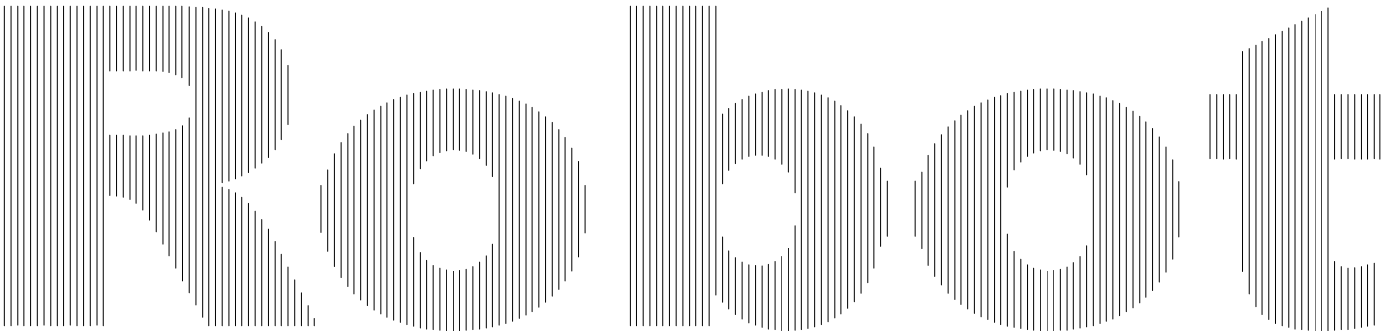
Simple and friendly

Kawasaki

Kawasaki Robot Controller
E Series

External I/O Manual



Kawasaki Heavy Industries, Ltd.

90204－1023DEF

PREFACE

This manual describes external I/O signals for the Kawasaki Robot Controller E series.

This manual also explains procedures for connecting the controller and an external device.
For supplying primary source and operations of robot, see Operation Manual, a separate manual.

Please understand the contents of this manual thoroughly and perform operations carefully.

[NOTE]

This manual supports the following controller models.
E10, E12, E13, E14, E20, E22, E23, E24, E73, E74, E94 (standard spec. for Japan)
E30, E32, E33, E34, E76, E77, E97 (standard spec. for North America)
E40, E42, E43, E44, E70, E71, E99 (standard spec. for Europe)
E25, E27 (explosion-proof spec. for Japan)
E35, E37 (explosion-proof spec. for North America)

1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damages, and/or problems relating to industrial property rights as a result of using the system.
2. It is recommended that all personnel assigned for activation, operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different site or sold off to a different user, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.

SYMBOLS

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damage by complying with the safety matters given in the boxes with these symbols.

⚠ DANGER

Failure to comply with indicated matters can result in imminent injury or death.

⚠ WARNING

Failure to comply with indicated matters may possibly lead to injury or death.

⚠ CAUTION

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation and maintenance.

⚠ WARNING

1. **The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Accordingly, it is necessary to give one's fullest attention when using this manual to perform any work. Should any unexplained questions or problems arise, please contact Kawasaki.**
2. **Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the safety manual, all pertinent laws, regulations and related materials as well as all the safety explanation described in each chapter, and prepare safety measures suitable for actual work.**

INTRODUCTORY NOTES

1. HARDWARE KEYS AND SWITCHES (BUTTON)

E series controller provides hardware keys and switches on the operation panel and the teach pendant for various kinds of operations. In this manual the names of the hardware keys and switches are enclosed with a square as follows. The terms “key” or “switch” which should follow the relevant names are sometimes omitted for simpler expression. When pressing two or more keys at the same time, the keys are indicated by “+” as shown in the example below.

EXAMPLES

ENTER: expresses the hardware key “ENTER”.
TEACH/REPEAT: indicates the mode switch “TEACH/REPEAT” on the operation panel.
A+MENU: indicates pressing and holding down A then pressing MENU.

2. SOFTWARE KEYS AND SWITCHES

E series controller provides software keys and switches which appear on the screen of the teach pendant for various kinds of operations depending on specifications and situations. In this manual, the names of software keys and switches are enclosed by “< >” parentheses. The terms “key” or “switch” which should follow the relevant names are sometimes omitted for simpler expression.

EXAMPLES

<ENTER>: expresses an “ENTER” key that appears on the teach pendant screen.
<NEXT PAGE>: expresses a “NEXT PAGE” key on the teach pendant screen.

3. SELECTION ITEMS

Very often an item must be selected from a menu or pull-down menu on the teach pendant screen. In this manual the names of these menu items are enclosed in brackets [XXX].

EXAMPLES

[Auxiliary Function]: Expresses the item “Auxiliary Function” in a menu. To select it, move the cursor to the relevant item by the arrow keys, and press the ↵ key. For detailed description, this procedure should be described every time, but “select [XXX] item” will be used instead for simpler expression.

CONTENTS

1.0 TYPES OF EXTERNAL I/O SIGNAL

When using a robot for various applications, some features may be required, such as an interlock system with peripheral equipment, a central control of HOLD/RUN, or a safety interlock. To enable control of these functions, external I/O (input/output) signals are used to communicate information to and from the peripheral equipment. External I/O signals can be classified into the following three types.

Hardware dedicated signal: A signal provided by the hardware system, whether or not to use it is selectable. This cannot be used as general purpose signal.

Software dedicated signal : A pre-defined signal provided by the software system, whether or not to use it is selectable. When used, general purpose signal must be assigned to replace the software dedicated signal. Software dedicated signals can be selected again when changing the system.

General purpose signal : A signal used freely during programming and teaching. I/O channels not assigned to software dedicated signals can be used as general purpose signals.

[NOTE]

The number of I/O channels is the sum of software dedicated signals and general purpose signals. This quantity should be taken into account when specifying the number of I/O signals.

⚠ WARNING

Software dedicated signals function after they are defined in the software. Safety interlocks must not be accomplished using only software. Use hardware based signals, such as limit switch, etc., for the safety circuit.

1.1 HARDWARE DEDICATED SIGNALS

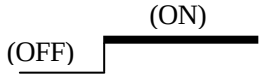
The hardware dedicated signals can be used mainly for external remote operation by changing the wiring in the hardware. They are connected to the terminal block on 1TR board. (See 2.0 Requirements for Connecting External I/O Signals.) The following 6 types of hardware dedicated signals are available:

Input: 1. External control power ON/OFF
2. External motor power ON
3. Safety circuit OFF
4. External HOLD

Output: 1. TEACH/REPEAT switch
2. Error occurrence

⚠ WARNING

Even if the External control power is turned OFF, power is still supplied to a part of controller. Be sure to shut OFF the main breaker when conducting maintenance or inspection.

External control power ON/OFF 	Input signal for turning control power ON externally. When +24 VDC is applied (contact closed), control power turns ON. When not applied (contact open), control power turns OFF. After turning the control power OFF, wait 2-3 seconds before turning it ON again.
External motor power ON 	Input signal for turning the motor power ON externally. When the contact is closed instantaneously (0.3-0.5 seconds), power turns ON. This signal is valid only when emergency stop, external motor power OFF, etc. are released and in error-free state.
Safety circuit OFF 	Input signal for turning the motor power OFF externally. When signal is open (contact open), motor power shuts OFF. The following 3 signals are available: Emergency stop, Safety fence input, and External trigger input.
External HOLD 	Input signal for temporarily stopping robot's repeat operation externally, only valid in repeat mode. When signal is open (contact open), robot cannot operate in repeat mode. When signal is opened during repeat mode, the robot stops immediately with cycle start remaining ON. When shorted again (contact close), robot resumes motion from the place where it stopped.
TEACH/REPEAT 	Contact output signal from TEACH/REPEAT switch on the operation panel. The contact is closed while teaching.
Error occurrence 	External output dedicated signal. The contact opens if error occurs in repeat mode.

[NOTE]

External motor power ON, Error occurrence output and TEACH/REPEAT output are also provided within the software dedicated signals. Use these signals as either hardware or software dedicated signals according to wiring conditions. (Both perform the same function.)

⚠ CAUTION

External HOLD is a function that stops the robot temporarily while the cycle start is ON in repeat mode. Robot motion suspends at the place where external HOLD is engaged, but the cycle start remains ON. Robot restarts motion from the same place when external HOLD is released.

1.2 SOFTWARE DEDICATED SIGNALS

⚠ WARNING

Software dedicated signals function after they are defined in the software. Safety interlocks must not be accomplished using only software. Use hardware based signals, such as limit switch, etc., for the safety circuit.

Once their initial settings have been made, software dedicated signals can be used for external remote control and interlock configurations. When a software dedicated signal is used, it occupies a portion of the general purpose signals in the system. Therefore, the number of general purpose signals decrease as the software dedicated signals are used. Although their electrical connection conditions are the same as that of general purpose signals, take note that they are different from hardware dedicated signals. The used software dedicated signals are connected to the connectors CN2 and CN4 on 1TW board as general purpose signals. (Refer to 2.0 Requirements for Connecting External I/O Signals.)

The software dedicated signals can be set as needed by:

1. Setting of software dedicated signals by Aux. function A-0601 and A-0602. (Refer to Operation Manual.)
2. DEFSIG command (Refer to AS Language Reference Manual.)

In addition, software dedicated signals specialized for each robot application are also available. (Refer to Appendix 6.0 Dedicated Signals Classified by Application.)

1.2.1 SOFTWARE DEDICATED INPUT SIGNALS

Signal Name	Function	Signal Type
External motor power ON (EXT. MOTOR ON)	Turns the motor power ON externally. (Functions in same way as the MOTOR ON key.)	
External error reset (EXT. ERROR RESET)	Resets errors externally. (Functions in same way as the <ERROR RESET> key.)	
External cycle start (EXT. CYCLE START)	Sets the cycle start externally. (Functions in same way as the CYCLE START key.)	
External program reset (EXT. PROGRAM RESET)	Resets program externally. Input of this signal during automatic operation stops cycle operation and resets to the first step of the main program. When RPS (external program selection) mode is set effective, the RPSxx signals that were set when this signal is input are imported and program step is reset to the first step of the program specified by RPSxx signals. (Refer to Appendix 2.)	
RPS-ON	Enables switching to another program specified by the external program number at the step where the aux. data of END is taught. (Refer to Appendix 2.)	
JUMP-ON	Enables switching to another program specified by the external program number at the step where aux. data of JUMP is taught. (Refer to Appendix 2.)	
JUMP-OFF	Disables switching to another program specified by the external program number at the step where aux. data of JUMP is taught. (Refer to Appendix 2.)	
External program number (RPSxx)	Sets up program number externally. The maximum program number specified by RPSxx signals varies with specification. (Refer to Appendix 2.)	
External HOLD (EXT_IT)	Stops robot temporarily in repeat mode. (Valid in repeat mode only.) When this signal circuit is open, robot does not operate in repeat mode. When this signal circuit opens during repeat mode, robot stops immediately and cycle start stays ON. When this signal circuit closes, robot resumes operation from the place where it stopped.	

Signal Name	Function	Signal Type
External slow repeat (EXT. SLOW REPEAT MODE)	Decreases repeat speed temporarily and externally. The speed is set by Aux. function A-0508. (Refer to Operation Manual.)	
I/F panel page N selection (I/F PANEL PAGE N SELECT)	Displays the I/F panel on TP. The corresponding I/F panel page is displayed when this signal is input.	
Auto save condition N (AUTOSAVE COND. N)	Backs up robot data. The corresponding data is saved based on the set condition when this signal is input. Auto save conditions are set in A-210. (Refer to the Operation Manual.)	
External PC program N start (External PC Program N start)	Executes a PC program. Names of PC programs executed by these signals are fixed. External PC program 1 start signal executes the PC program, "ZZEXTPC". External PC program 2 to 5 start signal executes "ZZEXTPC2" to "ZZEXTPC5", respectively.	
External PC program N abortion (External PC Program N abort)	Aborts a PC program. When each signal is input, system aborts the PC program corresponding to the signal number.	
External motor power OFF (EXT. MOTOR OFF)	Turns OFF the motor power externally. Motor power turns OFF when the contact closes. Do not use this signal to turn OFF the motor power under the condition on safety such as emergency stop, because this signal is processed only on the software.	

⚠ CAUTION

Signal types indicated by "" or "" must be set precisely for duration of 0.3-0.5 seconds. If the signal is too short, it may not be recognized. Also, do not leave ON the External motor power ON signal. When left ON and E-STOP is applied, the stop is effective only while E-STOP state is kept, and once released the motor power is reapplied immediately.

Explanation of Signal Type

 : Leading edge is detected. Recommended for Pulse signals.

 : Trailing edge is detected. Recommended for Pulse signals.

 : Leading edge is detected.

 : Level is detected.

1.2.2 SOFTWARE DEDICATED OUTPUT SIGNALS

Signal Name	Function	Signal Type
Motor power ON (MOTOR ON)	Indicates that the motor power is ON. Functions in same way as the MOTOR POWER lamp on TP.	
Error occurrence (ERROR)	Indicates that an error occurred. (Functions in same way as the ERROR display on TP.)	
Automatic (AUTOMATIC)	Indicates that all the conditions set in Aux. function A-0602 in respect to the following items are satisfied when the robot is operable or in automatic operation. 1. Panel switch in RUN. 2. EXT_IT not set to hold. 3. Panel switch in REPEAT. 4. Repeat continuous 5. Step continuous. 6. TEACH LOCK OFF. 7. CYCLE START ON. 8. RGSO ON. 9. Dryrun mode OFF.	
Cycle start (CYCLE START)	Indicates that the robot is in automatic operation (in cycle operation). Functions in same way as the CYCLE START lamp on TP.	
Teach mode (TEACH MODE)	Indicates robot is in teach mode. (TEACH/REPEAT switch is turned to TEACH on operation panel.) Functions in same way as the output from the TEACH/REPEAT switch in the hardware dedicated signals.	
Home pose 1 (HOME1)	Indicates robot is at the preset home pose 1. (Refer to Appendix 3.0.)	
Home pose 2 (HOME2)	Indicates robot is at the preset home pose 2. (Refer to Appendix 3.0.)	
Power ON (POWER ON)	Indicates controller power is ON. Functions in same way as the CONTROL POWER lamp on operation panel.	
RGSO	Is output when motor brake is released and robot is in the servoing condition.	
External program selection effective (Ext. prog. select (RPS) enabled.)	Is output when the external program selection mode is set effective (RPS effective). (Refer to Appendix 2.0.)	

Signal Name	Function	Signal Type
RPS-ST	Indicates robot is ready to switch to the external program number at the step where auxiliary data of END is taught. (Refer to Appendix 2.0.)	
JUMP-ST	Indicates robot is ready to switch to the external program number at the step where auxiliary data of JUMP is taught. (Refer to Appendix 2.0.)	
Program number (Program number)	The selected program number (xx part of pgxx) is output.	
Step number (Step number)	The step number of currently selected program is output.	
Teach lock ON (TEACH LOCK ON)	Is output when teach lock is ON.	
Auto save warning (AUTO SAVE WARNING)	Is output when an error occurs during auto saving.	
Servo ready (SERVO READY STATUS)	Is output in teach mode when servo system is neither in error nor in emergency stop.	
In PC program execution (External PC program executing)	Is output when a PC program is being executed.	
Emergency stop (Under emergency stop)	Is output in emergency stop.	
Dry run (Executing dry run)	Is output in dry run mode.	
Hold (Hold mode)	Is output in hold mode (including external hold).	
Safety fence open (Safety fence opened)	Is output when safety fence is open in repeat mode.	

1.3 GENERAL PURPOSE I/O SIGNALS

The general purpose I/O signals are assigned by block teaching or AS language programming. Signals are then output to ports or input from ports when executing the program in repeat mode. They are connected to connectors CN2 and CN4 on 1TW board. (Refer to 2.0 Requirements for Connecting External I/O Signals.)

In terms of hardware configuration, the general purpose I/O signals are the same as software dedicated signals. Software dedicated signals are defined in advance and used for condition output, remote operation, and dedicated functions. General purpose signals are used freely depending on each robot application.

⚠ WARNING

Avoid using only a general purpose signal for safety interlock.

⚠ CAUTION

When assigning general purpose signal numbers and functions, ensure that they are not duplicates of those previously assigned as hardware or software dedicated signals, or other general purpose signals. If duplicate assignments are made, the conflict may cause the controller to function unpredictably.

1.3.1 TYPES OF GENERAL PURPOSE SIGNALS

There are two types of general purpose I/O signals, signals for communicating externally and signals that can only be used internally. This manual describes only external I/O signals. For internal I/O signals, see AS Language Reference Manual.

For the E series controller, external I/O signals can be increased in increments of 32 channels. They contain both general purpose and software dedicated signals. When determining the system, take into account that the software dedicated signals occupy a portion of the total external I/O signal quantity.

[NOTE]

Expansion of external I/O signals is made in increments of 32 input and 32 output channels. The channel quantities for input and output are the same due to the hardware structure.

1.3.2 I/O TIMING OF GENERAL PURPOSE SIGNALS

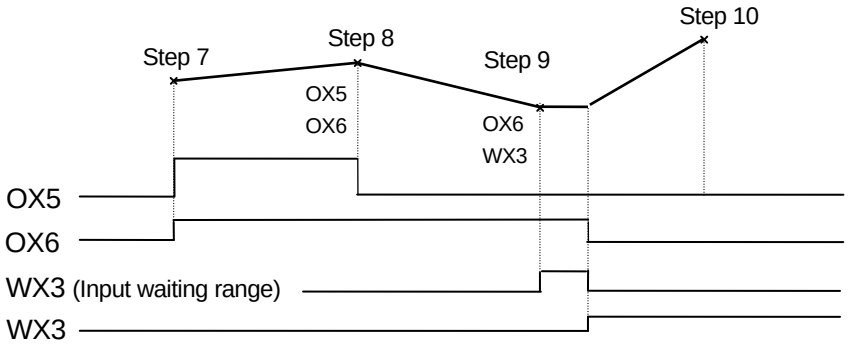
Teaching procedure for general purpose signals is different for block teaching and AS language programming. Fully understand the I/O timing of general purpose signals before using.

1.3.2.1 I/O TIMING THROUGH TEACHING

In block teaching, the information below is taught together all at once in each step using teach pendant.

1. Pose data of robot arm
2. Auxiliary data (Interpolation, speed, accuracy, clamp, tool and general purpose I/O (OX/WX) signal)

The general purpose signals taught in block teaching are called OX (output) and WX (input) signals. The timing of OX and WX when executing a program taught by block teaching is shown in the example below.



System Switch OX.PREOUT ON

If OX5 is taught in step 8:

1. When robot reaches the accuracy range of step 7 and starts to approach the taught point of step 8, OX5 turns ON.
2. When robot reaches the accuracy range of step 8 and starts moving toward the taught point of step 9, OX5 turns OFF because it is not taught in step 9.

If OX6 is taught in steps 8 and 9:

1. When robot reaches the accuracy range of step 7 and starts to approach the taught point of step 8, OX6 turns ON.
2. When robot reaches the accuracy range of step 8 and starts moving toward the taught point of step 9, OX6 remains ON because it is taught in step 9.

3. Normally, upon reaching the accuracy range of step 9, the robot starts to approach the taught point of step 10 and OX6 is turned OFF immediately (because OX6 is not taught in step 10). In this example, however, the controller waits for input of WX3, because WX3 is taught in step 9. Step 9 does not switch to 10 until WX3 is input.
4. When WX3 is input, the step switches to 10 and OX6 turns OFF.

If WX3 is taught in step 9:

1. When robot reaches the accuracy range of step 9, it checks for WX3 input.
2. When WX3 has been input, robot moves to the taught point of step 10. If not yet, the robot keeps waiting at step 9 until it is input.

⚠ CAUTION

1. OX signals turn OFF when robot stops due to: motor power OFF, cycle start OFF or HOLD. The OX signals turn ON again after restarting.

2. Switching from one step to the next occurs when the robot reaches a taught step, but the switching does not always coincide with the taught point. It depends on accuracy data of the taught step. The more accurately it is set, the closer the switching point will be to the taught point. The rougher it is set, the earlier the step switches. Therefore, note that the timings of input and output change depending on the accuracy range taught at that step.

1.3.2.2 I/O TIMING THROUGH AS PROGRAMMING

Besides block teaching (OX and WX signals) described above, general purpose I/O signals can also be taught by programming via AS Language. By programming with this method, general purpose I/O signals have a much wider application scope than OX and WX signals and can be used in various ways. The following list of instructions is used for controlling general purpose I/O signals. See AS Language Reference Manual for more details.

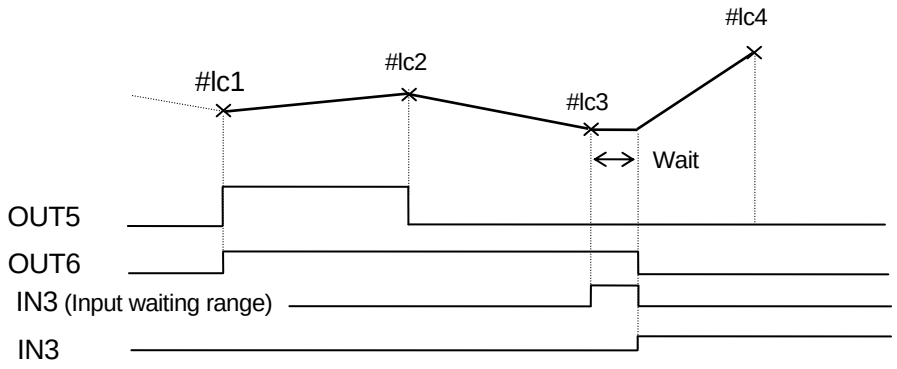
	Instruction	Function
Output signal control	SIGNAL	Turns ON/OFF the general purpose output signals (individual)
	BITS	Turns ON/OFF the general purpose output signals (in a group)
	RESET	Turns OFF the general purpose output signals (effects all the signals)
	RUNMASK	Controls the general purpose output signals at robot stop
	PULSE	Pulse output for the general purpose output signals
	DLYSIG	Delayed output for the general purpose output signals

	Instruction	Function
Input signal control	SWAIT	Waits until conditions for the general purpose input signals are satisfied.
	SIG( )	Determines if conditions are satisfied for the general purpose input signals.
	BITS( )	Reads the general purpose input signals specified by its parameters.
	ON/ONI	Interrupts program execution upon receiving the general purpose input signals.

The timing of general purpose I/O signals when programming with AS Language is shown in the example below. (Assuming that the system switch is OFF for PREFETCH. SIGINS.)

Program example:

```
11  JMOVE #lc1
12  SIGNAL 5,6
13  JMOVE #lc2
14  SIGNAL -5
15  JMOVE #lc3
16  SWAIT 1003
17  SIGNAL -6
18  JMOVE #lc4
```



System Switch PREFETCH. SIGINS OFF

The above timing chart is valid when accuracy for positioning (a value specified by ACCURACY instruction) is programmed to be precise. If the accuracy is rough, transitions occur before the robot reaches the actual taught point.

OUT5:

1. General purpose output signal (OUT5) turns ON when robot starts moving to #1c2.
2. After robot reaches #lc2 and the robot starts moving to #lc3, OUT5 turns OFF.

OUT6:

1. General purpose output signal (OUT6) turns ON when the robot moves to #1c2.
2. After reaching #lc2, robot starts moving to #lc3. OUT6 remains ON.
3. General purpose output signal (OUT6) turns OFF when robot moves to #1c4.

IN3:

1. Robot starts monitoring the general purpose input signal (IN3) once it starts moving to # lc3.
2. Robot waits because IN3 is not ON in this example when reaching #1c3.

3. Robot moves to #lc4 when IN3 turns ON. If IN3 is ON after robot has started signal monitoring but before arriving at #1c3, then the monitoring is disabled immediately and the robot moves to #1c4 without waiting.

⚠ CAUTION

Generally, OUT signals do not turn OFF when the robot stops due to motor power OFF or HOLD, unlike OX signals. If defined by RUNMASK instruction, OUT signals will function like OX signals, turning OFF when program execution is interrupted.

2.0 REQUIREMENTS FOR CONNECTING EXTERNAL I/O SIGNALS

Requirements for connecting external I/O signals differ for hardware signals and general purpose I/O signals (including software dedicated signals).

2.1 HARDWARE DEDICATED SIGNALS

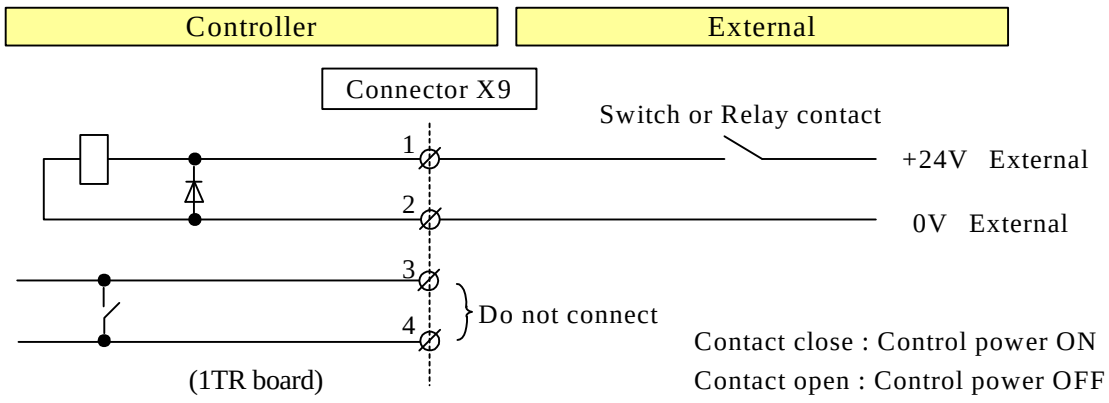
When using the hardware dedicated signals, connect them to the terminal block on 1TR board and comply with the requirements below.

2.1.1 EXTERNAL CONTROL POWER ON/OFF

This input signal turns the DC power supply (AVR) for the controller ON/OFF externally.

1. When using external control power ON/OFF

Leave the connection between pins 3 and 4 open and apply +24 V to pin 1 and 0 V to pin 2 of terminal block connector X9 on 1TR board. Connect pins 1-4 of connector X9 as shown in figure below.



CAUTION

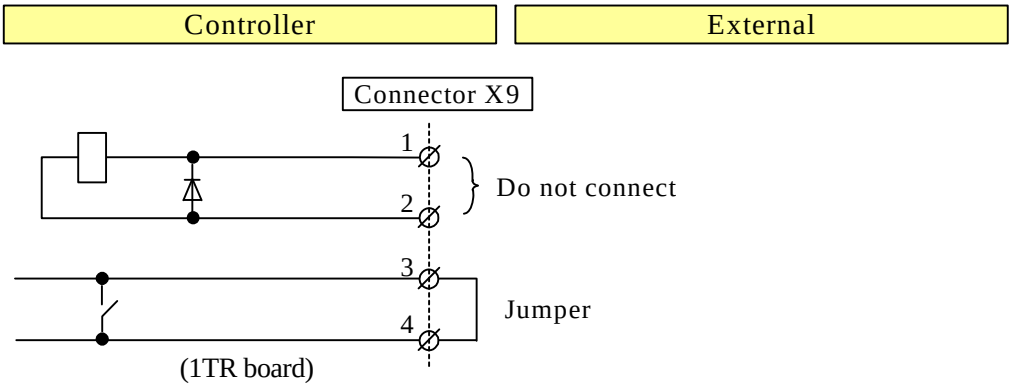
1. **Take caution when connecting pins 1 and 2 of connector X9. If connected incorrectly, damage to the 1TR board or external power supply may occur.**
2. **Error "D1560 [Power sequence board] DC 24V is abnormal." occurs when DC power is turned OFF by this input but this is not abnormal.**

CAUTION

1. Use a switch or relay contact that meets the following specifications:
Contact power capacity: DC24 V 0.2 A or more
(Relay coil specification DC24 V 10 mA ±20 %)
Power supply : DC24 V ±10 %
(Connect 0 V side to the ground.)
2. An interval of 2–3 seconds is required between the time when control power is turned OFF (contact open) to ON (contact close).
3. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.

2. When not using external control power ON/OFF

Connect pins 1-4 of terminal block connector X9 on 1TR board as shown below.



CAUTION

Pins 3 and 4 of connector X9 are jumpered when controller is factory shipped. When using external control power ON/OFF, make sure that the jumper is removed and connection to the connector X9 is configured as shown in the previous page.

2.1.2 EXTERNAL MOTOR POWER ON

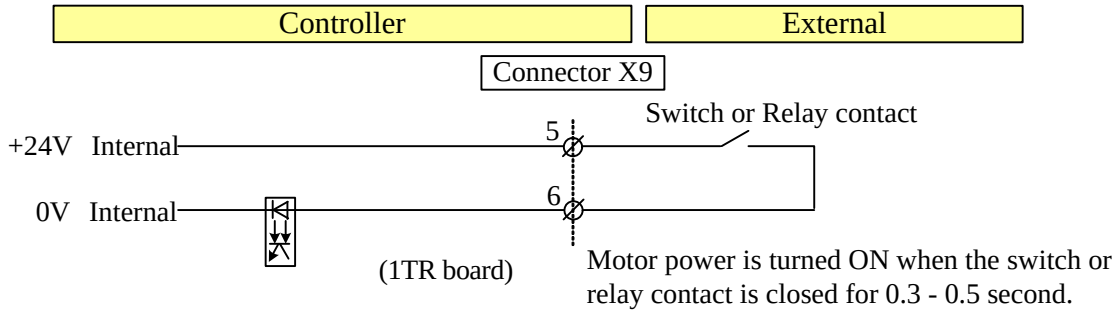
This input signal turns the motor power ON externally and has the same function as the MOTOR ON key.

⚠ WARNING

Never leave ON the External motor power ON signal (contact close). If left ON the robot may move unexpectedly, for example after an emergency stop is released.

1. When using external motor power ON

To turn ON the motor power, close connection between pins 5 and 6 of terminal block connector X9 on 1TR board. Connect a switch or relay contact between pins 5 and 6 of connector X9. Use a pulse input signal as the contact must not remain closed.



⚠ CAUTION

1. Use a switch or relay contact that meets the following specifications:
Contact power capacity: DC24 V 0.2 A or more
2. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.

2. When not using external motor power ON

Open connection between pins 5 and 6 of terminal block connector X9 on 1TR board and do not connect any wiring to them.

2.1.3 SAFETY CIRCUIT OFF

This input signal shuts OFF the motor power externally. When this signal circuit opens, motor power is shut OFF. The following 3 types of input signals are available for safety circuit.

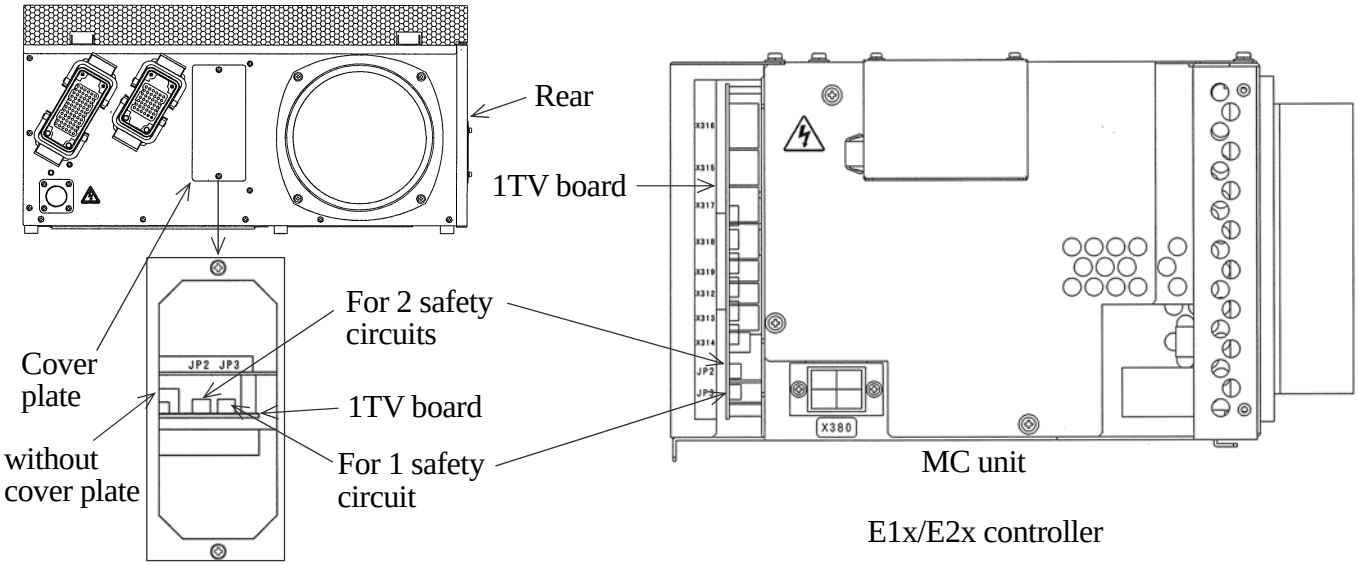
1. External emergency stop (Valid in teach and repeat mode.)
2. Safety fence input (Valid only in repeat mode.)
3. External trigger input (Valid only in teach mode.)

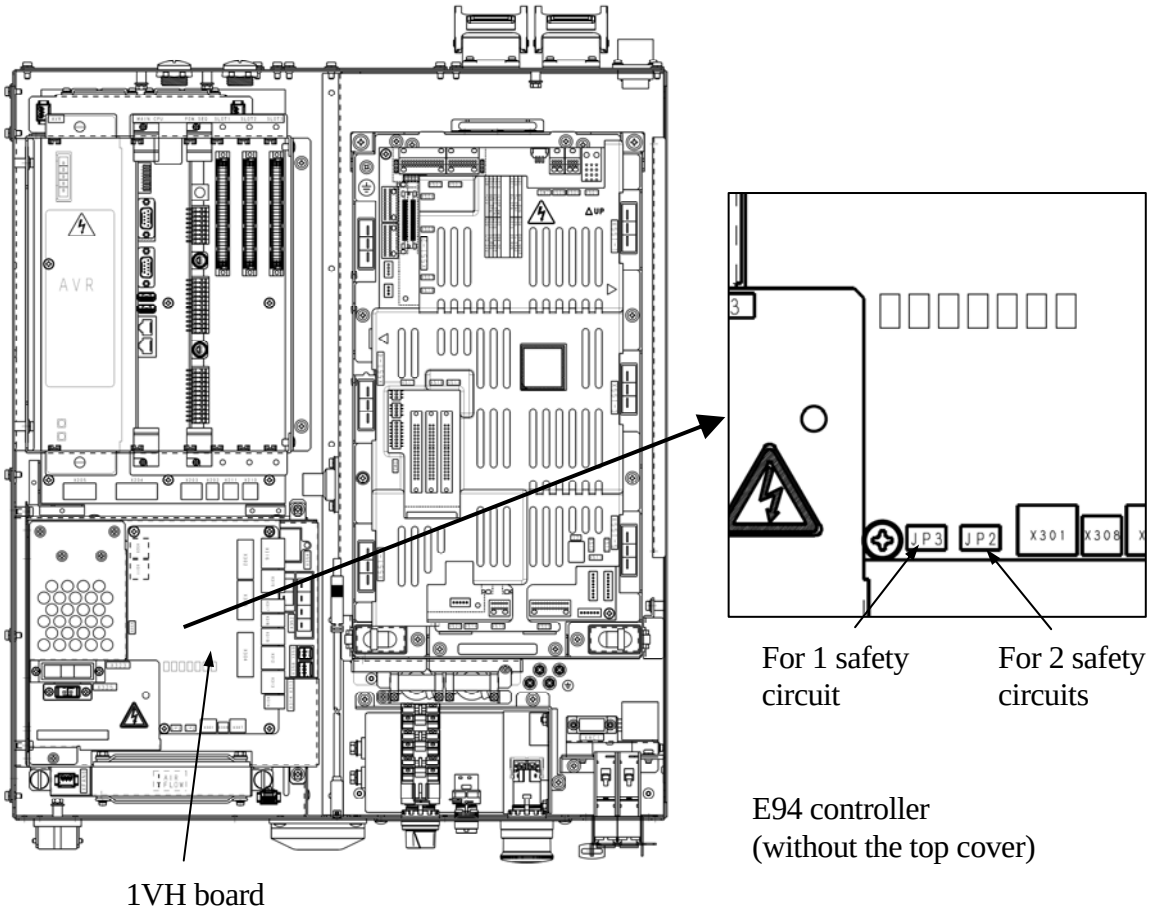
⚠ WARNING

The Safety circuit OFF needs to be designed based on IEC60204-1, ISO10218 and ISO13849-1, because its function and operation is very important for human safety. Safety circuit of E3x/E76/E77/E97 and E4x/E70/E71/E91/E94 controllers and safety circuit of E1x/E2x/E73/E74 controller satisfy requirements of PLd in category 3 and requirements of PLc in category 2 defined by ISO 13849-1:2006, respectively. (When E1x/E2x/E73/E74/E94 controller is configured with one safety circuit as shown below, the safety circuit does not satisfy the requirements of PL in above category. Optional safety circuit of E1x/E2x/E73/E74 controller also supports PLd in category 3.) When constructing the comprehensive safety system including robot, conduct risk assessments and make sure that safety circuit of the controller satisfies performance requirements.

2 safety circuits are provided on this controller. E1x/E2x/E73/E74/E94 controller can be configured with only one safety circuit, however, it should be configured with 2 safety circuits unless there is some particular reason. When using only one safety circuit, make the settings as shown below. E3x/E76/E77/E97 and E4x/E70/E71/E91 controllers cannot be configured with only one circuit.

Item	Setting
1. Dip switch SW2-1 on 1TR board	ON
2. Jumper, JP2 or JP3 on 1TV board (MC unit) or 1VH board	Insert the jumper into JP3 with JP2 open


Rear
1TV board
For 2 safety circuits
Cover plate
1TV board
without cover plate
For 1 safety circuit
JP2 JP3
X380
MC unit
E1x/E2x controller
E73/E74 controller


AVR
JP3
JP2
X301
X308
For 1 safety circuit
For 2 safety circuits
E94 controller
(without the top cover)
1VH board

⚠ WARNING

E1x/E2x/E73/E74/E94 controller should be configured with 2 safety circuits unless there is some particular reason. When using the E1x/E2x/E73/E74/E94 controller with 1 safety circuit, conduct enough risk assessments before using it.

⚠ CAUTION

Turn OFF the controller power when switching the safety circuit configuration.

[**NOTE**]

The following errors may occur in the safety circuit construction. When error occurs, perform the appropriate troubleshooting as shown below.

Error	Countermeasure
Inconsistent condition in safety circuit	Check the wiring of terminal block connector (X7, X8) and the inconsistent part indicated in the error message. To reset error, both contacts of the inconsistent part must be turned OFF once. (This error only occurs when using 2 safety circuits.)
Fuse blowout in safety circuit	F1 fuse (1 A) on 1TR board is blown out. Check if the connection to safety circuit (connector X7, X8) is correct, and replace the fuse.

2.1.3.1 EXTERNAL EMERGENCY STOP

This has the same function as the EMERGENCY STOP switch on the operation panel.

⚠ WARNING

1. Use a contact circuit (mechanical contact) for turning external E-STOP ON/OFF. Using a semiconductor circuit is extremely dangerous as shut OFF of the motor power may become inoperable if there is a system failure.
2. Never jumper pins 2-4 and 6-8 of X7 connector. Jumpering these pins disables E-STOP switches on the operation panel, teach pendant and on external E-STOP safety circuit, and robot will not stop when E-STOP switches are
3. Use external E-STOP switches that meet the following specifications:
(1) Contact power capacity: DC24 V 1 A or more
(2) Conformance with safety standards
(3) Positive opening mechanism (marked with ⊖)
(4) NC (Normally Closed) contact
(5) 2 contacts or more (for 2 safety circuits)

WARNING

4. Use an external E-STOP circuit relay that meets the following specifications:
(1) Contact power capacity: DC24 V 1 A or more
(2) Conformance with safety standards
(Do not use general control relay as it may not satisfy the safety standards.)
(3) Forced-guided type
5. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.
6. Connect 0 V External to the ground.

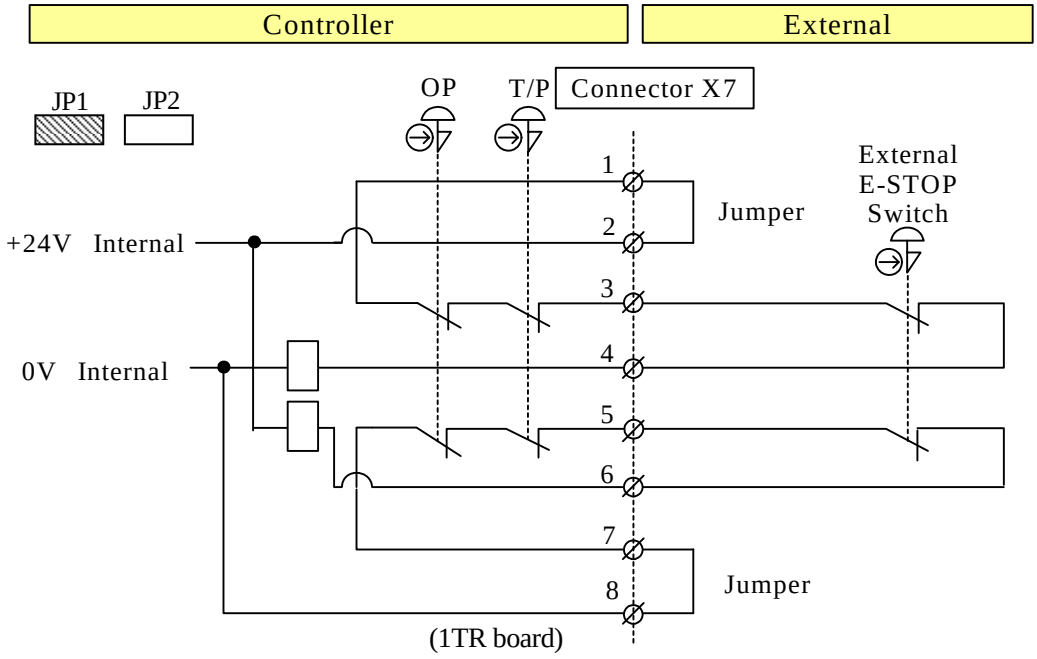
[**NOTE**]

When using Cubic S, X7 connector is connected with Cubic-S and connect external emergency stop signal to the Cubic-S. See 90210-1272DE* for details.

1. When using external emergency stop

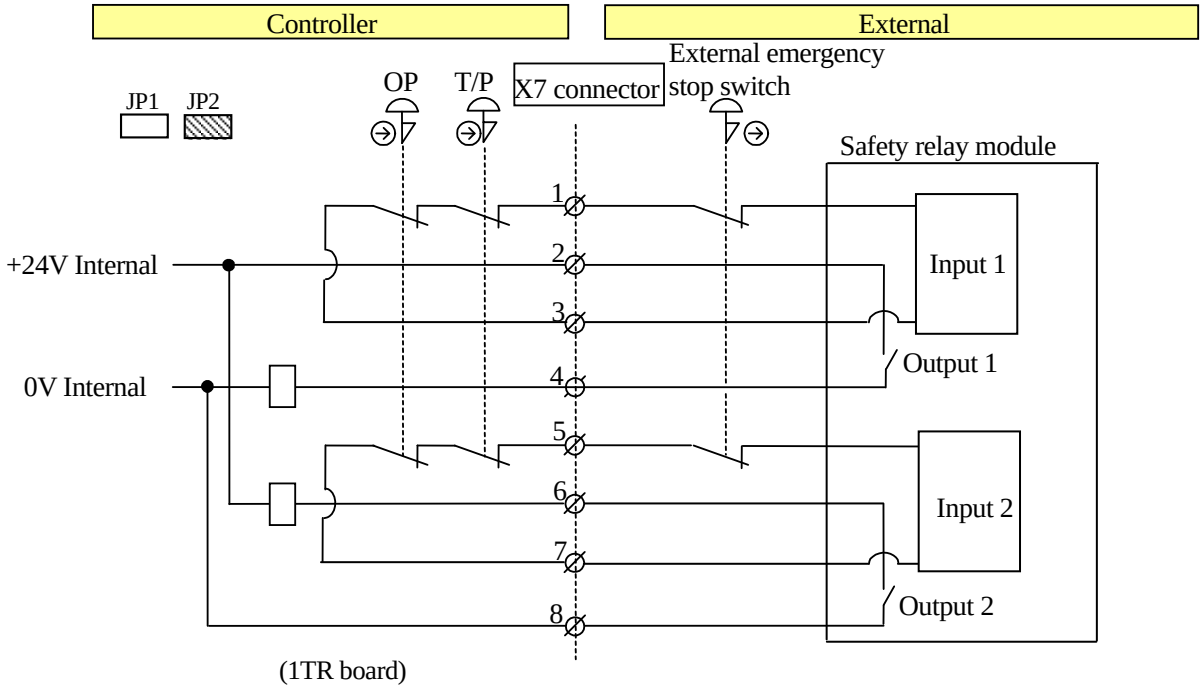
(1) For connecting external switch contact directly in two safety circuits

Remove jumpers between pins 3-4 and 5-6 of terminal block connector X7 on 1TR board, and connect emergency stop switch contacts as shown below. Jumper pins 1-2 and 7-8. Also, set jumper to the JP1 pins on 1TR board.



(2) For configuring 2 external safety circuits with external emergency stop input and emergency stop contacts taken out from the controller

On connector X7, remove all jumpers from pins 1-2, 3-4, 5-6, and 7-8. Take out the emergency stop contacts connected between pins 1-3, 5-7 from the controller. Also, set jumper to the JP2 pins on 1TR board. Connect external stop contacts to pins 2-4, 6-8 on connector X7.

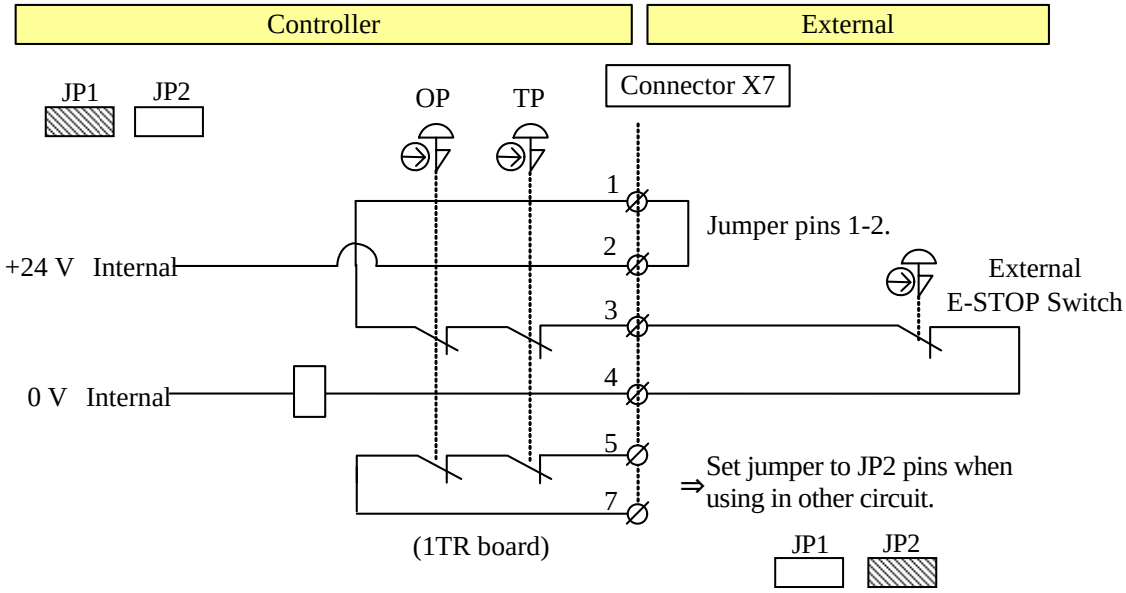


WARNING

Set jumper to the JP2 pins on 1TR board when taking out the emergency stop switch contacts from the controller. If the jumper is set to the JP1 pins, circuits for emergency stop monitor may exert a harmful influence on external circuits.

(3) When connecting external switch contact directly in one safety circuit (E1x/E2x/E73/E74/E94 controller only)

Remove jumper between pins 3-4 of terminal block connector X7 on 1TR board and connect external emergency stop switch contact as shown below. Jumper pins 1-2. Also, set jumper to the JP1 pins on 1TR board.



WARNING

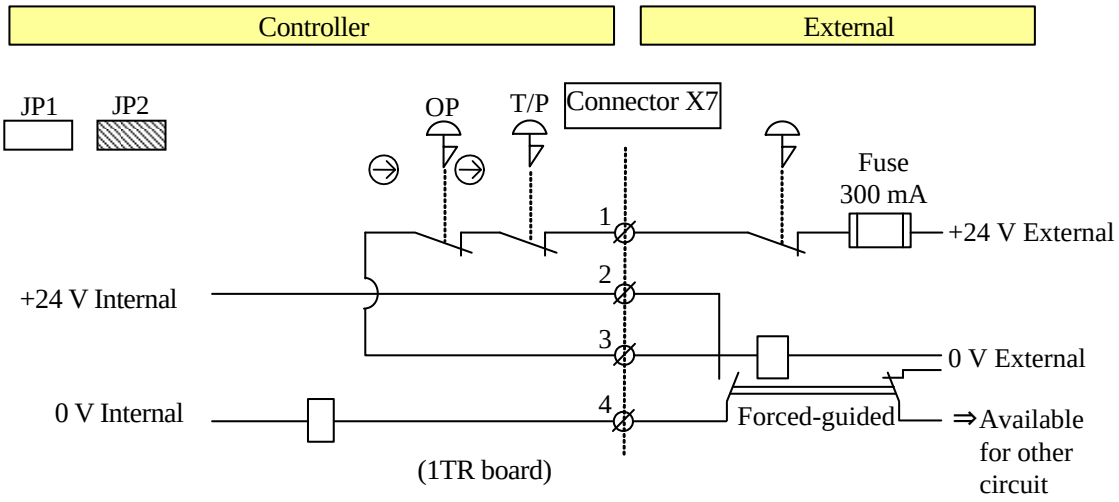
Set jumper to the JP2 pins on 1TR board when removing the emergency stop switch contacts from the controller. If the jumper is set to the JP1 pins, circuits for emergency stop monitor may exert a harmful influence on external circuits.

[**NOTE**]

When using in one safety circuit, the setting in 2.1.3 is required.

(4) For configuring one external safety circuit with external emergency stop input and emergency stop contacts taken out from the controller (E1x/E2x/E73/E74/E94 controller only)

Remove jumpers between pins 1-2 and 3-4 of terminal block connector X7 on 1TR board. Take out the emergency stop contacts connected between pins 1-3 from the controller. Also, set jumper to the JP2 pins on 1TR board. Connect external emergency stop contacts to pins 2-4 on connector X7.



WARNING

Set jumper to the JP2 pins on 1TR board when taking out the emergency stop switch contacts from the controller. If the jumper is set to the JP1 pins, circuits for emergency stop monitor may exert a harmful influence on external circuits.

DANGER

Use only a jumper or mechanical contact circuit independent of other circuits in external wiring. Connecting common line for a battery or other circuits is very dangerous as formation of bypass circuit in the power supply may disable the E-STOP switch.

[NOTE]

When using in one safety circuit, the setting in 2.1.3 is required.

2. When not using external emergency stop

Jumper pins 1-2, 3-4, 5-6, and 7-8 of terminal block connector X7 on 1TR board.

2.1.3.2 SAFETY FENCE INPUT

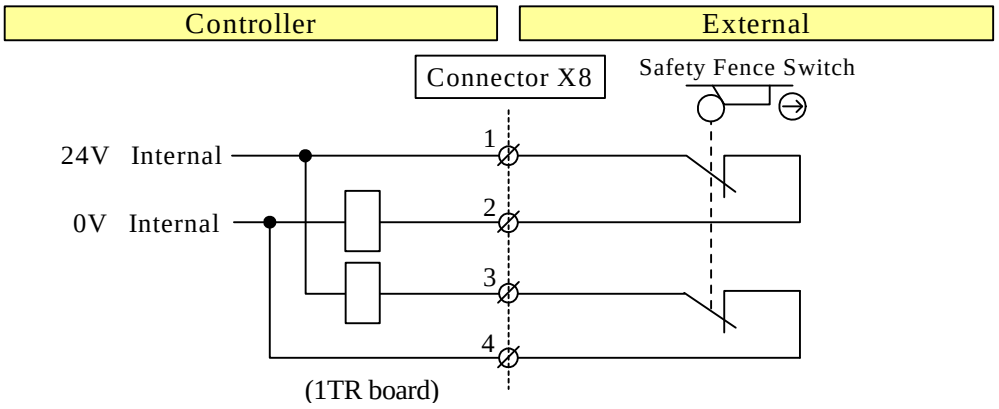
This input signal is valid only in repeat mode.

WARNING

1. Use a switch for safety fence that meets the following specifications:
(1) Contact power capacity: DC24 V 1 A or more
(2) Conformance with safety standards
(3) Positive opening mechanism (marked with ⊖)
(4) NC (Normally Closed) contact
(5) 2 contacts or more (for 2 safety circuits)
2. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.

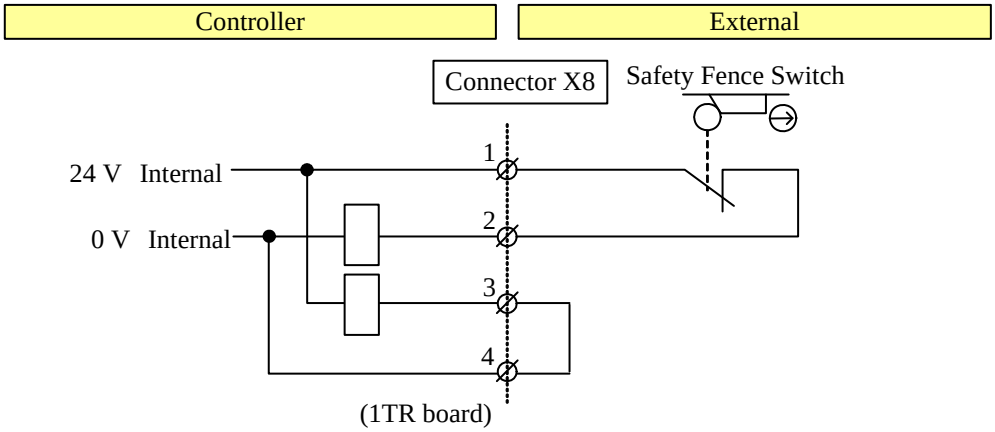
1. Using safety fence input in two safety circuits

Remove jumpers between pins 1-2 and 3-4 of terminal block connector X8 on 1TR board and connect switch contacts for safety fence as shown below.



2. Using safety fence input in one safety circuit (E1x/E2x/E73/E74/E94 controller only)

Remove jumper between pins 1-2 of terminal block connector X8 on 1TR board and connect switch contact for safety fence as shown below.



[NOTE]

When using in one safety circuit, the setting in 2.1.3 is required.

2.1.3.3 EXTERNAL TRIGGER INPUT

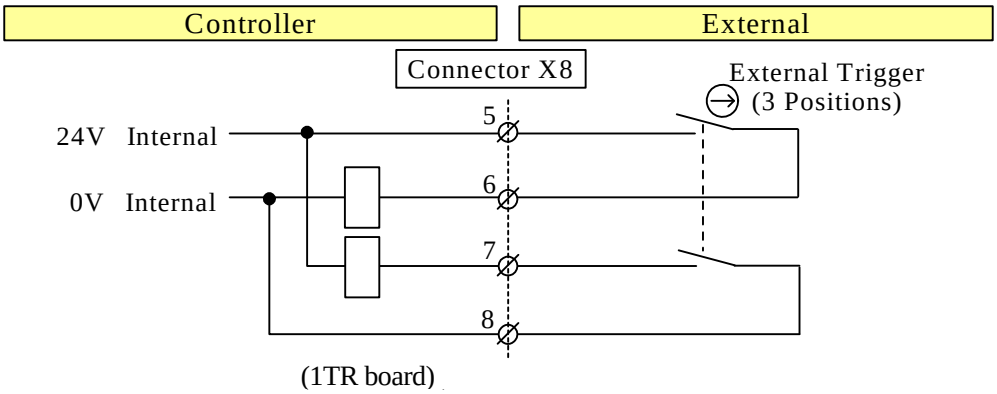
This input signal is valid only in teach mode.

WARNING

1. Use a switch for external trigger that meets the following specifications:
(1) Contact power capacity: DC24 V 1 A or more
(2) Conformance with safety standards
(3) Positive opening mechanism (marked with ⊖)
(4) 3-position type
(5) 2 contacts or more (for 2 safety circuits)
2. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.

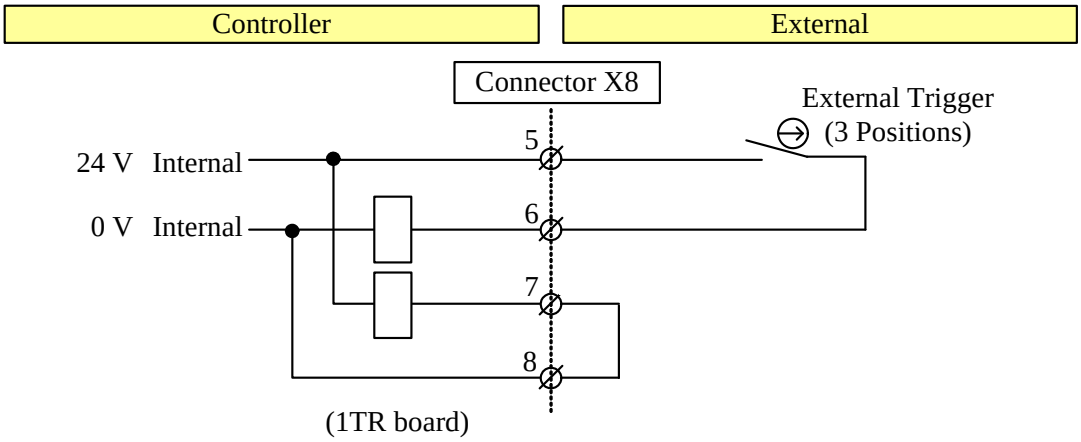
1. Using external trigger in two safety circuits

Remove jumpers between pins 5-6 and 7-8 of terminal block connector X8 on 1TR board and connect external trigger contacts as shown below.



2. Using external trigger in one safety circuit (E1x/E2x/E73/E74/E94 controller only)

Remove jumper between pins 5-6 of terminal block connector X8 on 1TR board and connect switch contacts for external trigger. Jumper pins 7-8.



[NOTE]

When using in one safety circuit, the setting in 2.1.3 is required.

3. When not using external trigger

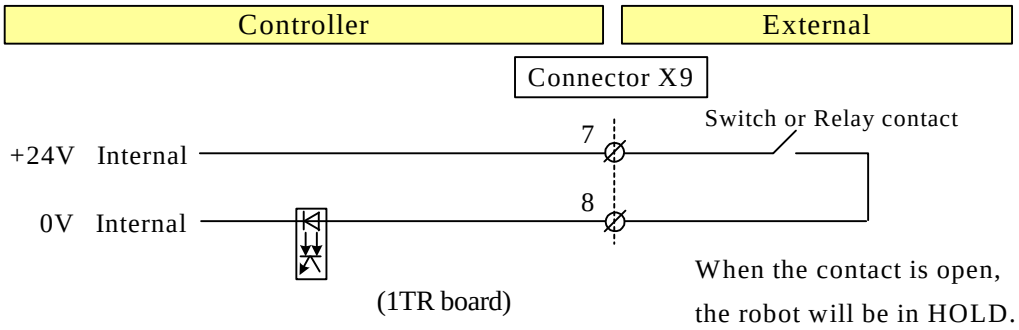
Jumper pins 5-6 and 7-8 of terminal block connector X8 on 1TR board.

2.1.4 EXTERNAL HOLD

This input signal temporarily holds the robot's repeat operation externally and is valid only in repeat mode.

1. Using external HOLD

Remove jumper between pins 7-8 of terminal block connector X9 on 1TR board and connect a contact for external hold as shown below. Robot will be in HOLD by opening this contact.



CAUTION

1. Use a switch or relay contact that meets the following specifications:
Contact power capacity: DC24 V 0.2 A or more
2. Use 22-24 AWG (0.2-0.3 mm^2) for the connector wiring material.

2. When not using external HOLD

Jumper pins 7-8 of terminal block connector X9 on 1TR board.

[NOTE]

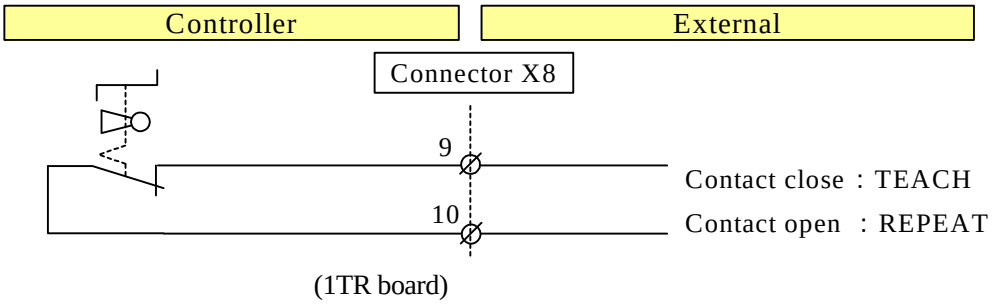
When using in one safety circuit, the setting in 2.1.3 is required.

2.1.5 TEACH/REPEAT OUTPUT

This contact output signal indicates the state of the TEACH/REPEAT switch on the operation panel.

1. Using TEACH/REPEAT output

This signal is output from pins 9-10 of terminal block connector X8 on 1TR board.



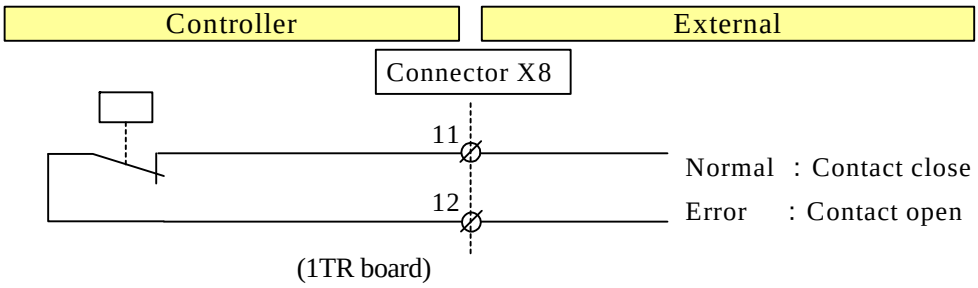
CAUTION

Do not connect a device that exceeds the load specification.
Contact specification: DC24 V 0.1 A or less

2.1.6 ERROR OCCURRENCE OUTPUT

A contact that outputs the error occurrence externally is provided between pins 11 and 12 of terminal block connector X8 on 1TR board.

1. Using error occurrence output



2.2 GENERAL PURPOSE I/O SIGNALS

All general purpose I/O signals (including software dedicated signals) are processed by 1TW board in controller. Refer to Appendix 7. for pin assignments. And refer to E series Controller Installation and Connection Manual for wiring harness connector type.

⚠ CAUTION

There are 2 types of 1TW boards to deal with difference in I/O common specifications: SINK/NPN spec. and SOURCE/PNP spec. Ensure that the correct board is installed before using.

2.2.1 EXTERNAL INPUT SIGNALS (External → Robot)

1TW board has 32 input circuits. There are two common connection pins (pins 18 and 19 of CN4) to which +24 V is supplied from outside for SINK/NPN spec and to which 0 V is supplied from outside for SOURCE/PNP spec. Each common supplies power to 16 circuits connected to pins 1-16 and 20-35 of CN4, respectively. External input signals are connected to these pins.

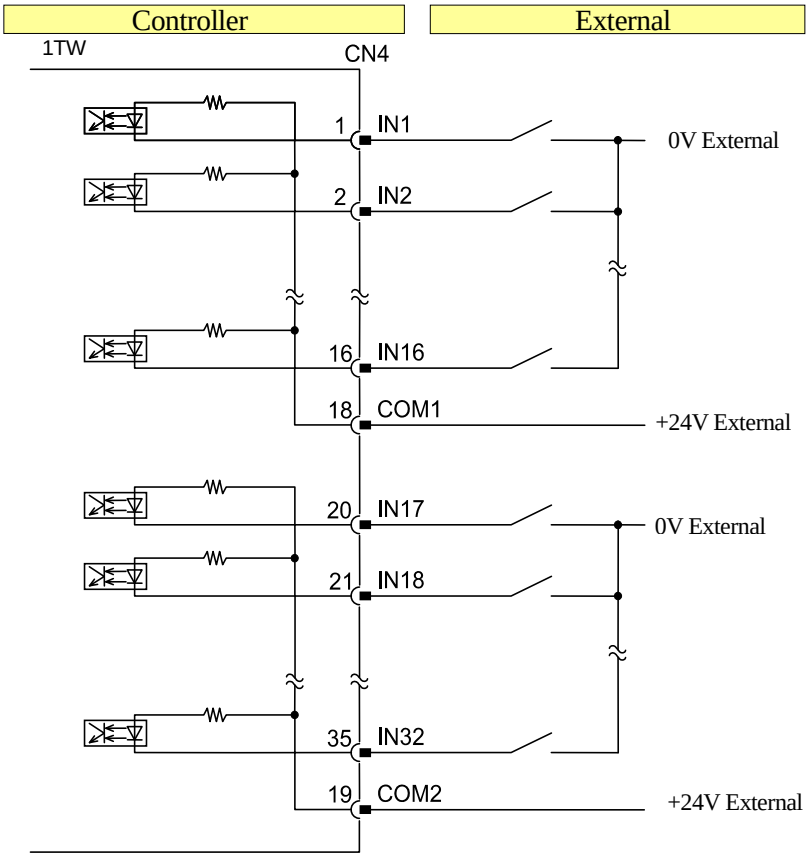
Input specifications:

Number of circuits: 32
Input type : Photo coupler input
Input voltage : DC24 V ±10 %
Input current : 10 mA
Connector type : 37-pin D-Sub connector

⚠ CAUTION

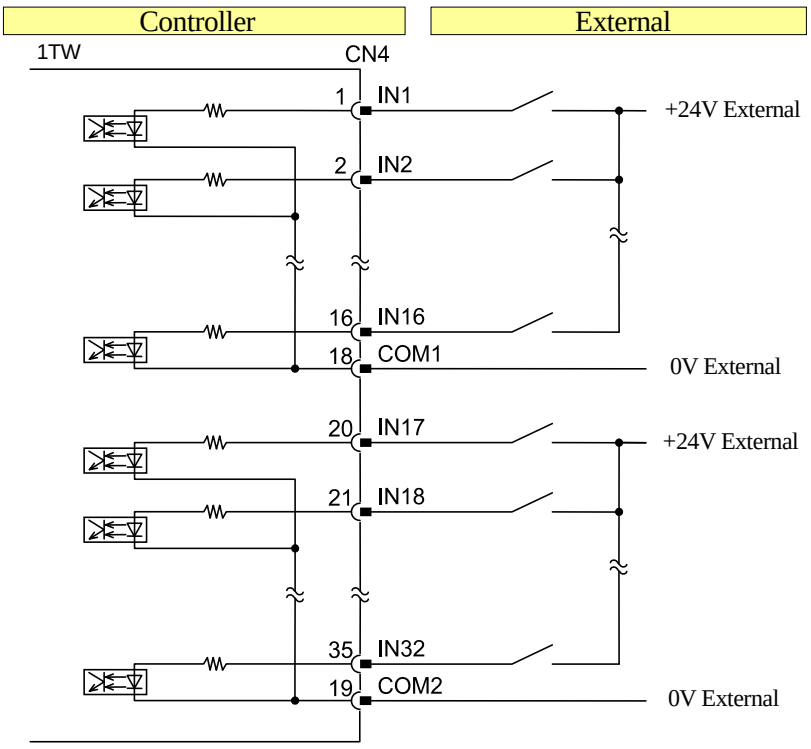
Ensure that the polarity of the external DC24 V power supply is correct. If incorrectly connected, damage to 1TW board, power source and contacts may occur.

1TW (SINK/NPN spec.)



General purpose input signal - 1TW (SINK/NPN)

1TW (SOURCE/PNP spec.)



General purpose input signal – 1TW (SOURCE/PNP)

2.2.2 EXTERNAL OUTPUT SIGNALS (Robot → External)

External +24 V power is supplied to the output circuit via pins 18 and 19 of CN2. 0 V is supplied to pins 36 and 37 of CN2 from outside.

Output specifications:

Number of circuits	: 32
Output type	: Transistor output
Voltage	: DC24 V ±10 %
Max. continuous load current	: 0.1 A or less
Connector type	: 37-pin D-Sub connector

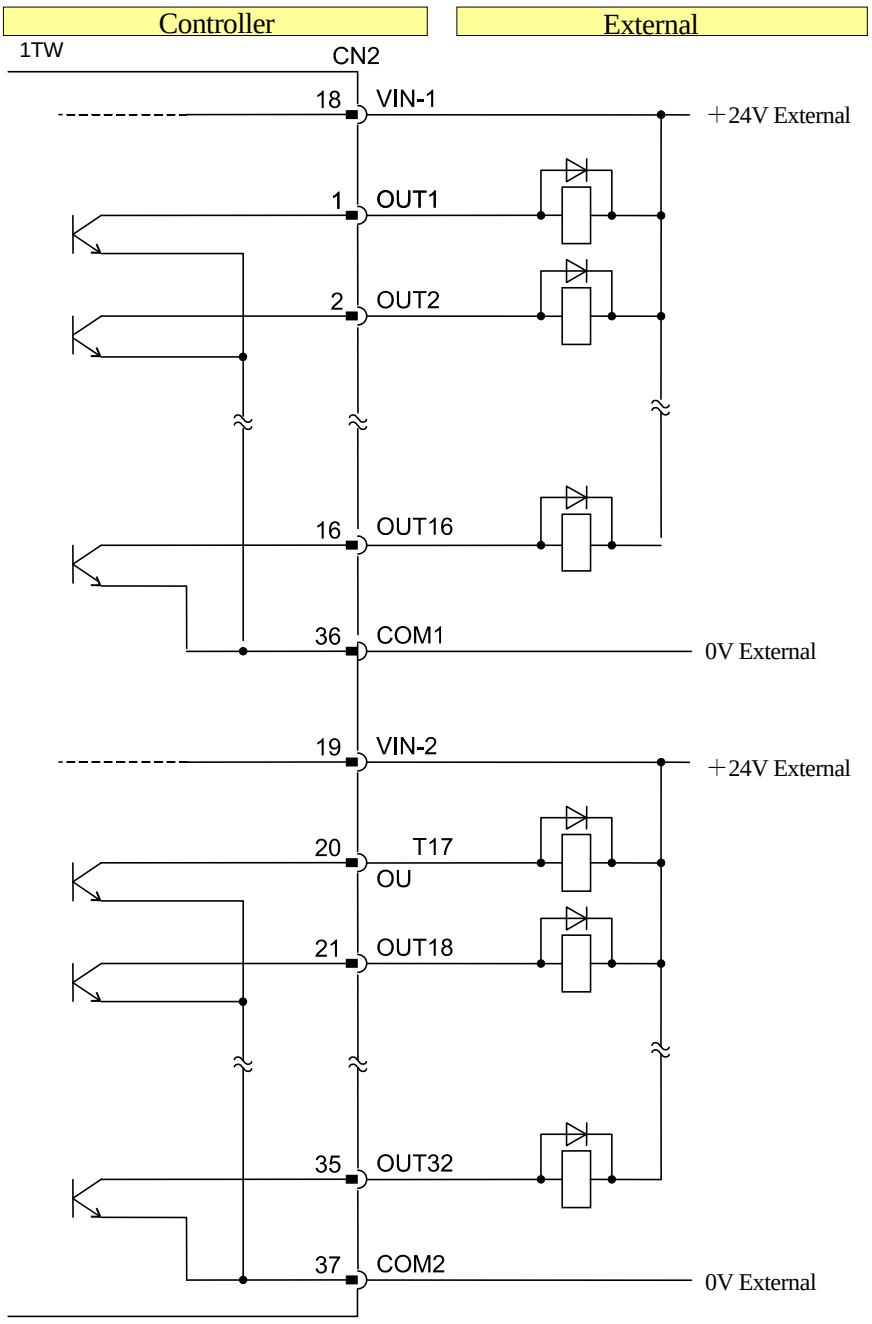
⚠ CAUTION

Ensure that the polarity of the external +24 V power supply is correct when connecting commons and signals to CN2. If incorrectly connected, damage to components on 1TW board may occur.

⚠ CAUTION

1. **All inductive loads (such as relay coil and solenoid valve) should be surge protection type or equipped with surge protection devices.**
2. **When diode is mounted for surge protection, take notice of the polarity. If mounted incorrectly, damage to components may occur from the current overload.**
3. **Power supply which is connected to VIN-1, 2 should be shared with the load.**
4. **Output load current should be 0.1 A or less per one circuit.**

1TW (SINK/NPN spec.)

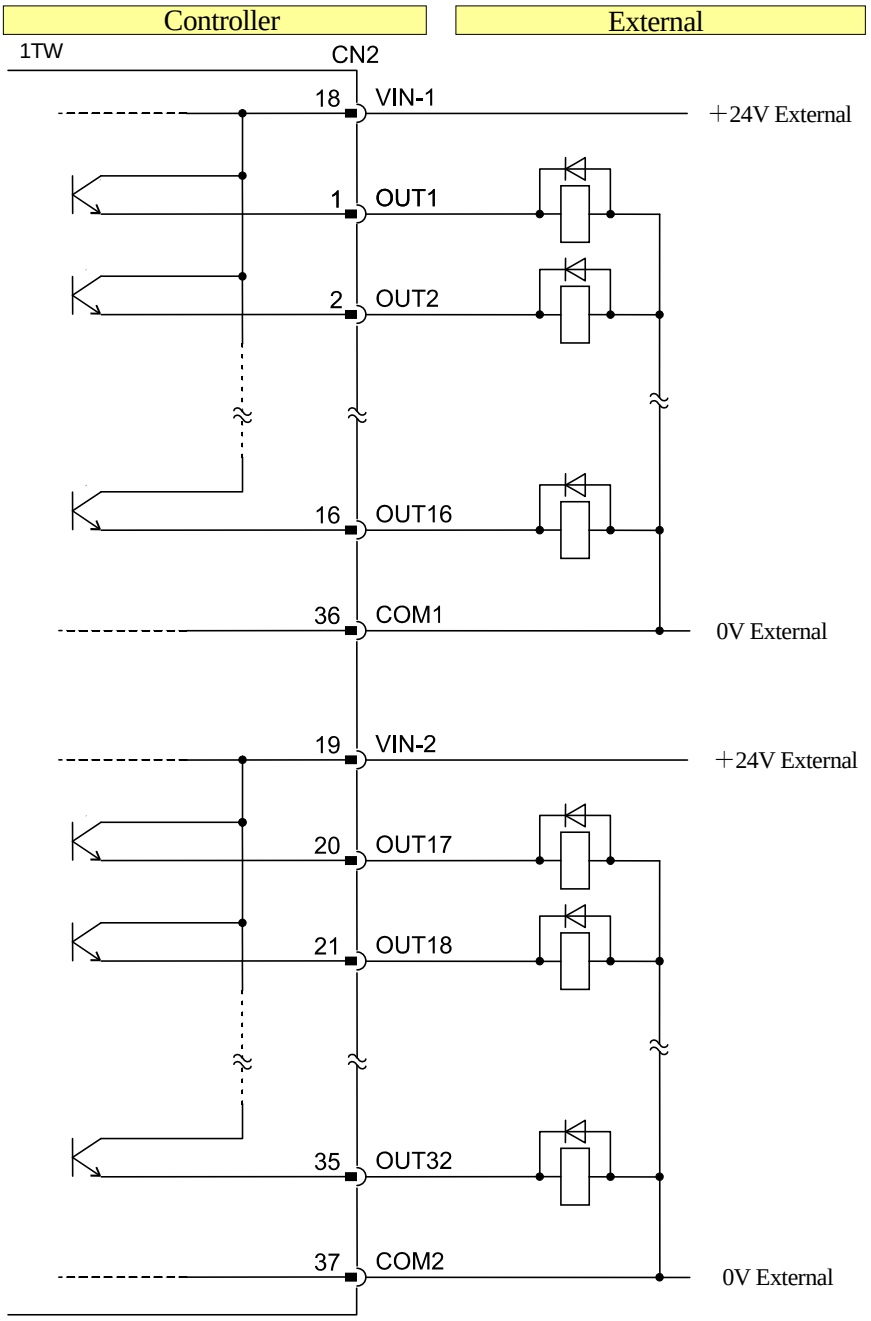


General purpose output signal-1TW (SINK/NPN)

CAUTION

Use surge protection type of the external relay or equip it with surge protection devices. (For diode, ensure the polarity.)

1TW (SOURCE/PNP spec.)



General purpose output signal-1TW (SOURCE/PNP)

3.0 PROCEDURES FOR CONNECTING EXTERNAL I/O SIGNALS

Take notice of the following details when connecting external I/O signals to controller and peripheral equipment (such as interlock panel, etc.).

⚠ WARNING

Turn OFF the power supply to the controller and peripheral equipment when connecting external I/O. Prevent accidental turn ON of the power until all connections are complete by tagging the breaker to indicate that work is in progress or by assigning a supervisor to stand in front of the breaker. Failure to do so is extremely dangerous and may result in electric shock or damage to the electrical system.

⚠ CAUTION

1. **Take the necessary noise countermeasures on equipment with external I/O connections to controller. Electrical noise that interferes with the I/O may cause malfunction or damage to the electrical system.**
2. **Do not mistake pin No. on connectors when connecting external I/O. It causes breakdowns in the electrical system.**
3. **Prevent people or equipment (forklift, objects, etc.) from stepping on or riding over the external I/O cables. An unprotected cable may become damaged causing breaks in the electrical system.**
4. **Avoid wiring the external I/O cable and power line close together or in parallel as much as possible. Separate the cables and lines by at least 20 cm. Electromagnetic induction from the robot motor cable, the power lines for peripheral equipment, welding cable, etc. (either in or outside the controller) may cause noise interference in the I/O cable and lead to malfunction.**
5. **Use shielded cable for the external I/O cable and connect the shielded wire to the controller.**
6. **Fix the external I/O cable with tying bands to the harness support set on top of the controller unit so that the connectors on the terminal board are free from excessive force (pulling, snagging of cable, etc.).**
7. **Use seal connector, etc. so that the external I/O harness never suffers insulation failure or disconnection at the intake port.**

3.1 CONNECTING HARDWARE DEDICATED SIGNALS

1. For wiring of external I/O signals use
   The inlet provided: on the left side of E1x/E2x/E3x/E4x controller, on the rear or left side of E7x controller or on the rear of E9x controller

2. Connect the wires for connecting hardware dedicated signals to terminal block connectors X7, X8 and X9 on 1TR board. See 2.1 Hardware Dedicated Signals and Appendix 7.0 for the pin specifications and assignments.

3. For more details about connecting hardware dedicated signals, refer to Installation and Connection Manual.

3.2 CONNECTING GENERAL PURPOSE SIGNALS

1. For wiring of external I/O signals use
   The inlet provided: on the left side of E1x/E2x/E3x/E4x controller, on the rear or left side of E7x controller or on the rear of E9x controller

2. Connect the wires for connecting general purpose signals to connectors CN2 and CN4 on 1TW board. See Appendix 7. for the pin assignments.

3. For more details about connecting general purpose signals, refer to Installation and Connection Manual.

3.3 CONNECTING EXPANDED I/O SIGNALS (OPTION)

The number of available I/O signals can be expanded using an internal I/O board, the daughter board of arm ID board. For details, refer to option manuals on the arm ID board and option harness. Arm ID board cannot be used for RS03 robot connected with E7x controller. For the use of internal I/O board, see “Appendix 9.0 Internal I/O Signal for RS03 (E70/E73/E76)”.

APPENDIX 1.0 PROCEDURES FOR STOPPING ROBOT

There are two primary methods to stop robot motion immediately, external HOLD and external emergency stop. Even if controller power is shut OFF, motion can be restarted from the point where it was stopped.

APPENDIX 1.1 EXTERNAL EMERGENCY STOP (SAFETY CIRCUIT OFF)

⚠ DANGER

When entering robot motion range, be sure to stop the robot by (external) emergency stop. To prevent accidental entry into the robot motion range, provide a safety fence with a safety plug installed on its door and with an interlock system to cut the motor power OFF by safety circuit OFF when the safety plug is withdrawn.

The robot stops immediately and cycle start is turned OFF (cycle stop) when turning motor power OFF by safety circuit OFF. To stop the robot in an emergency, use the external emergency stop not the external HOLD, described later. Do not use the external emergency stop during operation except for emergencies. It places extreme loads on the mechanical unit. Normally, stop the robot's motion by using the external HOLD first, and then turn the motor power OFF by external emergency stop.

APPENDIX 1.2 EXTERNAL HOLD

⚠ DANGER

External HOLD stops robot motion with brake lock. However, the motor power is still ON. Turn the motor power OFF by safety circuit OFF before entering the robot motion range.

The external HOLD stops robot immediately and maintains its position with the brakes engaged. This is valid only in repeat mode. Manual operation in teach mode is possible even in external HOLD condition.

⚠ CAUTION

In external HOLD condition, output signals from robot will be as follows:
1. All auxiliary data OX signals become OFF.
2. Clamp signals for handling specifications and OUT signals not defined by RUNMASK instruction in SIGNAL command of AS language do not change.
After releasing external HOLD, the robot restarts motion from where it stopped and OX signals are restored to ON. If cycle start is turned OFF for some reason, e.g. by switching to teach mode, before releasing HOLD, the cycle start needs to be turned ON again.

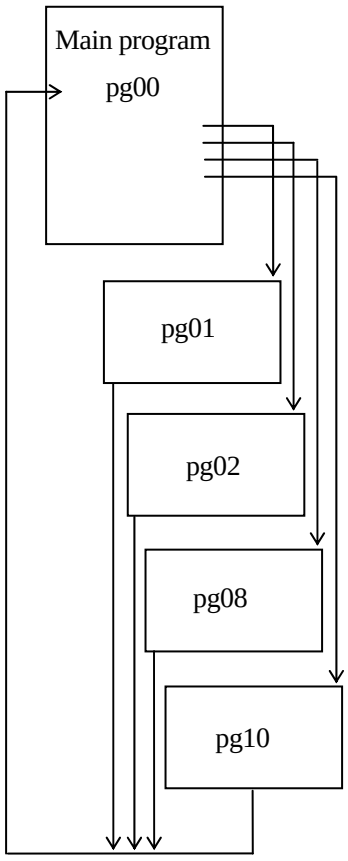
APPENDIX 2.0 EXTERNAL PROGRAM SELECTION FUNCTION

The following methods can be used to change programs externally.

1. IF instruction in AS program
2. RPS function (software dedicated signal)
3. JUMP function (software dedicated signal)

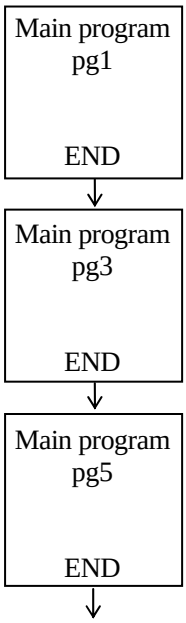
IF instruction in AS program

IF instruction judges the selection signal code and calls up the proper program. (not using RPS function.)

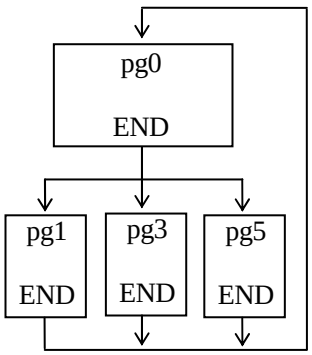


RPS function

After program execution completes at a step taught by END, another program is selected.

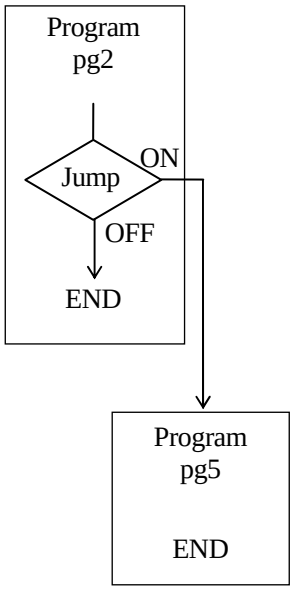


Below, the external program number (RPSxx) is set to 0 at program END.



JUMP function

In the middle of a program, selects whether to continue program execution (JUMP OFF) or to switch to another program (JUMP ON) at the step where JUMP is taught.



APPENDIX 2.1 USING IF INSTRUCTION TO SWITCH BETWEEN PROGRAMS

Using AS instructions as below, it is possible to select a program for call up. The signal code specified by the BITS function is read, and based on that code the IF instruction calls up the selected program.

Program example

```
.PROGRAM pg00()
 100    HOME                  ; Moves to home position
        WAIT   SIG(1009)      ; Waits for input signal IN9 (Program selection OK signal from
                                external device)
        TWAIT 0.1             ; Waits for 0.1 second (Setting time for input signal IN10-13)
        pg.no = BITS(1010,4)  ; Program selection signal (IN10-13)
        IF pg.no = = 1 THEN   ;
        CALL pg1              ;
        END                   ;
        IF pg.no = = 2 THEN   ; Calls an operation program according to the input code
        CALL pg2              ;
        END                   ;
        IF pg.no = = 8 THEN   ;
        CALL pg8              ;
        END                   ;
        IF pg.no = = 10 THEN  ;
        CALL pg10             ;
        END                   ;
        GOTO 100
.END
```

The above program is an example in which AS Language instructions SIGNAL, BITS and IF….THEN….. END are used. BITS and CASE…..VALUE…..END, or EXTCALL can also be used. See AS Language Reference Manual for more details.

APPENDIX 2.2 USING RPS FUNCTION TO SWITCH BETWEEN PROGRAMS

The following software dedicated signals are used for changing programs using the RPS function. To use software dedicated signals, they first need to be defined as dedicated signals by the auxiliary functions A-0601 (input) and A-0602 (output) or DEFSIG command.

Output	External program selection effective (RPS)	Is output when the external program selection mode is set effective (RPS effective).
	RPS-ST	Indicates that robot is ready to switch the program. Outputs when executing the step taught END with RPS effective.
Input	RPS-ON	Enables switching to the program set by the program selection signals. When signal is ON at the step taught END with RPS effective, the program is switched to the program number that is set by RPSxx.
	External program number (RPSxx)	Sets up program selection signals externally. The program is switched according to these signals. The number of signals to be used can also be set.
	External program reset (EXT. PROGRAM RESET)	Resets to the first step of the program externally. Input of signal during automatic operation stops the cycle. When RPS mode is set effective (external program selection mode), the external program number signals (RPSxx) that were set when this signal is input are read and the program set by RPSxx is reset to its first step.

RPS code list (when using 7 bits)

Signal / Program	RPS1	RPS2	RPS4	RPS8	RPS16	RPS32	RPS64
PG0	×	×	×	×	×	×	×
PG1	○	×	×	×	×	×	×
PG2	×	○	×	×	×	×	×
PG3	○	○	×	×	×	×	×
⋮							
PG15	○	○	○	○	×	×	×
PG16	×	×	×	×	○	×	×
⋮							
PG99	○	○	×	×	×	○	○

○ : ON
× : OFF

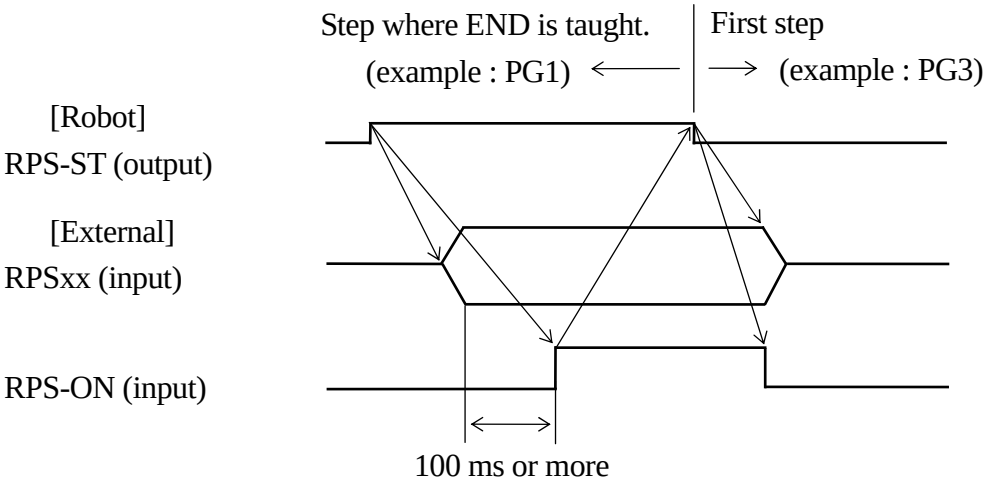
The example above uses a binary code of 7 bits. BCD code (binary coded decimal) can also be used. (In some cases only binary code can be used depending on the AS software.)

CAUTION

PG01 and PG1 are not the same program names. When switching programs by using external program number (RPS), 0-9 should be taught with program names like PG0, PG1-9. PG01 cannot be used with RPS.

Signal timing

This section describes the signal timing for selecting a program by RPS.

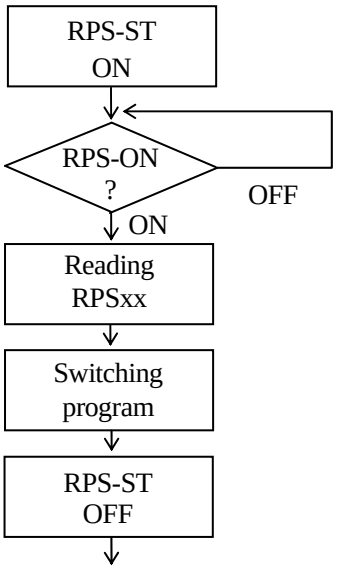


When executing the step taught by END with RPS effective, RPS-ST, approval signal for inputting program is output from the robot. At this time, set external program number signals RPSxx at the external device (interface panel, etc.), and output RPS-ON signal, the approval signal for reading RPS signals, after a delay of 100 ms or more from RPS signal setting. The controller confirms the RPS-ON signal after the axes coincide with the END taught point, reads RPSxx signals and internally sets as the next program for execution. Finally, RPS-ST is set OFF. Maintain RPS-ON and RPSxx signals until RPS-ST is turned OFF.

CAUTION

If RPSxx signals are not set when RPS-ON signal is output from the external device, an error in reading the RPSxx signal occurs, resulting in a program selection error.

RPS program selection flow diagram

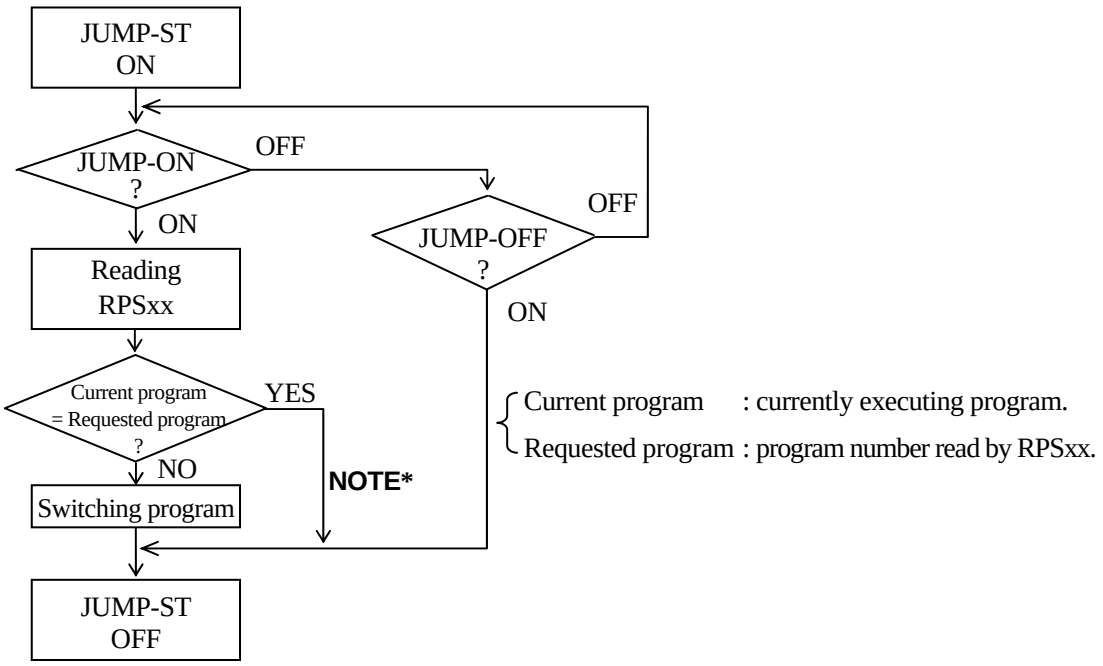


APPENDIX 2.3 USING JUMP FUNCTION TO SWITCH BETWEEN PROGRAMS

The following software dedicated signals are used for switching programs by the JUMP function. When using software dedicated signals, the signals first need to be set dedicated by auxiliary functions A-0601 (input) and A-0602 (output) or DEFSIG command.

Output	JUMP-ST	Indicates that robot is ready to switch to another program. This is output at the step where JUMP or EXTCALL instruction is taught with RPS effective.
Input	JUMP-ON	Allows switching to the program set by the external program selection signals. When this input signal is ON at the step where JUMP is taught with RPS effective, the program switches to the program number set by RPSxx.
	JUMP-OFF	The program does not switch, it proceeds to the next step, when this signal is input at the step where JUMP is taught with RPS mode effective.
	External program number (RPSxx)	Sets program selection signals from an external source in binary format. Program is switched according to these signals. Bit quantity can be set according to the number of the external program.

JUMP function flow diagram



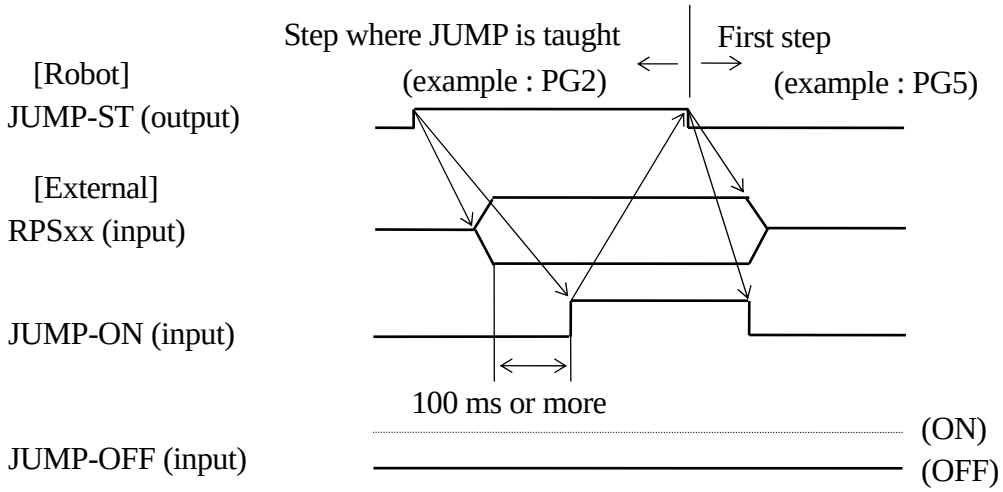
NOTE* When EXTCALL instruction is conducted, the following error message is displayed:
(P1014) Cannot execute because program already in use.

1. When both JUMP-ON and JUMP-OFF are input, JUMP-ON is given priority.
2. If the number of the current and requested programs is the same, JUMP-ON does not switch programs.

Signal timing

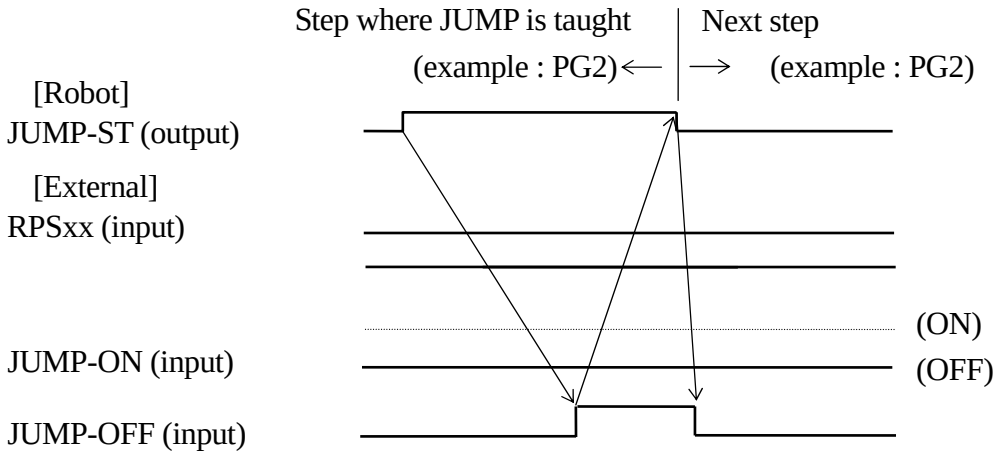
This section describes signal timing when selecting a program by the JUMP function.

Signal timing set by JUMP function



When executing the step taught by JUMP with RPS effective, JUMP-ST, the approval signal for inputting program number, is output from the robot. At this time, set external program number signals RPSxx at the external device (interface panel, etc.), and output JUMP-ON signal, the approval signal for reading the RPS signals, after a delay of 100 ms or more from RPS signal setting. The controller confirms the JUMP-ON signal after the axes coincide with the JUMP taught point, reads RPSxx signals and internally sets as the next program for execution. Finally, JUMP-ST is set OFF. Maintain JUMP-ON and RPSxx signals until JUMP-ST is turned OFF.

When the motion is continuous without jumping

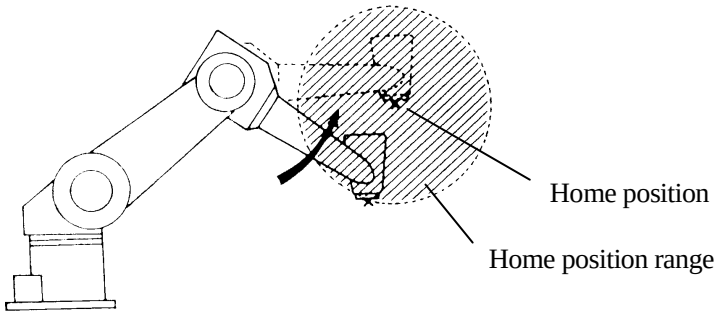


APPENDIX 3.0 OUTPUT FUNCTION FOR HOME POSITION SIGNAL

⚠ WARNING

This signal is output when the software determines that each robot joint angle is located in the specified range, based on data from position detector (encoder) mounted on each axis of the robot arm. Therefore, avoid using this signal alone for safety interlock. Additional hardware type interlocks such as limit switches, etc. for detecting home position should be installed for safety.

When the robot arm is within the home position range, an OUT signal can be output externally. (Both the range and OUT signal are specified in advance.) Two home position signals are available (1st and 2nd) in the system and a home position can be registered for each.



Home position : Register the joint values (angle values) of the robot arm. When joints coincide with these registered values (within the home position range), the signal is output unconditionally.

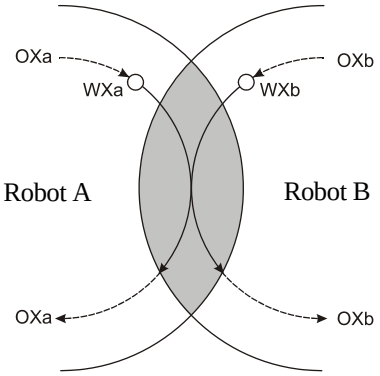
Home position range : Register the range based on the values registered above for outputting the home position signal. Set in mm. (Do not set less than 1 mm.)

The channel number for outputting the home position can be registered by the auxiliary function A-0602 (or DEFSIG command). The home position and its range can be registered by A-0402 (or SETHOME and SET2HOME instructions).

APPENDIX 4.0 MUTUAL INTERLOCK

When robots are installed in close proximity to each other, their work envelopes may overlap. In this situation, interlocking (mutual interlocking) between the robots is required.

For example, the area of interference between robots A and B in figure below is represented by the shaded area.



: Mutual interfering area

○ : Indicates a point (WXa or WXb) where a robot confirms that the other robot is out of the mutual interfering area before entering that area.

------- : Indicates an area where the robots send OXa (OXb) signal allowing the other to enter interfering area.

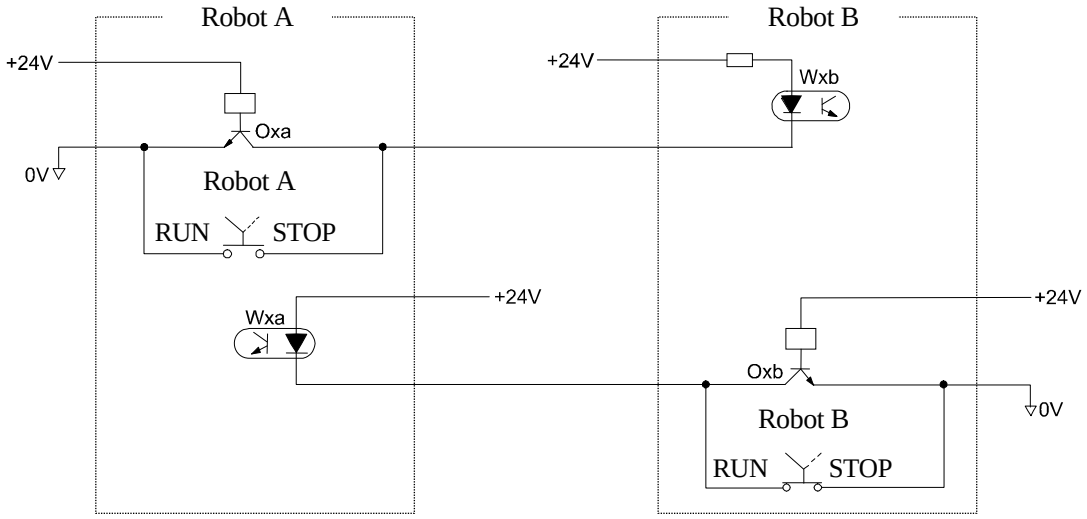
When viewing from robot A,

1. Robot A confirms that robot B is out of the interfering area (Robot B is sending OXb signal) by checking WXa before entering that area.
2. Robot A allows robot B to enter the interfering area by sending OXa signal while robot A is out of the interfering area.

⚠ CAUTION

Observe the output timing carefully when teaching the permission signal (OXa, OXb signals) for the interfering area.

Example of mutual interlock circuit



[NOTE]

The above RUN/STOP switch is not actually prepared for the robot. Robots A and B described here are given as an example to be understood easily.

APPENDIX 5.0 OUTPUT TIMING OF CLAMP SIGNAL (HANDLING APPLICATION)

⚠ WARNING

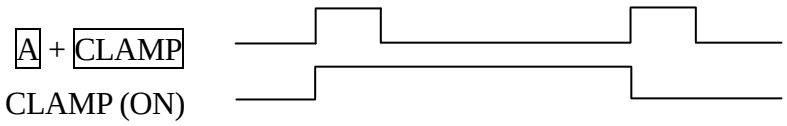
Do not turn controller power to the robot OFF during a material handling operation. When controller power is turned OFF, all output signals including clamp signals become OFF. If the clamp signal is lost during a material handling process, the gripper may release the object being held and causing damage or injury to property and personnel.

Clamp signals set via Aux. 0605 (or HSETCLAMP command) are used for many purposes depending on the application, for example, controlling grippers for a handling task. Only those robot models which allow clamp signals to be defined as dedicated signals can use this signal. Solenoid valves for controlling a gripper are optional in handling applications.

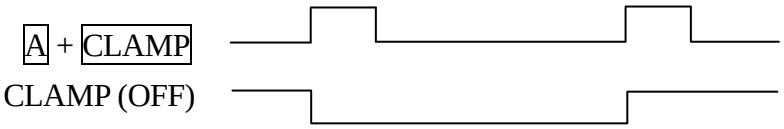
In teach mode

The selected signal is output and switched ON/OFF by pressing A + CLAMP on the teach pendant.

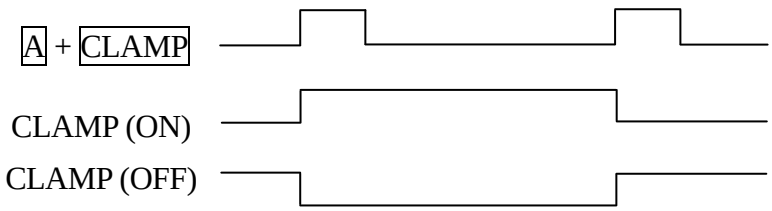
Single solenoid : When setting clamp signal as one output in Clamp ON



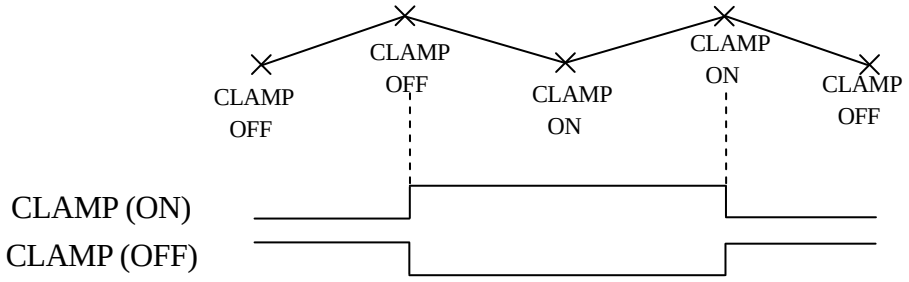
Single solenoid : When setting clamp signal as one output in Clamp OFF



Double solenoid



In REPEAT/CHECK mode



(Double solenoid spec.)

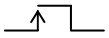
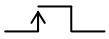
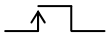
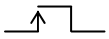
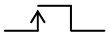
CLAMP (ON) and CLAMP (OFF) in the above figures indicate the output timing for the clamp signals that are set in advance. Maximum of 8 clamp signals can be set.

APPENDIX 6.0 DEDICATED SIGNALS CLASSIFIED BY APPLICATION

APPENDIX 6.1 HANDLING SPECIFICATION

Material handling dedicated input signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
Controller power ON/OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	H	Refer to 1.1 Hardware Dedicated Signals.	
Safety circuit OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
HOLD	H	Refer to 1.1 Hardware Dedicated Signals.	
External motor power ON	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
External error reset	S	Refer to 1.2 Software Dedicated Signals.	
External cycle start	S	Refer to 1.2 Software Dedicated Signals.	
External program reset	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ON	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-OFF	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ON	S	Refer to 1.2 Software Dedicated Signals.	
RPSxx	S	Refer to 1.2 Software Dedicated Signals.	
External HOLD	S	Refer to 1.2 Software Dedicated Signals.	
External slow repeat mode	S	Refer to 1.2 Software Dedicated Signals.	

⚠ CAUTION

When using the internal wiring of the robot, use the arm ID board. In that case, allocate the signal by Aux. 0607. Refer to the Arm ID Board Manual for details.

Material handling dedicated output signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
TEACH/REPEAT switch output	H	Refer to 1.1 Hardware Dedicated Signals.	
Error occurrence output	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	S	Refer to 1.2 Software Dedicated Signals.	
Error occurrence	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Automatic	S	Refer to 1.2 Software Dedicated Signals.	
Cycle start	S	Refer to 1.2 Software Dedicated Signals.	
Teach mode	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Home position 1	S	Refer to 1.2 Software Dedicated Signals.	
Home position 2	S	Refer to 1.2 Software Dedicated Signals.	
Power ON	S	Refer to 1.2 Software Dedicated Signals.	
RGSO	S	Refer to 1.2 Software Dedicated Signals.	
RPS mode	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ST	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ST	S	Refer to 1.2 Software Dedicated Signals.	
Clamp (Max. 8 ch.)	S	Is output as clamp signals for handling applications. Maximum 8 channels are provided for clamp signals, and output condition can be set ON or OFF for each channel. Both single and double solenoid specifications are available. (Refer to Appendix 5. Output Timing of Clamp Signal.) Maximum 8 channels are provided for the solenoid.	 or 

CAUTION

When using the clamp signal with the internal wiring, use the arm ID board. Allocate the signal to the internal wiring by Aux. 0607. Refer to the Arm ID Board Manual for details.

Material handling software dedicated signals (Standard setting at factory shipment)

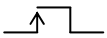
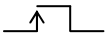
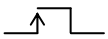
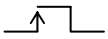
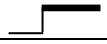
Output signal			Input signal		
Dedicated signal name	**Signal number**		**Dedicated signal name**	**Signal number**	
Motor power ON	OUT 1	1		IN 1	1001
Cycle start	OUT 2	2		IN 2	1002
Error occurrence	OUT 3	3		IN 3	1003
	OUT 4	4		IN 4	1004
	OUT 5	5		IN 5	1005
	OUT 6	6		IN 6	1006
	OUT 7	7		IN 7	1007
	OUT 8	8		IN 8	1008
Clamp1 OFF*	OUT 9	9		IN 9	1009
Clamp1 ON*	OUT 10	10		IN 10	1010
	OUT 11	11		IN 11	1011
	OUT 12	12		IN 12	1012
	OUT 13	13		IN 13	1013
	OUT 14	14		IN 14	1014
	OUT 15	15		IN 15	1015
	OUT 16	16		IN 16	1016

NOTE* Availability of this setting depends on specification.

APPENDIX 6.2 SPOT WELDING SPECIFICATION FOR PNEUMATIC GUN

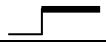
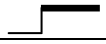
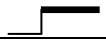
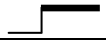
Spot welding dedicated input signals

H : Hardware dedicated signal
S : Software dedicated signal

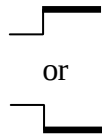
Signal Name		Function	Signal Type
Controller power ON/OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	H	Refer to 1.1 Hardware Dedicated Signals.	
Safety circuit OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
HOLD	H	Refer to 1.1 Hardware Dedicated Signals.	
External motor power ON	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
External error reset	S	Refer to 1.2 Software Dedicated Signals.	
External cycle start	S	Refer to 1.2 Software Dedicated Signals.	
External program reset	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ON	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-OFF	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ON	S	Refer to 1.2 Software Dedicated Signals.	
RPSxx	S	Refer to 1.2 Software Dedicated Signals.	
External HOLD	S	Refer to 1.2 Software Dedicated Signals.	
External slow repeat mode	S	Refer to 1.2 Software Dedicated Signals.	
Weld completed	S	A weld completed signal transmitted from 1 or 2 weld controllers (timer contactors). (See Spot Welding Control section for details.) After output of the command signal (RUN), weld is completed by input of this signal and the robot move to next welding point.	
Weld fault	S	A fault signal transmitted from up to 8 weld controllers (timer contactors). Robot stops moving immediately after receiving this signal.	
Retractable gun retracted detection	S	Used for detecting retractable welding gun in the state of retraction. Individual detection for each clamp signal can be made. (Max. 8 ch.)	
Retractable gun extended detection	S	Used for detecting retractable welding gun in the state of extension. Individual detection for each clamp signal can be made. (Max. 8 ch.)	

Spot welding dedicated output signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
TEACH/REPEAT switch output	H	Refer to 1.1 Hardware Dedicated Signals.	
Error occurrence output	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	H	Refer to 1.1 Hardware Dedicated Signals.	
Error occurrence	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Automatic	S	Refer to 1.2 Software Dedicated Signals.	
Cycle start	S	Refer to 1.2 Software Dedicated Signals.	
Teach mode	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Home position 1	S	Refer to 1.2 Software Dedicated Signals.	
Home position 2	S	Refer to 1.2 Software Dedicated Signals.	
Power ON	S	Refer to 1.2 Software Dedicated Signals.	
RGSO	S	Refer to 1.2 Software Dedicated Signals.	
RPS mode	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ST	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ST	S	Refer to 1.2 Software Dedicated Signals.	
Weld command* (Max. 8 ch.)	S	Signal for initiating welding, can be output to a max. of 8 weld controllers (timer contactor). (See Spot Welding Control section for details.) Select signal type as level or pulse (pulse duration).	 or 
Weld schedule (Max. 6 ch.)	S	Outputs weld schedule to weld controller (timer contactor). The max. number of output signals is 6 bits. Its format, individual or binary, is selectable. (See Spot Welding Control section for details.)	
Weld fault reset (Max. 8 ch.)	S	Resets weld fault condition of weld controller (timer contactor). Is output when reset switch is pressed on teach pendant. (See Spot Welding Condition section for details.)	
Gun pressurization command (Max. 8 ch.)	S	Signal that can be output individually depending on the clamp signal numbers. (See Spot Welding Control section for details.)	

NOTE* Max. total number of channels available for weld command and material handling command is 8 ch.

Signal Name		Function	Signal Type
Stroke change (Max. 8 ch. × 2)	S	Signal that switches the stroke, either extension or retraction, when using retractable weld gun. Separate signals for extension and retraction command can be output individually for each clamp that is used.	
Clamp* (Max. 8 ch.)	S	Signal that outputs in material handling applications. Max. 8 channels are provided for clamp signals and output condition (ON or OFF state) can be set for each channel. Both single and double solenoids are available. (Refer to Appendix 5.)	 or

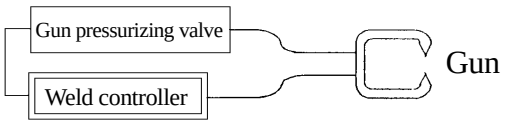
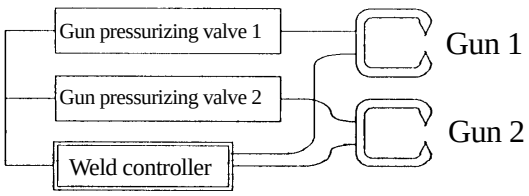
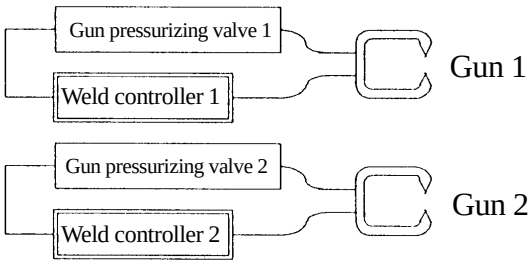
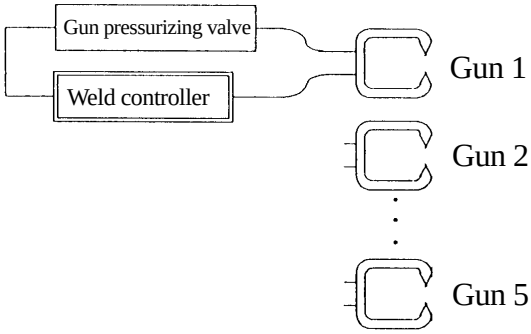
NOTE* Max. total number of channels available for weld command and material handling command is 8 ch.

Spot welding control

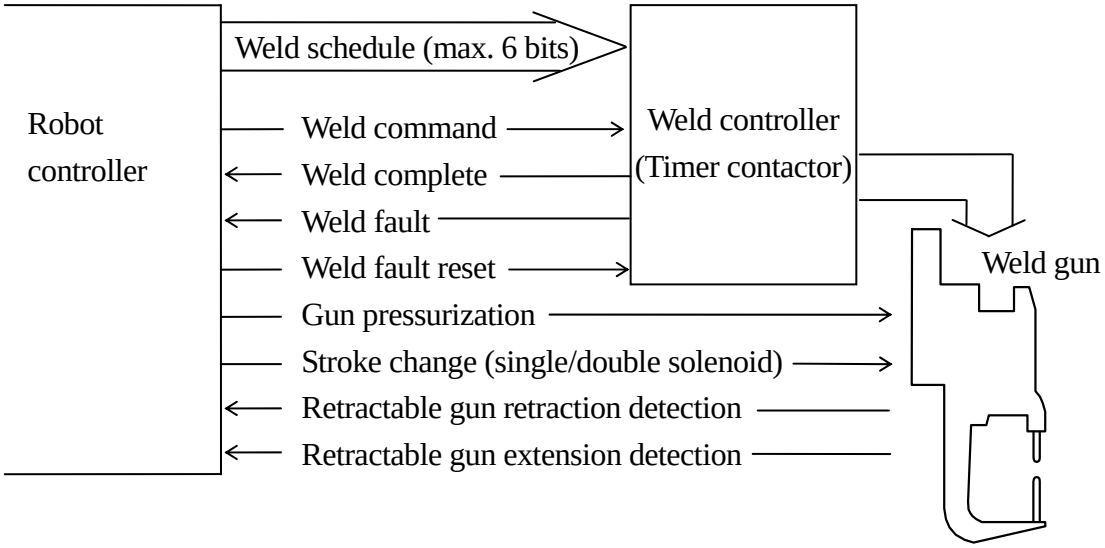
1. Spot welding specifications

Weld gun	**Type**	Single stroke gun Cylinder-type, retractable gun Stopper-type, retractable gun
	Quantity	Max. number of simultaneously operable guns is two. (Except that multiple guns can be controlled by a single weld controller.)
Weld controller (Timer contactor)		Maximum of two, controlled individually.
Weld schedule		Maximum of six bits. (When output is in binary format, max. of 63.)

2. Example of various connection types

One gun (Standard type)	
Two guns without simultaneous welding	
Two guns with simultaneous welding	
Gun change	

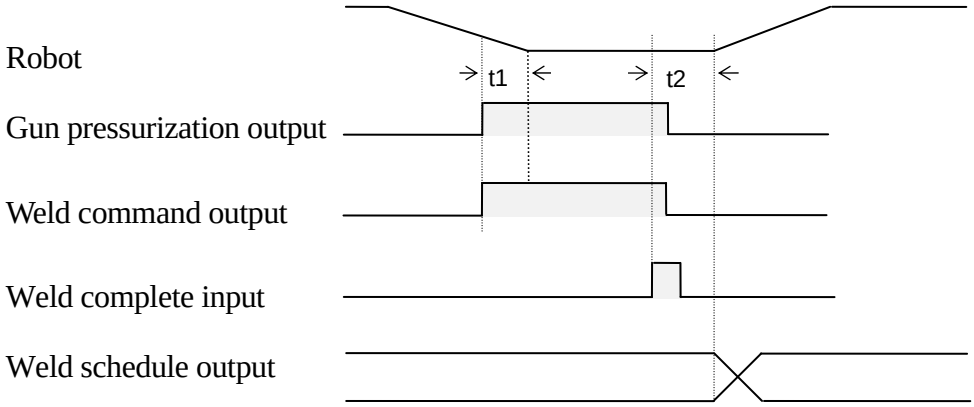
3. Welding I/O signals



[NOTE]

Some weld controllers (timer contactor) may not have a separate input for weld command and weld schedule. In such case, see (6) Connection to Weld Controller.

4. Weld timing diagram



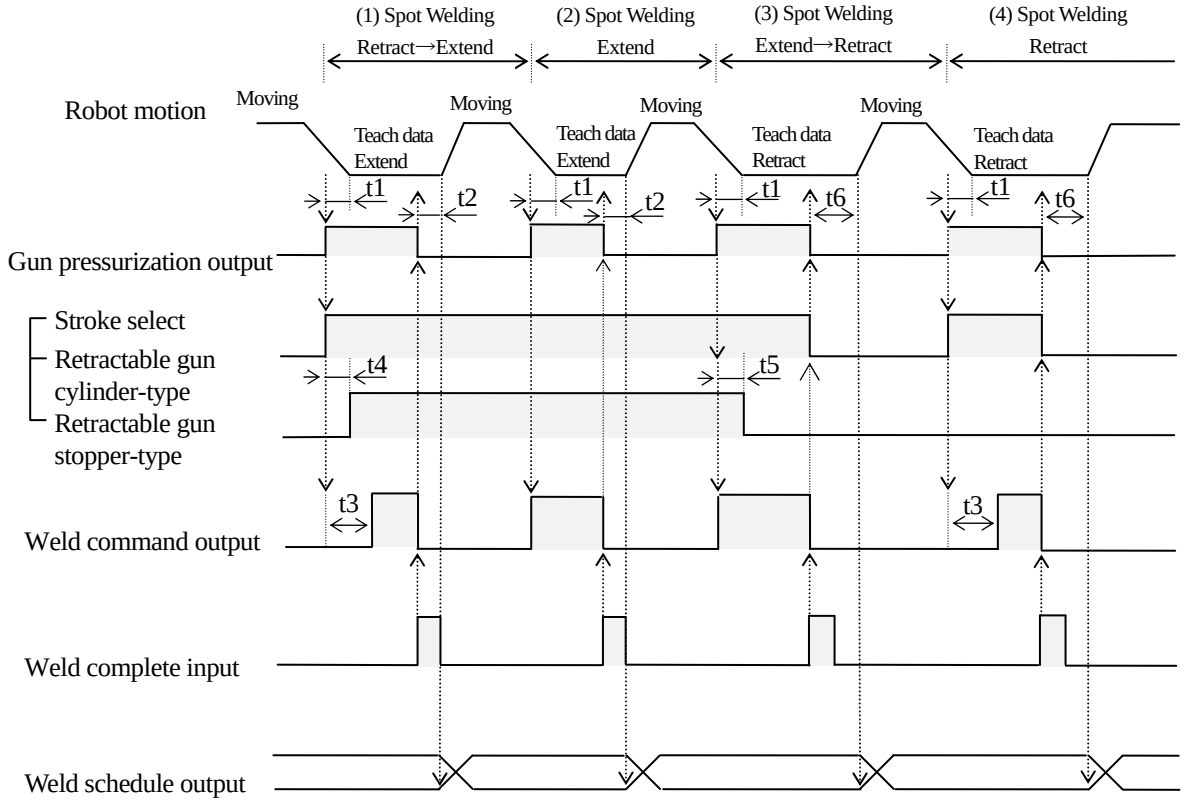
t1 : Gun pressurization and weld command signals can be output before reaching the actual taught point (axis coincidence). (Variable 0-0.99 s.)

t2 : After receiving weld complete signal from weld controller, movement to the next taught point can be delayed. (Variable 0-0.99 s.)

[NOTE]

1. The weld command in the chart above is level output. (Pulse output is also available.)
2. This example shows a gun pressurization that is controlled by the robot controller, not a weld controller.
3. The weld complete signal duration must be more than 0.1 sec., or keep the signal ON until the weld command is set to OFF (if the weld command is a level output).

5. Timing diagram (Retractable gun)



t1 : Possible time for output of the gun pressurization signal in advance of axis coincidence with taught point (0-0.99 s, variable).

t2 : After receipt of the weld complete input signal, possible delay time before opening gun and starting motion (0-0.99 s, variable).

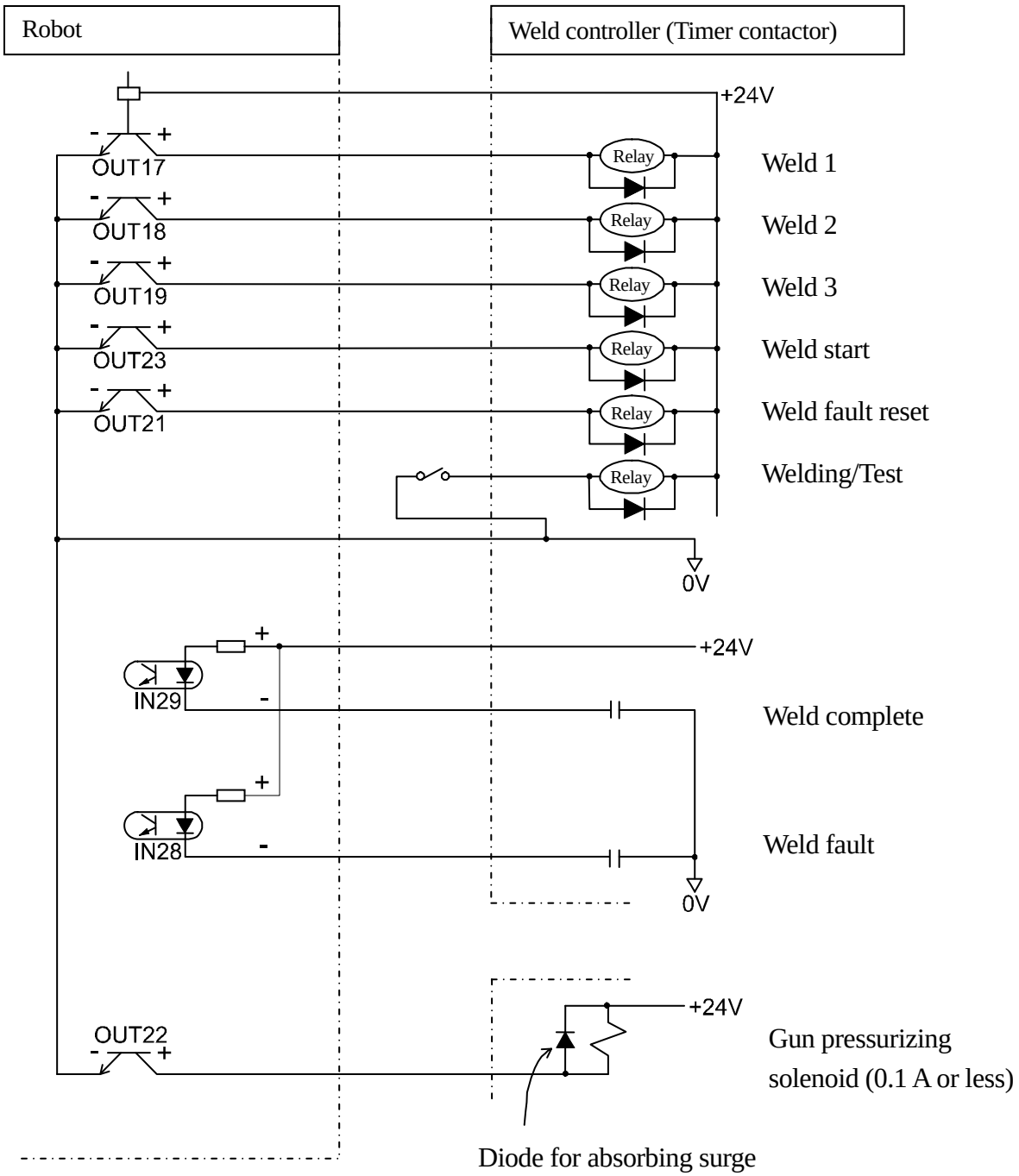
t3 : After the gun clamp output (retraction to extension), delay time before output of the weld initiation command. Used for retractable guns only (0-9.9 s, variable).

t4 : For stopper type retractable gun, delay time before outputting the signal for changing the gun opening from retraction to extension (0-9.9 s, variable).

t5 : For stopper type retractable gun, delay time before outputting the signal for changing the gun opening from extension to retraction (0-9.9 s, variable).

t6 : After receipt of the weld complete input signal, possible delay time before restarting motion in extension to retraction (0-9.9 s, variable).

6. Connection to weld controller (Timer contactor) when using 1TW board



[NOTE]

1. This example demonstrates direct control of the gun pressurization by the robot using weld fault and reset.
2. Install surge killer such as diode to relays and solenoids.
3. When solenoid valve for gun pressurization is driven by direct signals from the robot, verify and confirm the electric load capacity.
4. It is possible to change the OUT and IN signal numbers from/to the robot.

Spot welding software dedicated signals (Standard setting at factory shipment)

Output signal			Input signal		
Dedicated signal name	**Signal number**		**Dedicated signal name**	**Signal number**	
Motor power ON	OUT 32	32	External motor power ON	IN 32	1032
Error occurrence	OUT 31	31	External error reset	IN 31	1031
Automatic	OUT 30	30	External cycle start	IN 30	1030
Cycle start	OUT 29	29	Welder #1 weld complete	IN 29	1029
Teach mode	OUT 28	28		IN 28	1028
Home position 1	OUT 27	27		IN 27	1027
	OUT 26	26		IN 26	1026
	OUT 25	25		IN 25	1025
Clamp 2 ON (Handling)	OUT 24	24		IN 24	1024
Welder #1 weld command	OUT 23	23		IN 23	1023
Clamp 1 (Weld gun clamp)	OUT 22	22		IN 22	1022
	OUT 21	21		IN 21	1021
#1 Weld schedule WS 8	OUT 20	20		IN 20	1020
#1 Weld schedule WS 4	OUT 19	19		IN 19	1019
#1 Weld schedule WS 2	OUT 18	18		IN 18	1018
#1 Weld schedule WS 1	OUT 17	17		IN 17	1017

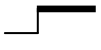
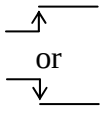
[NOTE]

Take note that standard dedicated signal assignment for spot welding specification uses channels 17 through 32.

APPENDIX 6.3 ARC WELDING SPECIFICATION

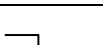
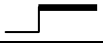
Arc welding dedicated input signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
Control power ON/OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	H	Refer to 1.1 Hardware Dedicated Signals.	
Safety circuit OFF	H	Refer to 1.1 Hardware Dedicated Signals.	
HOLD	H	Refer to 1.1 Hardware Dedicated Signals.	
External motor power ON	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
External error reset	S	Refer to 1.2 Software Dedicated Signals.	
External cycle start	S	Refer to 1.2 Software Dedicated Signals.	
External program reset	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ON	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-OFF	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ON	S	Refer to 1.2 Software Dedicated Signals.	
RPSxx	S	Refer to 1.2 Software Dedicated Signals.	
External HOLD	S	Refer to 1.2 Software Dedicated Signals.	
External slow repeat mode	S	Refer to 1.2 Software Dedicated Signals.	
Wire inching	S	Inches wire while this signal is ON. (Invalid while weld is being executed)	
External weld ON/OFF	S	Switches weld ON/OFF. When leading edge is detected during weld OFF, it turns weld ON. When trailing edge is detected during weld ON, it turns weld OFF.	
Wire retracting	S	Retracts wire while this signal is ON. (Invalid while weld is being executed)	
Positioner stop	S	Terminates welding when using a positioner connected externally.	

Arc welding dedicated output signals

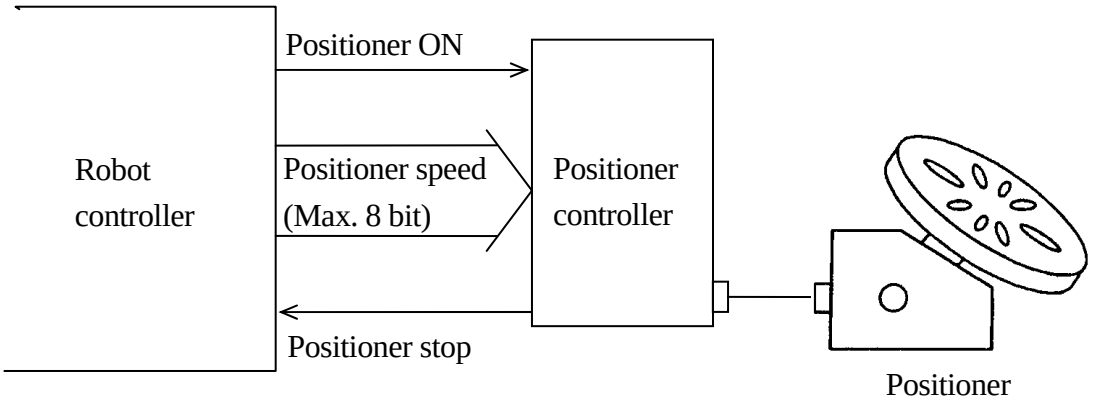
H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
TEACH/REPEAT switch output	H	Refer to 1.1 Hardware Dedicated Signals.	
Error occurrence output	H	Refer to 1.1 Hardware Dedicated Signals.	
Motor power ON	S	Refer to 1.2 Software Dedicated Signals.	
Error occurrence	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Automatic	S	Refer to 1.2 Software Dedicated Signals.	
Cycle start	S	Refer to 1.2 Software Dedicated Signals.	
TEACH mode	S	Refer to 1.2 Software Dedicated Signals. (Not required when using hardware dedicated signal.)	
Home position 1	S	Refer to 1.2 Software Dedicated Signals.	
Home position 2	S	Refer to 1.2 Software Dedicated Signals.	
Power ON	S	Refer to 1.2 Software Dedicated Signals.	
RGSO	S	Refer to 1.2 Software Dedicated Signals.	
RPS mode	S	Refer to 1.2 Software Dedicated Signals.	
RPS-ST	S	Refer to 1.2 Software Dedicated Signals.	
JUMP-ST	S	Refer to 1.2 Software Dedicated Signals.	
Positioner ON	S	Rotates the positioner when using a positioner connected externally.	
Positioner speed (Max. 8 bit)	S	Outputs the speed for rotating the positioner when using a positioner connected externally.	
Error (Max. 8 bit)	S	Is output when an error occurs within the specified range of error codes.	
WCR	S	Outputs when welder is in operation. Displays “In execution” when ON and “Not executed” when OFF.	
Weld ON/OFF	S	Outputs the state of weld ON/OFF. Displays “Weld ON” when ON and “Weld OFF” when OFF.	

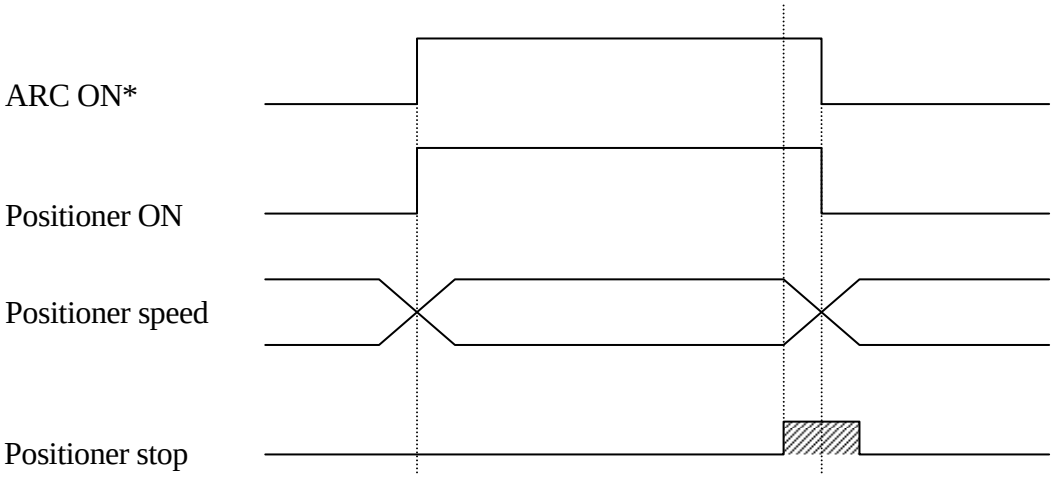
Arc welding control

1. Positioner stop instruction (STWC, STWE) sequence

(1) Welding I/O signals



(2) Weld timing diagram



NOTE* ARC ON signal is output to the welder. It is automatically turned ON/OFF by the robot controller.

2. Procedures for connecting with welder by external I/O signals

It is possible to connect to the welder by the following dedicated I/O signals.

Arc welding dedicated input signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
Electric pole stuck	S	Inputs the electric pole stuck signal sent from the welder. When robot receives this signal, it performs error stop immediately. ERROR (E6562) "Electric pole stuck" (This error is valid only for the TIG specification.)	
Torch interference	S	Inputs the state of the limit switch set in the torch bracket. The limit switch comes off when the torch collides with the base metal. When this signal is detected as OFF, the robot performs error stop. ERROR (E6506) "Torch interference."	
Wire stuck	S	Inputs the output signal from the welder when the wire sticks to the base metal while the Wire stuck detection signal is output by the robot. When this signal is detected, the robot performs error stop. ERROR (E6503) "Wire stuck."	
Wire touch	S	Inputs the output signal from the welder when the wire contacts the base metal while the Touch sensing signal is output by the robot. When this signal is input, robot senses the wire has touched the base material (touch sensing). (This signal is valid only when the touch sensing function is effective.)	
WCR	S	Inputs the signal which indicates that welding is being executed by the welder. If this signal is not received within one second after ARC ON signal is output, the robot performs error stop. ERROR (E6502) " Arc failure."	

Arc welding dedicated output signals

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
Touch sensing	S	Is output when the robot performs touch sensing. Robot senses the wire has touched with the base metal when receiving the Wire touch signal while this signal is output. (This signal is valid only when the touch sensing function is effective.)	
Wire stuck detection	S	Is output when the robot performs wire stuck detection. When robot detects the Wire stuck signal while this signal is output, the robot performs error stop. ERROR (E6503) "Wire stuck" (This signal is output during crater processing or arc spot welding.)	
Feeder ON	S	Is output during wire feeding (inching) and wire retracting.	
Gas ON	S	Is output when the robot discharges the shielded gas.	
Wire feed	S	Is output when robot feeds the wire.	
Wire reverse feed	S	Is output when robot retracts the wire.	
ARC ON	S	Is output when the robot executes welding. When the robot cannot detect WCR within one second of this signal turning ON, the robot performs error stop. ERROR (E6502) " Arc failure" (This signal is not output with weld OFF.)	

Dedicated output signals for arc welding current and voltage

H : Hardware dedicated signal
S : Software dedicated signal

Signal Name		Function	Signal Type
Arc welding current output (Max. 16 bit)	S	Outputs the current value to welder when welding. This signal is output simultaneously with ARC ON signal. Switching between BCD code/Binary is possible.	
Arc welding voltage output (Max. 16 bit)	S	Outputs the voltage value to welder when welding. This signal is output simultaneously with ARC ON signal. Switching between BCD code/Binary is possible.	

Set these welding related signals using Aux. function A-0601 Dedicated input signal, Aux. function A-0602 Dedicated output signal or DEFSIG (AS monitor command). Set all the signals in each group. It is not possible to set just one signal in a group.

A signal can be set to "unused" by inputting the following values when assigning it.

1000 : input signal

0 : output signal

EXAMPLE 1

When the signal number for torch interference is assigned 1000, robot does not perform error detection for torch interference.

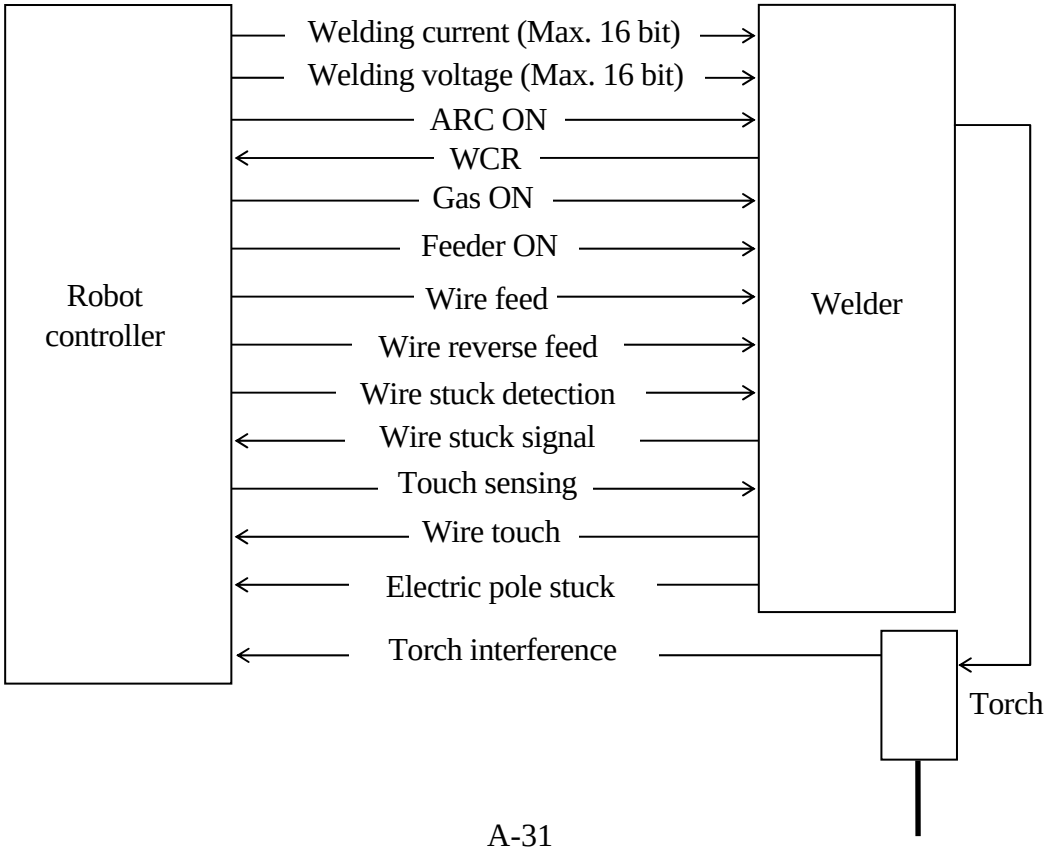
EXAMPLE 2

When the signal number for gas ON is assigned 0, robot does not output the gas ON signal.

[NOTE]

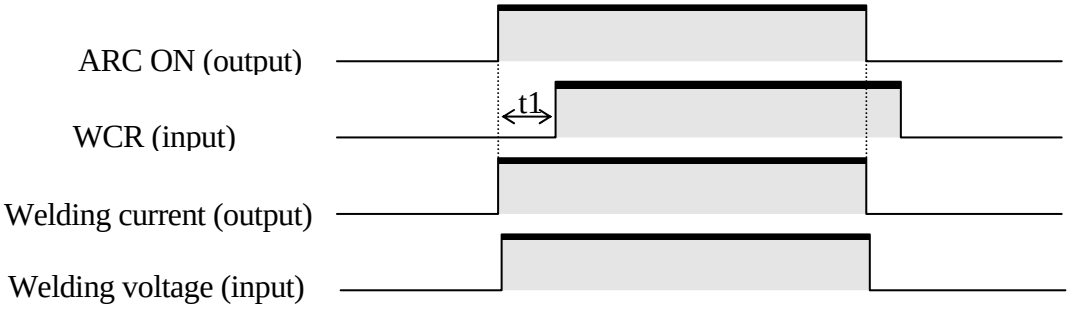
1. These signals are not provided in some software versions.
2. Using these signals disables the welding interface built-in to 1GN and D/A part of the 1TW board.

1. Arc I/O signals



2. I/O timing diagram

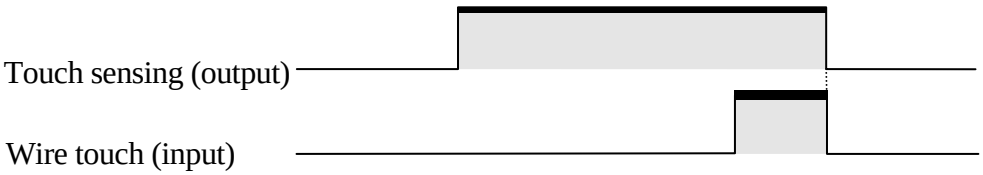
(1) When executing arc welding



t1 : Time from ARC ON to the detection of WCR. When it takes one or more seconds, robot performs error stop.
ERROR (E6503) "Wire stuck."

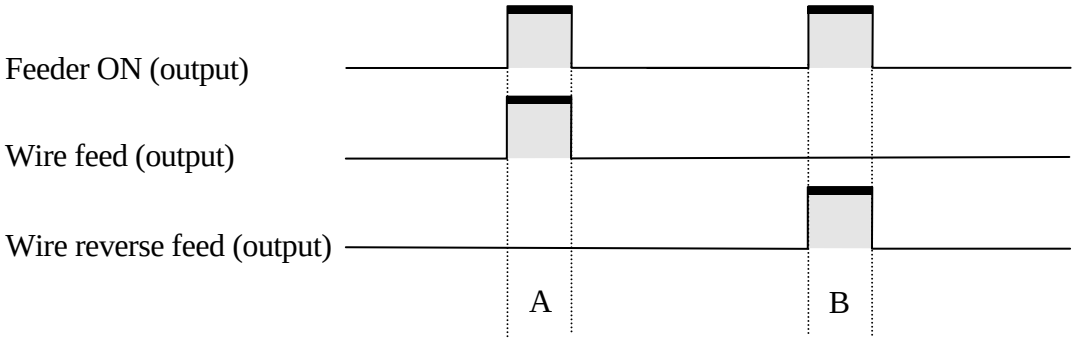
When welding, the command signals for welding current and voltage are output simultaneously with ARC ON. If the robot does not detect WCR within 1 second of ARC ON, it performs error stop. When welding is completed, ARC ON signal turns OFF and the welding current and voltage signal also stop outputting. After the welder confirms that ARC ON is turned OFF, it terminates welding and stops output of WCR.

(2) Touch sensing



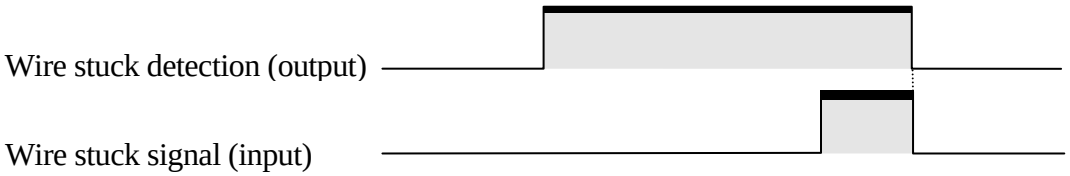
When executing touch sensing, robot outputs touch sensing signal. When the base metal is detected, wire touch signal is input from the welder. When the robot detects this signal, it recognizes that contact has been made with the base metal, stops outputting touch sensing signal and terminates touch sensing.

(3) Wire inching/retracting



When executing wire inching, Feeder ON and Wire feed signal are output simultaneously as in A above. When executing wire retracting, Feeder ON and Wire reverse feed are output simultaneously as in B above.

(4) Wire stuck detection



When the robot executes wire stuck detection, the Wire stuck detection signal is output to the welder. When the welder detects wire stuck, the Wire stuck signal is input to the robot, and the robot performs error stop.
ERROR (E6562) “Electric pole stuck”
The wire stuck detection is automatically conducted after crater processing or arc spot welding.

Arc welding software dedicated signals (Standard setting at factory shipment)

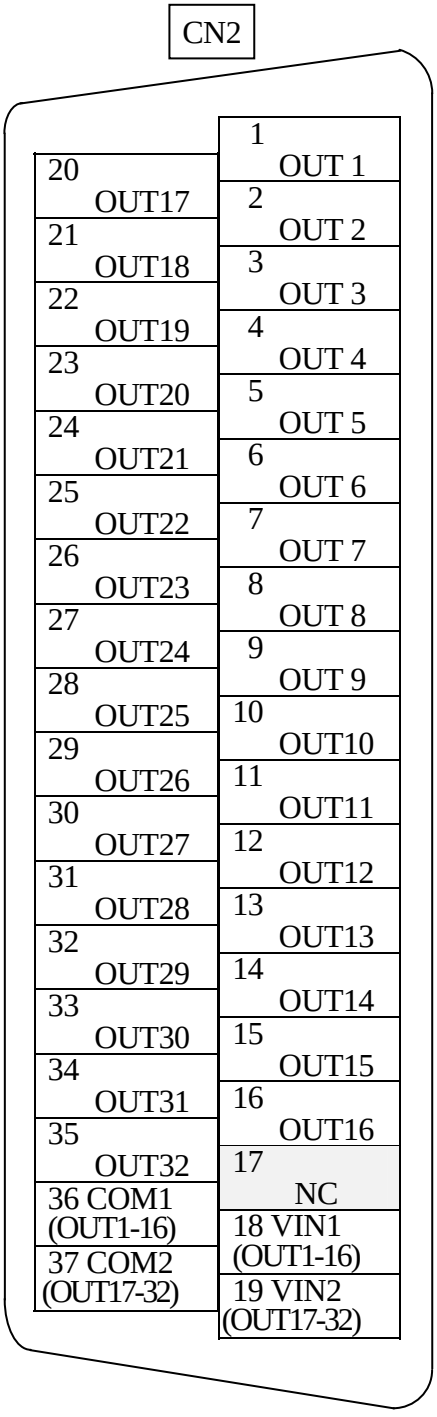
Output signal			Input signal		
Dedicated signal name	**Signal number**		**Dedicated signal name**	**Signal number**	
Motor power ON	OUT 32	32	External motor power ON	IN 32	1032
Error occurrence	OUT 31	31	External error reset	IN 31	1031
Automatic	OUT 30	30	External cycle start	IN 30	1030
	OUT 29	29		IN 29	1029
	OUT 28	28		IN 28	1028
	OUT 27	27		IN 27	1027
	OUT 26	26		IN 26	1026
	OUT 25	25		IN 25	1025
	OUT 24	24		IN 24	1024
	OUT 23	23		IN 23	1023
	OUT 22	22		IN 22	1022
	OUT 21	21		IN 21	1021
	OUT 20	20		IN 20	1020
	OUT 19	19		IN 19	1019
	OUT 18	18		IN 18	1018
	OUT 17	17		IN 17	1017

[**NOTE**]

Take note that standard dedicated signal assignment for arc welding specification uses channels 17 through 32.

APPENDIX 7.0 EXTERNAL I/O SIGNAL PIN ASSIGNMENT

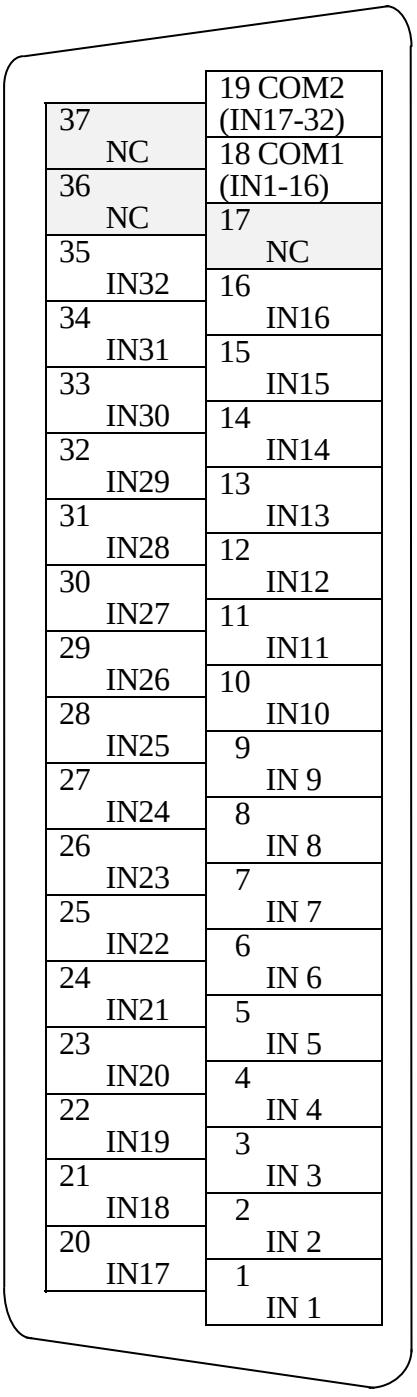
APPENDIX 7.1 1TW BOARD PIN ASSIGNMENT



[NOTE]

1. This figure shows the pin assignment of connectors on 1TW board. Refer to E series controller Installation and Connection Manual for harness connector type.
2. For the channel numbers of each additional 1TW board, add 32 to the numbers above.

CN4



[NOTE]

1. This figure shows the pin assignment of connectors on 1TW board. Refer to E series controller Installation and Connection Manual for harness connector type.
2. For the channel numbers of each additional 1TW board, add 32 to the numbers above.

APPENDIX 7.2 HARDWARE DEDICATED SIGNAL PIN ASSIGNMENT ON 1TR BOARD

Terminal block connectors are provided in order of X7, X8 and X9 from the top of the 1TR board.

Connector X7

1
2
3
4
5
6
7
8

Pin No.	Factory Setting	Function
1	Short	Safety circuit OFF by external emergency stop
2		
3	Short	
4		
5	Short	
6		
7	Short	
8		

Connector X8

1
2
3
4
5
6
7
8
9
10
11
12

Pin No.	Factory Setting	Function
1	Short	Safety circuit OFF by safety fence switch
2		
3	Short	
4		
5	Short	Safety circuit OFF by external trigger
6		
7	Short	
8		
9	Open	TEACH/REPEAT switch output
10		
11	Open	Error occurrence output
12		

Connector X9

1
2
3
4
5
6
7
8
9
10

Pin No.	Factory Setting	Function
1	Open	External control power ON/OFF
2		
3	Short	
4		
5	Open	External motor power ON
6		
7	Short	External HOLD
8		
9	Open	+24V for I/O (9: I/O 24 V, 10: 24 G) Current capacity (including internal I/O and conveyor encoder): 0.7 A for controller with standard spec. 0.6 A for controller with explosion-proof spec. 0.4 A for E7x controller (It is necessary to reduce the current capacity when adding external axes.)
10		

APPENDIX 8.0 GENERAL PURPOSE SIGNAL ASSIGNMENT LIST

Output Signal			Input Signal		
Signal Number		Signal Name	Signal Number		Signal Name
OUT 1	1		IN 1	1001	
OUT 2	2		IN 2	1002	
OUT 3	3		IN 3	1003	
OUT 4	4		IN 4	1004	
OUT 5	5		IN 5	1005	
OUT 6	6		IN 6	1006	
OUT 7	7		IN 7	1007	
OUT 8	8		IN 8	1008	
OUT 9	9		IN 9	1009	
OUT 10	10		IN 10	1010	
OUT 11	11		IN 11	1011	
OUT 12	12		IN 12	1012	
OUT 13	13		IN 13	1013	
OUT 14	14		IN 14	1014	
OUT 15	15		IN 15	1015	
OUT 16	16		IN 16	1016	

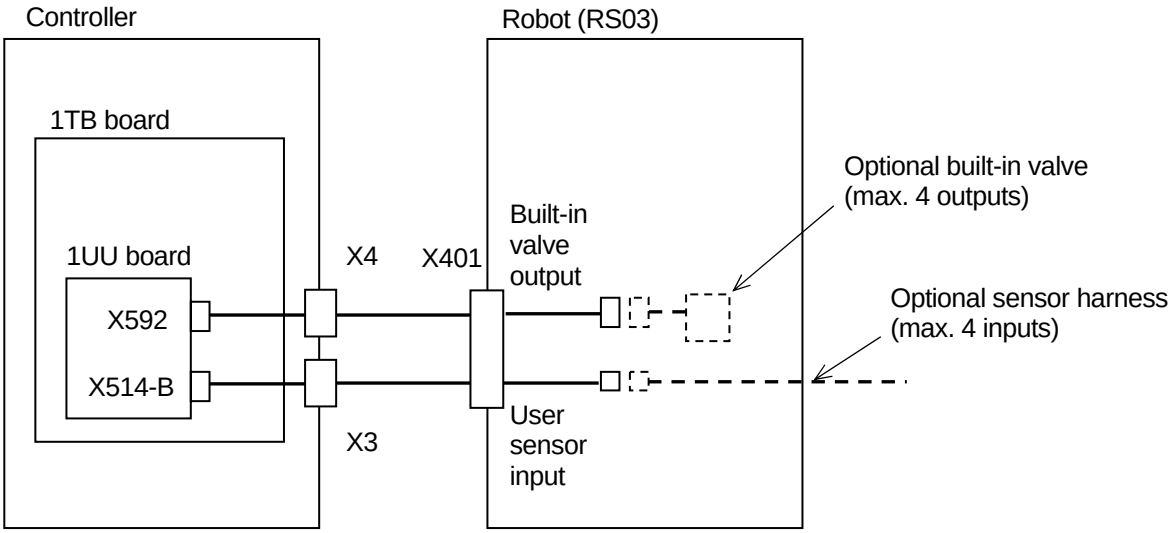
Output Signal			Input Signal		
Signal Number		Signal Name	Signal Number		Signal Name
OUT 17	17		IN 17	1017	
OUT 18	18		IN 18	1018	
OUT 19	19		IN 19	1019	
OUT 20	20		IN 20	1020	
OUT 21	21		IN 21	1021	
OUT 22	22		IN 22	1022	
OUT 23	23		IN 23	1023	
OUT 24	24		IN 24	1024	
OUT 25	25		IN 25	1025	
OUT 26	26		IN 26	1026	
OUT 27	27		IN 27	1027	
OUT 28	28		IN 28	1028	
OUT 29	29		IN 29	1029	
OUT 30	30		IN 30	1030	
OUT 31	31		IN 31	1031	
OUT 32	32		IN 32	1032	

APPENDIX 9.0 INTERNAL I/O SIGNAL FOR RS03 (E70/E73/E76)

APPENDIX 9.1 OUTLINE OF INTERNAL I/O SIGNAL CONTROL

E70/E73/E76 controller is used for RS03 robot and is equipped with 1UU board (internal valve/sensor interface board for RS03) mounted on CN3 of 1TB board (servo board) as standard. Internal I/O signals can be used via 1UU board.

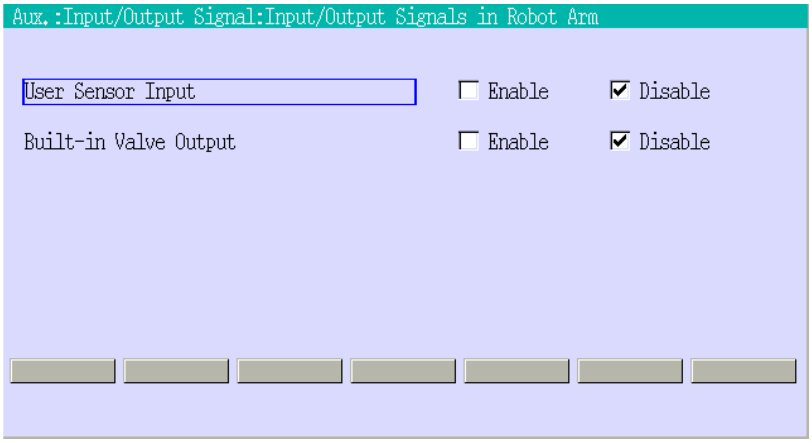
1UU board has 4 inputs and 4 outputs, and the common voltage can be switched by setting jumper on 1UU board. For details, see "Appendix 9.3 1UU Board Setting".



Refer to "Optional Harness Manual" for details on connection.

APPENDIX 9.2 SOFTWARE SETTING AND SIGNAL ALLOCATION OF INTERNAL I/O FOR RS03

Select whether to use user sensor input and built-in valve output via Auxiliary function 0610.



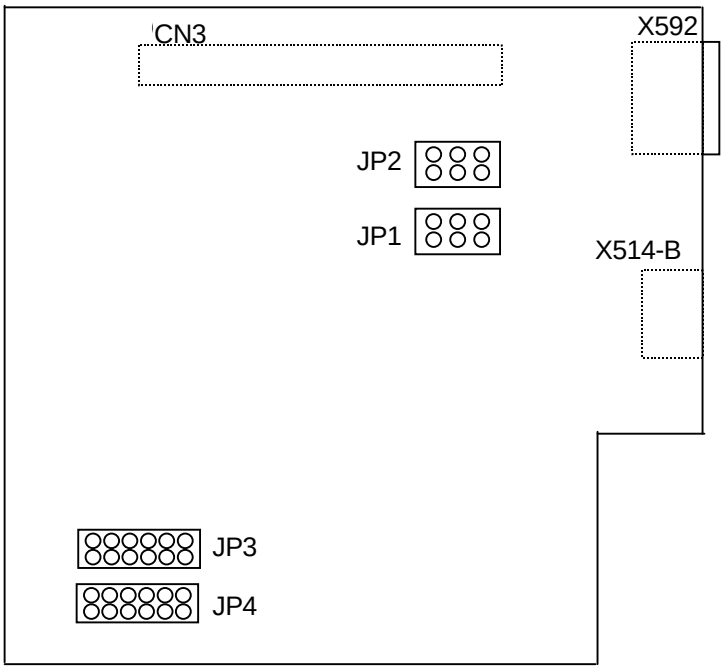
CAUTION

When [User Sensor Input] is set to [Enable], 4 inputs are automatically allocated to signal numbers IN13 -16.

CAUTION

When [Built-in Valve Output] is set to [Enable], 4 outputs are automatically allocated to signal numbers OUT9 -12. For the clamp specification, set it via Auxiliary function 0605.

APPENDIX 9.3 1UU BOARD SETTING



APPENDIX 9.3.1 JUMPER

No.	Content	Setting
JP1	JP1: 4 user sensor inputs	Jumper is set on JP1.
JP2	JP2: Prohibited	
JP3	JP3: NPN, SINK spec. JP4: PNP, SOURCE spec.	Jumper is set on JP3 as the standard setting for E73.
JP4		Jumper is set on JP4 as the standard setting for E70/E76.

APPENDIX 9.3.2 CONNECTOR

No.	Content	Connection
X514-B	4 user sensor inputs	X3
X592	4 built-in valve outputs	X4 and X316 (1TQ/1TV board)
CN3	Interface between servo boards	Servo board CN3

APPENDIX 9.4 ERROR CODE

(E1295) [Servo board XX] 24V for internal valve is low.

Content

In robot with internal valve/sensor interface board (1UU board) mounted, the voltage drop of 24 V supplied to the board for the internal valve is detected.

Cause

The error occurs due to ground fault or short-circuit in the 24 V line for internal valve. If the error occurs without any ground fault or short-circuit in the 24 V line, the cause may be:

1. Disconnection of X592 harness
2. Defect in the internal valve/sensor interface board (1UU board)
3. Defect in 1TQ/1TV board

Countermeasure

1. Check for ground fault or short-circuit in the 24 V line for internal valve, such as internal harness or separate harness.
2. Check for disconnection of X592 harness.
3. Replace the internal valve/sensor interface board (1UU board).
4. Replace 1TQ/1TV board.
5. Replace the servo board.

(E1382) [Servo board XX] Valve, sensor I/F board missing.

Content

Internal valve/sensor interface board (1UU board) cannot be used.

Cause

1. Internal valve/sensor interface board (1UU board) is not mounted.
2. 1UU board is broken.
3. Type of 1UU board is incorrect.(1UU board with neither JP1 nor JP2 cannot be used.)

Countermeasure

1. Check if the internal valve/sensor interface board (1UU board) is mounted.
2. Replace the internal valve/sensor interface board (1UU board) if the board is mounted.
3. Replace the 1UU board with the board with the correct part number.

(E1383) [Servo board XX] ArmID communication setting mismatch btwn software and hardware.

Content

For the setting of user sensor input, there is a mismatch between setting on software and hardware jumper setting to JP1/JP2 and sensor input cannot be established.

Cause

Settings of software and hardware do not agree as follows when internal valve/sensor interface board (1UU board) is mounted.

・Software: [User Sensor Input] is set to [Enable], Hardware: Jumper is set to JP2 (Arm ID)

Countermeasure

1. Set the jumper to JP1 on the internal valve/sensor interface board (1UU board).

2. Turn OFF/ON the controller power after change of the setting.

This error also occurs if Arm ID option is enabled on software. In such case please contact the nearest Kawasaki office to disable Arm ID option.

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