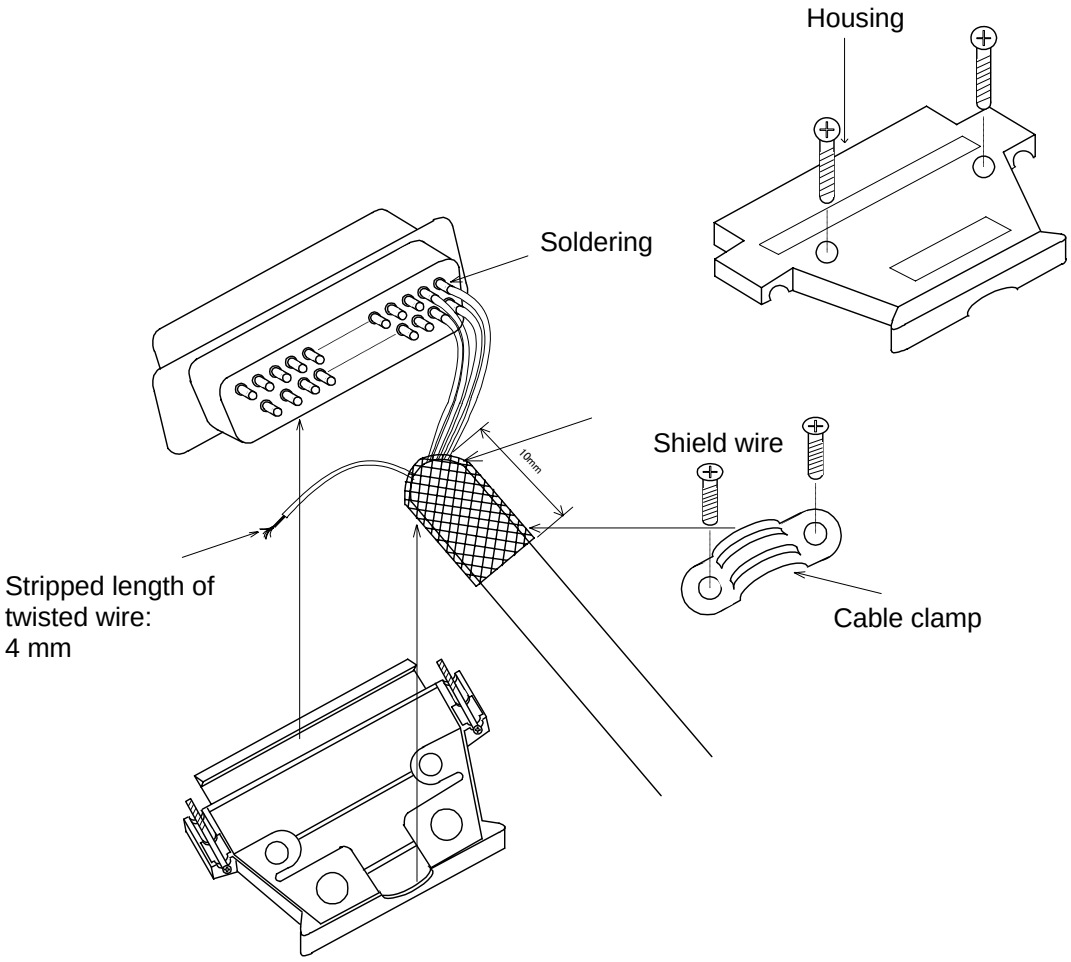
Name	I/O	Function	Signal judgment
EMSST_A ~ EMSST_B	O	Used to detect the EMERGENCY stop switch equipped on the control panel or teach pendant, and system input signal of emergency stop.	ON: Contact open OFF: Contact close Non-voltage contact

I : Input signal

O : Output signal

15.2 Fabricating Cable Using D-SUB Connector

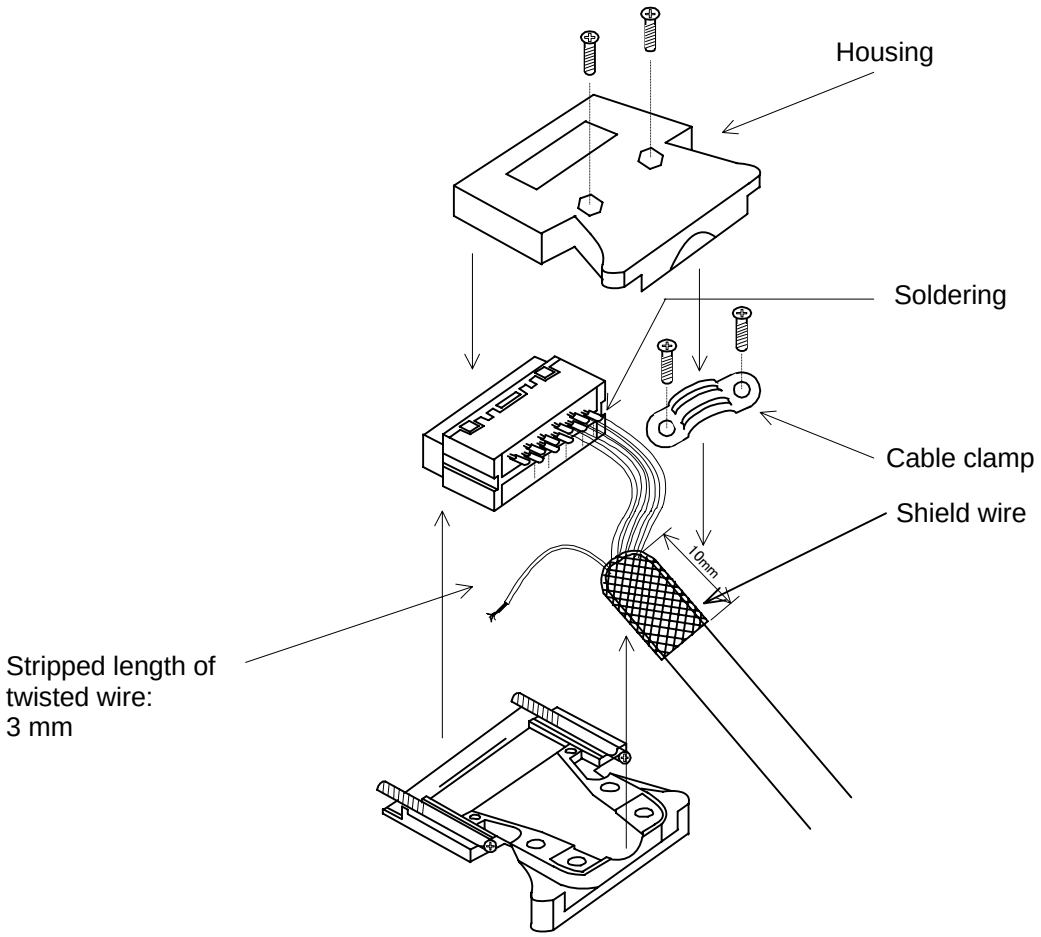
The cables to TS3100 high-speed input signal connectors TRIG, and extension I/O module connectors INPUT/OUTPUT.



Note: The shield wire of the cable using a D-SUB connector is connected to the ground of the TS3100 robot controller through the housing. Completely connect the shield wire to the housing using the cable clamp.

15.3 Fabricating Cable Using Half-Pitch Connector

A cable to the TS3100 external I/O signal connectors INPUT/OUTPUT, SYSTEM, and conveyor synchronization signal connectors CONV should be fabricated as shown below.



Note: The shield wire of the robot control signal cable is connected to the ground of the TS3100 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.

APPROVED BY:_____

CHECKED BY: _____

PREPARED BY:_____