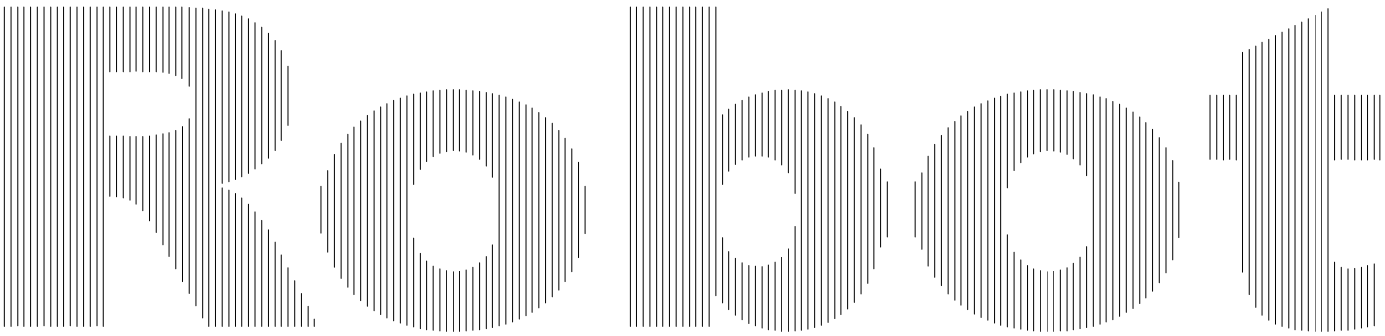
Simple and friendly

Kawasaki

Kawasaki Robot Controller

T Series

Operation Manual



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90203－1111DEC

PREFACE

This manual describes operating instructions for the Kawasaki Robot Controller T series. This manual should be read with careful review of the related manuals listed below. Only after the contents of all the manuals are thoroughly read and understood may the robot be used.

1. Safety Manual
2. Installation and Connection Manual for Arm
3. Installation and Connection Manual for Controller
4. Inspection and Maintenance Manual

The contents of this manual are described on condition that installation and connection of the robot are done in accordance with the above listed manuals.

This manual provides as much systematic information as possible on the standard operating methods for a variety of Kawasaki robot applications. Information specific to each application is explained at the end of this manual. However, not every possible operation, condition or situation that should be avoided can be described in full. Therefore, should any unexplained questions or problems arise during robot operation, contact Kawasaki. Refer to the contact information listed on the rear cover of this manual for the nearest Kawasaki office.

This manual explains all application functions and optional functions, but not every function detailed here may be included with the robot at purchase. Thus, if application is changed the robot software and hardware will require corresponding additions/changes. Also, diagrams and teach pendant screens given in the manual may differ slightly from those in your application.

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 of 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 rights 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.
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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. Should any unexplained questions or problems arise, please contact Kawasaki.**
2. **Safety related contents described in this manual apply to each individual workpiece and not to all robot workpiece. In order to perform every workpiece 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 workpiece.**

INTRODUCTORY NOTES

1. HARDWARE KEYS AND SWITCHES (BUTTONS)

T 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

MOD : expresses the hardware key “MODIFY”.
HOLD/RUN : expresses the mode change switch on the operation panel.
ENABLE + PROG : indicates pressing and holding down ENABLE then pressing PROG.

2. SOFTWARE KEYS AND SWITCHES

T 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

<Complete> : expresses a “Complete” key that appears on the teach pendant screen.
<Constants> : expresses a “Constants” key on the teach pendant screen.

3. SELECTION ITEMS

Quite 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 will be enclosed [XXX] in brackets.

EXAMPLES

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

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1.0 OVERVIEW

T series controllers provide a variety of control functions required for more sophisticated car manufacturing. There are two types of controllers: single robot arm controller and multiple robot arm controller.

All types of controllers provide basic functions for controlling pose (position and posture), velocity, acceleration, and signal output/ input. In addition, multiple arm cooperation/ synchronization, additions of control axes and functions are also available depending on application requirements.

1.1 MODELS OF T SERIES CONTROLLERS

As T Series Controller, following models are available depending on the number and size of robot arms connected.

1. For control of single large-sized robot arm (T52)

1.2 ROBOT ARMS CONNECTED TO T SERIES CONTROLLERS

Small-sized to large-sized robots can be connected to T Series Controller. Following table shows some example of robots that can be connected to T Series Controller.

		Controller model
		T52
Robot type	New small-sized series	
	Small-sized series	
	Medium-sized series	
	Large-sized series	ZX, ZT, ZB, ZS, HR, BX, KJ series

1.3 SPECIFICATIONS FOR T SERIES CONTROLLERS

Specifications for representative T series controllers are as shown below. For other models, refer to the specification sheets.

1. Model		T52	
2. Structure		Fully enclosed, indirect cooling type	
3. Construction and dimension		See attachment.	
4. Number of controller axes		8 axes	
5. Driving method		Full digital servo	
6. Operation method		Manual operation mode	Joints individual, base coordinates, tool coordinates
		Repeat operation mode	Joint interpolation, Linear interpolation, Circular interpolation (option)
7. Teaching method		Teaching or programming	
8. Memory capacity		8MB	
9. I/O Signal		General Input	960 (via PLC incl. dedicated signals)
		General Output	960 (via PLC incl. dedicated signals)
10. Operation Panel		Mode selector switch (Auto/ Manual/ Teach/ Disconnect)	
		Emergency stop switch (with lock, light)	
		Master ON switch, Buzzer, Buzzer stop/ Error reset	
11. Master ON Unit		Cubic-S (manufactured by KHI)	
12. PLC		PC10P－DP-I/O or PC10P	
13. Teach Pendant		Standardized Teach pendant exclusive for Toyota 10 m	
14. Harness		Separate harness (Control panel ← → Robot) 7 m	
15. External Connection		X-LNE1, FL-NET, Ethernet, X-APL1, X-APL2	
16. Mass		150 Kg	
17. Power requirements		AC200－AC220 V±10 %, 50/60 Hz, 3 Φ	
		Robot dedicated ground, Leakage current Max 100 mA	
18. Environment		Ambient temperature 0 – 45 ℃, Relative humidity 35 – 85 ℃ (Non-condensing)	
19. Coating color		Munsell 10GY9/1 or equivalent	
20. Option			
	Teach pendant harness	5 m, 15 m	
	Separate harness	5 m, 10 m, 15 m	
	Auxiliary memory device	USB flash memory	
	Motor brake release device	Brake release switch BOX	
	AC power outlet	AC100V power outlet BOX	
21. Others		For maintenance parts and spare parts, contact Kawasaki.	

1.4 OPERATION METHODS FOR T SERIES CONTROLLERS

T series controller can be used in many combinations according to the number and type of robot arms and application fields where robot arms are used. Following points are considered so that the operation methods in each combination do not get too complicated.

1. In multiple robot arm control, each robot arm is controlled separately in teach mode, as in single robot arm control, by selecting individual mode.

2. For all T series controllers, the teach pendant and operation panel use the same hardware switches*. Also, common teach pendant and operation panel are used for all robot models.

3. Procedure of programming, program editing, playback, status display, and parameter setting and modifying are all common in every T series controller, unless otherwise necessary.

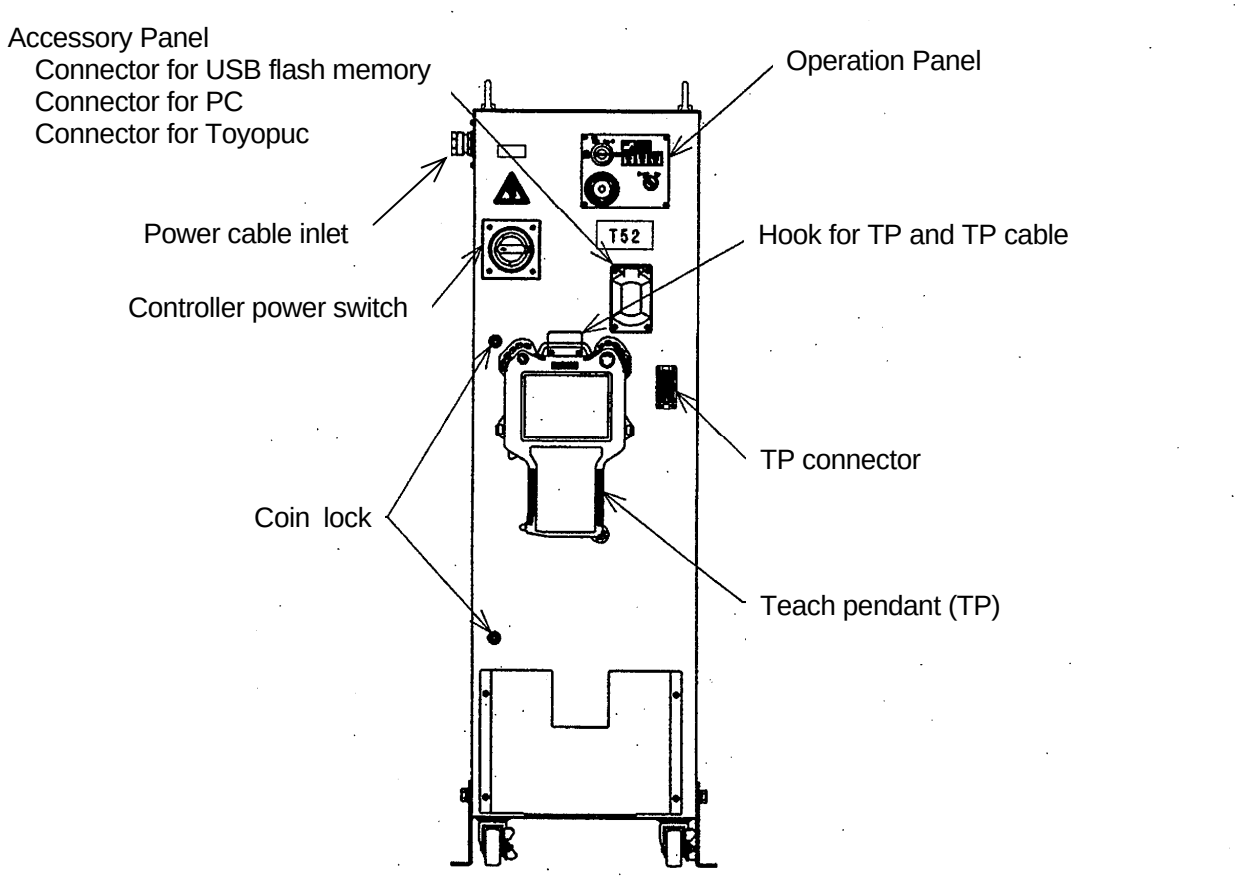
4. TP maintenance support function, which is made available at error occurrence, is also standardized for all models and applications.

2.0 SWITCHES, KEYS AND SCREENS

This chapter explains the exterior of the controller and the switches equipped here. It also explains about the teach pendant, its hardware keys and operation screen.

2.1 CONTROLLER EXTERIOR

The figure below shows the exterior appearance of the Europe specification T52 controller (for other type controllers, see Connection and Installation manuals). Controller power switch, external memory device, operation panel, etc. are located at the front of the controller. Teach pendant (TP) is connected to the connector located at the front of the controller, and when not in use, it is hanged on the TP hook.

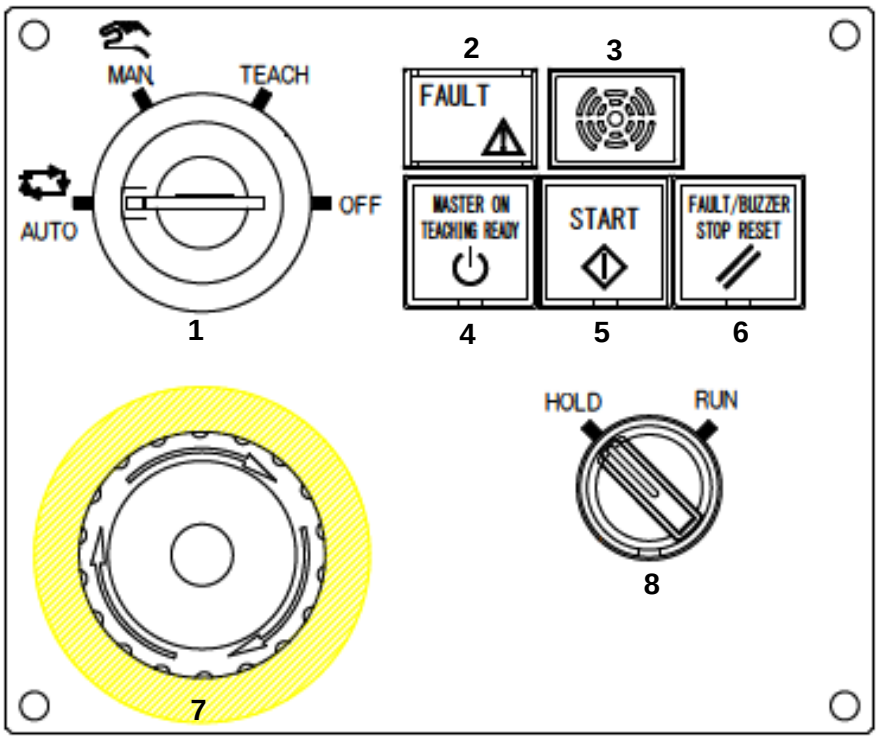


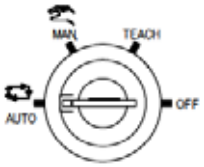
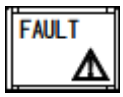
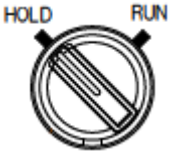
2.2 SWITCHES ON THE CONTROLLER AND THEIR FUNCTIONS

The switches on the controller and their functions and operation methods are as follows.

	Description
Power cable inlet	Inlet for cable supplying power to the controller.
Controller power switch	Turns ON/OFF power for the controller. Controller power lamp on the operation panel lights while this power is ON.
Coin lock	Locks the controller door.
TP hook	Hang TP on this hook while not in use.
Operation panel	Switches and lamps necessary for robot operation are placed on this panel.
Hook for TP cable	Hang TP cable on this hook.
TP connector	Connects the TP to the controller.
Connector for USB flash memory	USB flash memory can be used as external memory device.
Connector (for PC)	Connects PC to controller.
Connector (for TOYOPUC)	Connects TOYOPUC to controller.

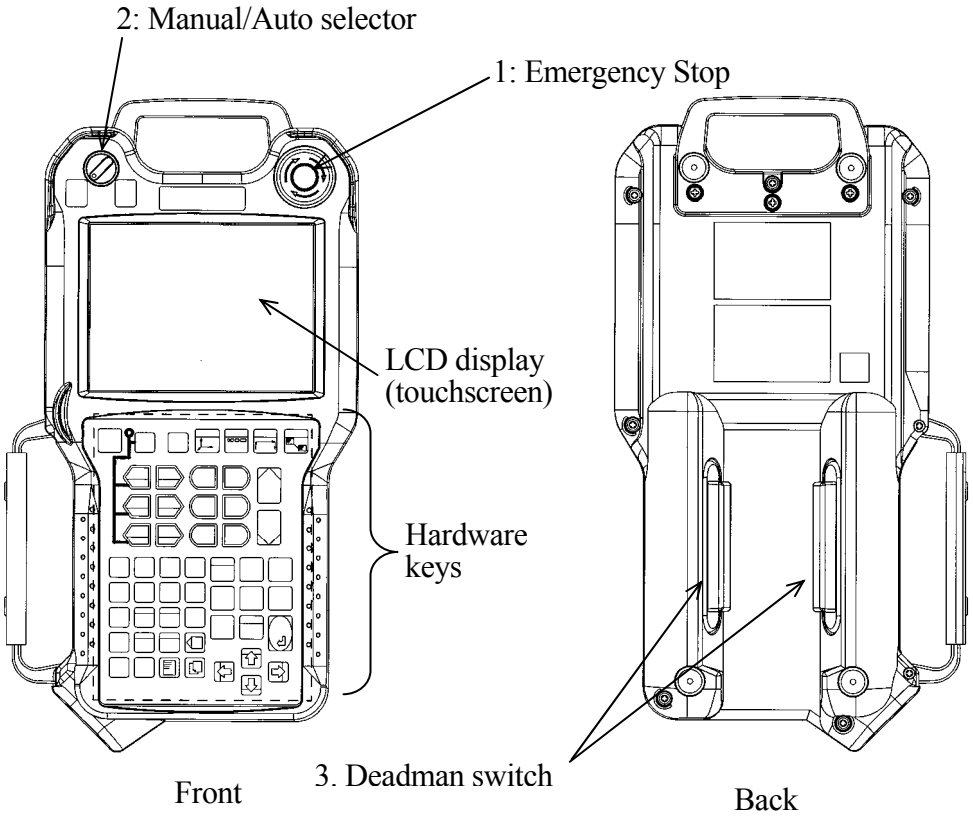
Switches on the operation panel



No.	Switch	Function
1	 (MODE SELECTOR)	AUTO: Used in repeat mode, executes program in conjunction with peripheral equipment. MANUAL: Used in repeat mode, executes program independently. TEACH: Used to teach programs to robot. OFF: Disconnects robot from the line.
2		This lamp turns on when an error occurs.
3		The buzzer sounds when error occurs.
4		[Teach mode][Repeat mode] Press this switch to turn ON the MASTER ON lamp and motor power.
5		When in repeat mode, pressing this switch starts cycle operation. The switch lights during cycle operation.
6		Press this switch to reset error. FAULT lamp (described above) turns off when the error is properly reset. (Error cannot be reset when the error is occurring continuously.) Also, turns off the busser when pressed while the buzzer is sounding.
7		Press this switch when an erroneous condition occurs. Motor power is shut off and robot stops. Controller power is not shut off.
8		HOLD: Disables robot to operate. RUN: Enables robot to operate.

2.3 TEACH PENDANT EXTERIOR

The figure below shows the exterior appearance of the Teach Pendant. Teach pendant carries hardware keys, switches and buttons for manual operation of the robot or data editing, and liquid crystal screen that serves as display and touchscreen.

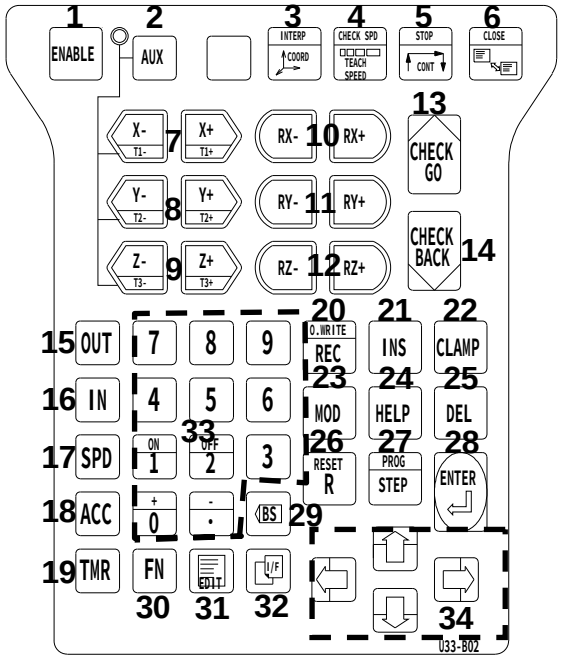


⚠ WARNING

1. **Touching more than one place on the touchscreen may cause the teach pendant to operate the button different from the one pressed, so always press only one place on the touchscreen.**
2. **Malfunction of the touchscreen may cause the teach pendant to operate the button different from the one pressed, so do not use the touchscreen to conduct operations concerning safety.**
3. **Use your finger or touch pen exclusive for the touchscreen. Using writing pen or other utensils with sharp or pointed end may damage the touchscreen.**

Hardware Key Layout

The hardware keys are positioned on the Teach Pendant as shown below. The function of the keys may vary according to robot specifications.



Difference between the keys depending on the specifications:

22: Functions differ for: spot welding specification.

33: These keys are treated as one group in this manual.

34: These keys are treated as one group in this manual.

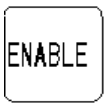
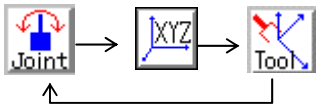
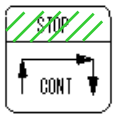
2.4 FUNCTION OF TEACH PENDANT SWTICHES AND HARDWARE KEYS

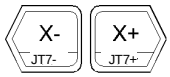
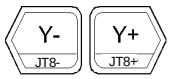
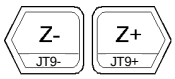
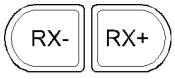
The functions of switches, buttons and hardware keys on the teach pendant are explained in this section. See the following tables.

1. Function of buttons and switches

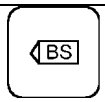
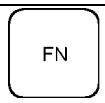
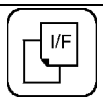
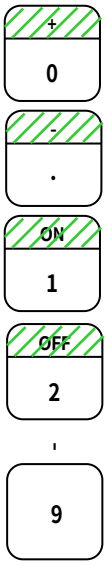
No.	Switch/ button	Functions
1	Emergency Stop Button	Pressing this button cuts off the power supply and the robot stops. To release emergency stop, turn this button to the right until the button returns to its original position.
2	Manual/ Auto selector switch	Used together with the mode selector switch on the operation panel, switches between Manual operation (Teach mode) and Automatic operation (Playback mode).
3	Deadman switch	This switch is an enable switch. Unless this switch is pressed and brought to "enable" status, power to motor cannot be supplied and brake is locked, therefore robot axes cannot be jogged*. **NOTE*** Effective only in Teach mode. This switch has a 3 positional function that cuts off the motor power supply to the robot by releasing this switch completely or pressing in the switch fully.

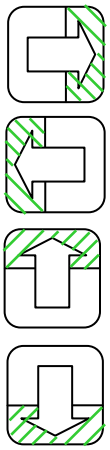
2. Hardware key Functions

No.	Hardware key	Functions	Functions when pressed with ENABLE key
1		Pressed to enable operation of keys pressed together to prevent accidental operations. Also, when pressed simultaneously with keys with two functions, selects the function printed on the upper part of the key. The green keys are used together with ENABLE key.	Unavailable
2		Used together with AXIS keys to operate auxiliary axes. LED lights while aux. axis is in use.	Unavailable
3		For spot welding, arc welding, laser welding, servo MATEHAN, painting and sealing specifications: Selects the coordinate system for manual operation. Press this button to switch among operation modes. 	For spot welding specifications: Selects the interpolation mode in playback motion. Press this button to switch between joint interpolation and linear interpolation. Linear → Joint → Linear For painting and sealing specifications: Press this button to switch among the interpolation modes. Linear →Linear 2 → Circular → Circular2 → Joint → Linear
4		Sets speed level for manual operation. 1*→2→3→4→5→1* **NOTE*** 1 is for inching	Sets speed level for Check GO/BACK. 1→2→3→4→5→1
5		Sets how program is repeated for Check GO/BACK. Toggles between Once and Continuous. Once → Continuous → Once	Holds the robot and stops the cycle operation*. **NOTE*** Cycle operation is not stopped when the robot is held via HOLD/RUN.
6		Changes the active screen: Program display screen → Monitor 1 screen → Monitor 2 screen → Program display screen	Closes the currently active Monitor screen.

No.	Hardware key	Functions	Functions when pressed with ENABLE key
7		Moves JT1. Moves JT7 pressed with AUX.	Unavailable
8		Moves JT2. Moves JT8 pressed with AUX.	Unavailable
9		Moves JT3 Moves JT9 pressed with AUX.	Unavailable
10		Moves JT4	Unavailable
11		Moves JT5.	Unavailable
12		Moves JT6.	Unavailable
13		Starts Check GO (plays back steps in forward order) when pressed while holding the Deadman switch.	Unavailable
14		Starts Check BACK (plays back steps in reverse order) when pressed while holding the Deadman switch.	Unavailable
15		Sets the general purpose output signal number for auxiliary data.	Unavailable
16		Sets the general purpose input signal number for auxiliary data.	Unavailable
17	(10 levels)	Sets the speed level (0 to 9) for auxiliary data. Selecting 10 allows direct input of speed value.(Optional)	Unavailable
18		Sets accuracy level (0 to 4) for auxiliary record data.	Unavailable
19	(10 levels)	Sets wait timer for auxiliary data (0 to 9). Selecting 10 allows direct input of the time.(Optional)	Unavailable

No.	Hardware key	Functions	Functions when pressed with ENABLE key
20		Records the pose and auxiliary data to the selected step.	Overwrites the pose and auxiliary data of a recorded step with the newly entered data.
21		Unavailable	Inserts new steps to a program.
22		For spot welding specification: Clamp 1 instruction changes as below every time this key is pressed. ON→OFF→ON	When pressed with Deadman switch: 1. welds manually with selected gun when manual weld is ON (turned ON via F9 key). 2. pressurizes manually the selected gun when manual weld is OFF (turned OFF via F9 key) (does not weld).
		For servo hand specification: Clamp 1 instruction changes as below every time this key is pressed. ON→OFF→ON	When pressed with Deadman switch: Opens/ closes hand manually while switching Clamp1 signal ON/ OFF.
		For painting and sealing specifications: Unavailable	Unavailable
23		Unavailable	Modifies pose data recorded to a program step.
24		Displays help information. Pressing HELP after pressing FN Reset/ R or <Gun Status> displays help information.	Unavailable
25		Unavailable	Deletes recorded step.
26		Erases data in the input box, calls R code input box, returns to the previous screen, etc.	Unavailable
27		Opens dialog box to select program step.	Opens dialog box to select program.
28		Enters input data into memory, execute procedure, etc.	Unavailable

No.	Hardware key	Functions	Functions when pressed with ENABLE key
29		Backspace key. Deletes the data before the cursor.	Unavailable
30		Enables input of FN instruction. Refer to Chapter 4.	Unavailable
31		Switches to Edit mode when in Teach mode with Deadman OFF. When pressed in Edit mode, ends editing and returns to Teach mode screen.	Unavailable
32		Shows/ hides I/F panel screen.	Unavailable
33		Enters numeric values.	. →－ 0 →＋ 1 →ON (used for manual output of output signals) 2 →OFF (used for manual output of output signals)

No.	Hardware key	Functions	Functions when pressed with ENABLE key
34		Moves the cursor.	1. Teach mode/Playback mode screen: Changes the currently selected active step. (Up/down keys) 2. Edit screen Changes pages. (Up/down keys) 3. In data setting screens: Selects items (Up/down and left /right keys)

2.5 TEACH PENDANT DISPLAY SCREEN

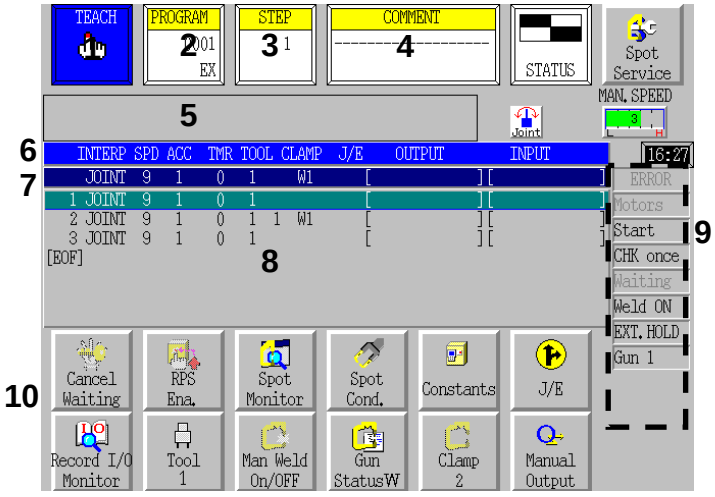
T series controller is equipped with teach pendant containing LCD display as shown in the figure below. This section describes each area in the display and their functions in teach and repeat mode.

2.5.1 TEACH MODE SCREEN

The teach mode screen is divided into display areas and operation keys. The screen partly differs according to the robot application. The screen for servo hand specification is as follows.

2.5.1.1 DISPLAY AREA

This section explains about the display areas. The areas displayed are numbered 1 – 10.



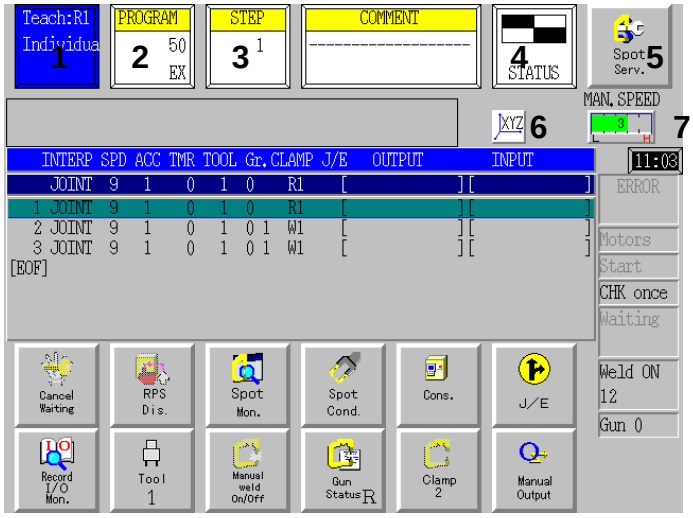
No.	Display area	Contents displayed
1	Teach mode/ Repeat mode	Displays the following information: 1. Teach mode/ repeat mode
2	Program number	Displays the number of currently selected program.
3	Step number	Displays the number of currently selected step.
4	Comments	The first 18 characters written as the comment for Step 1 is shown here. For comments other than on Step 1, see the comment column for each step in the program (scroll to the far right) in edit screen or see the comments written in FN 99 (for FN instruction, see Chp. 4). For painting and sealing specifications, pressing ENABLE

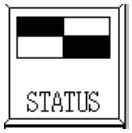
No.	Display area	Contents displayed
		displays the PC program execution status. Maximum of 3 program status are displayed in ascending order (Maximum of 5 programs are executed at one time).
5	Guide message display	Displays error message and other information.
6	Element instruction display (Element instruction bar)	Displays a set of element instructions for each application.
7	Set parameter value display (Parameter value bar)	Displays the auxiliary data set to each instruction for the currently selected step.
8	Program display area	Displays the auxiliary data taught to the steps shown.
9	Status display (area surrounded in dotted line)	Displays the current status of the robot connected. 1. Items that are always displayed in fixed places Error, Motors (Master ON), Start (Executing), CHK cont./ once, Waiting 2. Following items vary display place or are displayed only when the program/ function is active. (Some items are not displayed depending on specifications.) Emergency Stop, GUN number, Weld ON/OFF, Machine lock, etc.
10	Function (F) keys	Displays function keys.

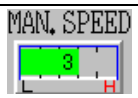
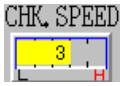
2.5.1.2 OPERATION KEYS

1. Operation keys other than F keys

This section explains operation keys 1- 7 displayed on the top section of the teach mode screen. Some keys may vary according to robot specification.



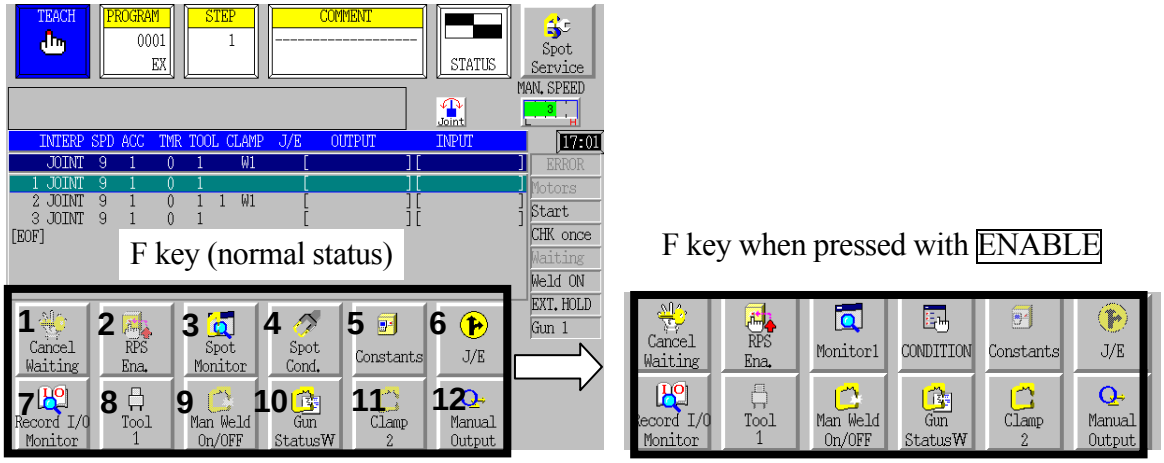
No.	Spec.	Operation Key	Functions	When pressed with ENABLE key	
				Operation Key	Functions
1	All spec.		Pressing this key displays the robot selection screen.		Pressing this key displays the group selection screen.
2	All spec.		Pressing this key displays the Program select screen.		Unavailable
3	All spec.		Pressing this key displays the Step select screen.		Unavailable
4	All spec.		Allows selection of the Monitor 1, Interface Panel, Aux. functions, and keyboard screens.		Unavailable

No.	Spec.	Operation Key	Functions	When pressed with ENABLE key	
				Operation Key	Functions
5	Spot welding		Pressing this key displays the Spot Service screen. Edit information such as weld conditions.		Displays the menu screen for Service. Operations such as monitor setting are selected from this menu.
	Painting and sealing		Displays the menu screen for Service. Operations such as monitor setting are selected from this menu.		
6	All spec.	(Manual operation coordi-nates selection key)	Sets the coordinate system for manual operation in teach mode. The key changes as follows each time it is pressed: Joint axes→Base coordinates→Tool coordinates→Joint axes		
7	All spec.		Selects the speed level for manual operation. Pressing the key switches between the levels (1 to 5).		Selects the playback speed level for Check GO/BACK. Pressing the key switches between the levels (1 to 5).

2. F keys

The table below explains the functions of F keys (1- 12) on teach mode screen.

The location of the F keys vary depending on robot specifications. In spot welding specification, the screen appears as shown below. When ENABLE key is pressed, F keys will be as shown on the right.



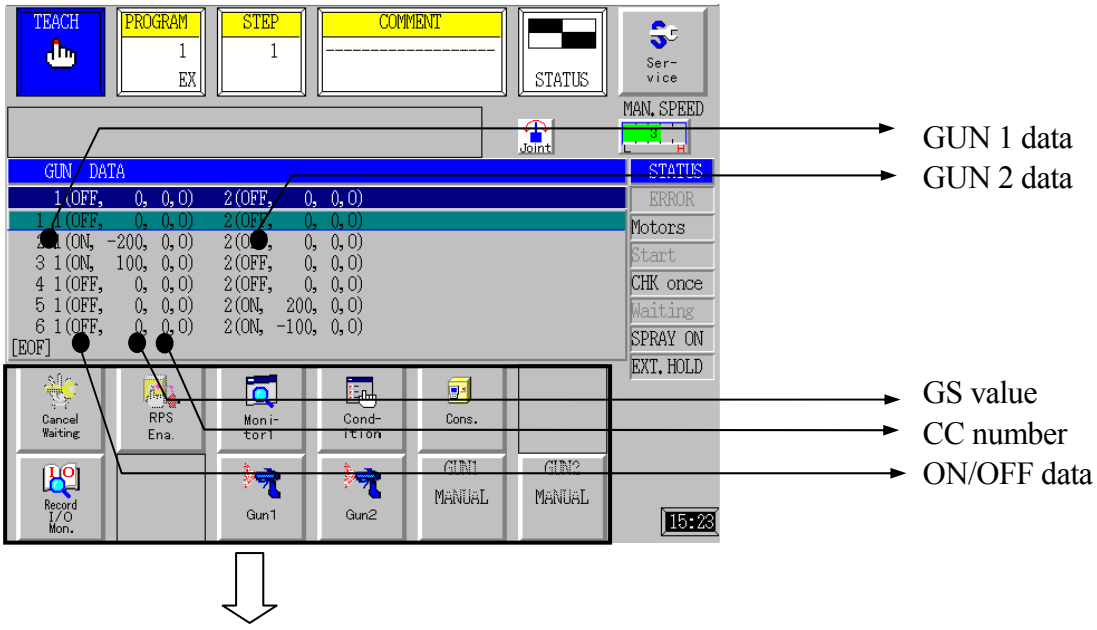
No.	Specification	F key	Functions	When pressed with ENABLE key	
				F key	Functions
1	All specifications		(Unavailable. Icon is shown shaded.)		Releases I waiting, WI waiting (spot weld) and J/E waiting.
2	All specifications		(Unavailable. Icon is shown shaded.)		Selects whether or not to enable RPS. The current status is indicated on the F key.
3	Spot welding, robot base		Short cut key to the spot weld monitor.		Displays list of monitoring functions, such as axis monitor.

No.	Specification	F key	Functions	When pressed with ENABLE key	
				F key	Functions
	Painting and sealing		Displays list of monitoring functions, such as axis monitor.	Same as above	Same as above
4	Spot welding, robot base		Sets conditions to weld manually.		Sets teach/ repeat conditions. The condition screen can also be called from Service screen.
	Painting and sealing		Sets teach/ repeat conditions. The condition screen can also be called from Service screen.	Same as above	Same as above
5	Spot welding, robot base, painting and sealing		Calls Constant function screen where actual operation data such as tool data are set.		(Unavailable. Icon is shown shaded.)
6	All specifications		Records J (jump) and E (end) instructions. Toggles between J (Jump) and E (End) instructions. OFF→J→E→OFF		(Unavailable. Icon is shown shaded.)
7	Spot welding, servo hand, robot base, painting and sealing		Displays the name of IO signal taught in current step. If no signal is taught in the selected step, nothing is displayed.		
8	Spot welding, servo hand, servo MATEHAN, robot base, painting and sealing		Sets tool number for the tool instruction. The number shown on the key is the currently selected tool number.		(Unavailable. Icon is shown shaded.)
9	Spot welding, servo hand		(Unavailable. Icon is shown shaded.)		Turns ON/OFF Manual Welding. The sparks are shown in red when Welding is ON.

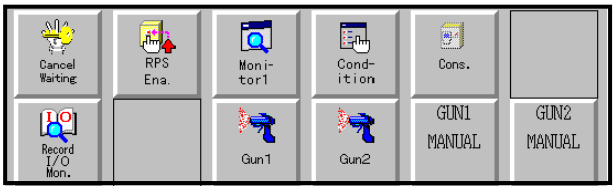
No.	Specification	F key	Functions	When pressed with ENABLE key	
				F key	Functions
	Painting and sealing		Sets Gun control information (GS value, CC number) for GUN1. See Chp. 4 for details.		Sets GUN1 ON/OFF information.
10	Spot welding		Sets gun status information, an instruction proper to spot welding (normal welding, etc.). See Chp. 4 for details.		Manually connects/ disconnects gun to controller in control circuit when gun status information is set to 4(A)/0(R).
	Robot base		(No key available for robot base specification.)		(No key available for robot base specification.)
	Painting and sealing		Sets Gun control information (GS value, CC number) for GUN2. (Only when GUN2 is used).		Sets GUN2 ON/OFF information.
11	Spot welding, Servo hand		(Unavailable. Icon is shown shaded.)		Open/ closes Clamp 2. The clamp signal data changes accordingly.
	Robot base		(Unavailable. Icon is shown shaded.)		Open/ closes Clamp 2. The clamp signal data changes accordingly.
	Painting and sealing		Sets whether to perform workpiece deviation compensation (C) or not (0=no display). (Option)		Sets whether to perform workpiece deviation compensation (C) or not (0=no display). (Option)
12	Spot welding, robot base, painting and sealing		Sends output signal manually. Also resets signals when setting the signal number to 0.		Same as left.

2.5.1.3 GUN DATA SCREEN (PAINTING AND SEALING SPECIFICAITON ONLY)

In painting and sealing specification, there is a second page to the teach mode screen to set gun data necessary to use sealing gun. Press ENABLE + → to display the gun data screen.



F keys when ENABLE key is pressed:

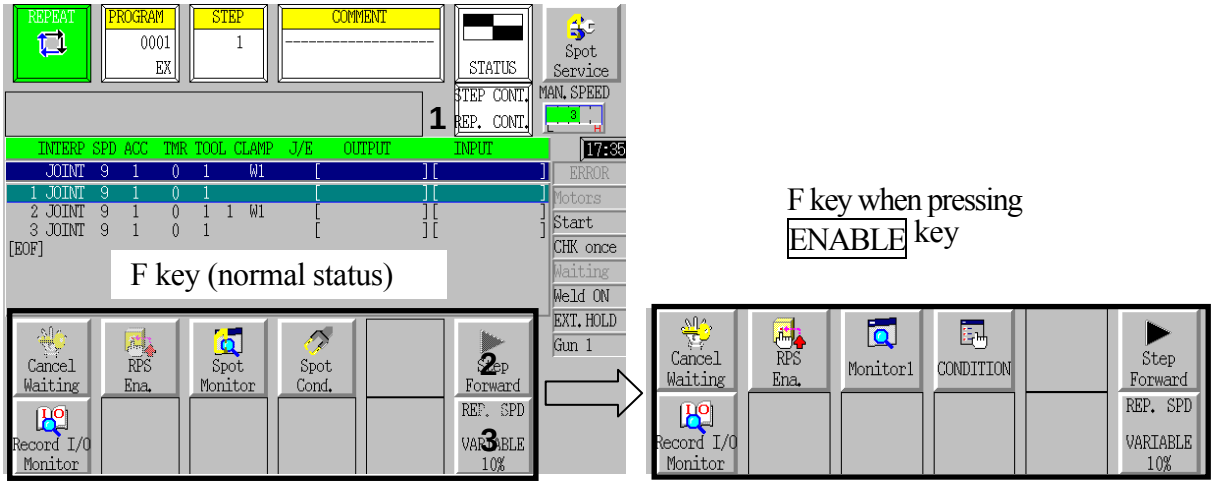


The following operation keys are displayed only in gun data screen.

No.	Specifi-cation	F key	Functions	F key	Functions when pressing Enable
11	Painting and Sealing		(Unavailable. Icon is shaded.)	GUN1 MANUAL	Outputs GUN1 signal while the key is pressed.
12	Painting and Sealing		(Unavailable. Icon is shaded.)	GUN2 MANUAL	Outputs GUN2 signal while the key is pressed. (Only when GUN2 is used.)

2.5.2 REPEAT MODE SCREEN

In repeat mode, the teach pendant screen is divided into display areas and function keys as in teach mode. Some keys and displays vary according to robot specifications. In spot welding specification, the screen appears as shown below. When ENABLE key is pressed, the F keys change as shown on the right.



2.5.2.1 OPERATION KEYS

This section explains the function keys shown only on repeat mode screen. See the following table. Some keys may not appear in some specifications.

No.	Specifi-cations	Operation Key	Functions	When pressed with ENABLE	
				Operation Key	Functions
1	All specifi-cations	STEP CONT. REP. CONT.	Sets repeat conditions*. Current setting is displayed on the key.		Unavailable
2	All specifi-cations		(Unavailable. Icon is shown shaded.)	Step Forward	Used to execute steps one by one when [Step Once] is selected.
3	All specifi-cations		(Unavailable. Icon is shown shaded.)	REP. SPD VARIABLE 10%	Changes repeat speed temporarily without changing the recorded speed.

NOTE* There are four (4) repeat conditions. Refer to the chart below.

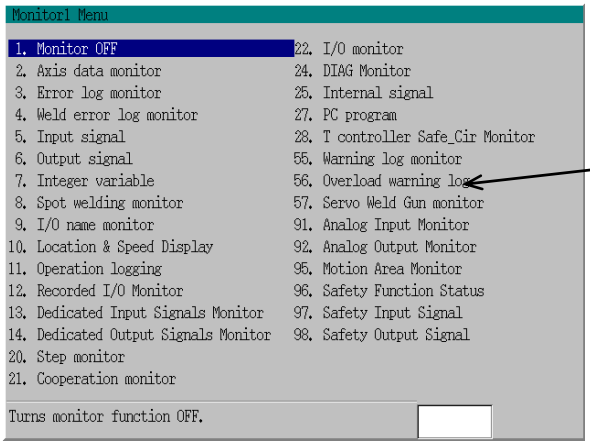
		STEP	
		ONCE	CONT.
REPEAT	ONCE	Executes 1 step and then stops. (Cycle stays ON). Pressing ENABLE+<Step Forward> executes the next step. Execution stops at the last step**.	The steps are executed continuously. Program execution stops when the last step** is reached.
	CONT.	Steps are executed one by one as above. (Cycle stays ON). Pressing ENABLE+<Step Forward> executes the next step. When the last step** is reached, program is repeated from the first step. When RPS is ON, execution program is changed by program selection signal at the step with END instruction.	The steps are executed continuously, and when the last step** is reached, program is repeated from the first step. When RPS is ON and an END instruction is processed, the program execution depends on the RPS signal received. This is the setting for normal playback operations.

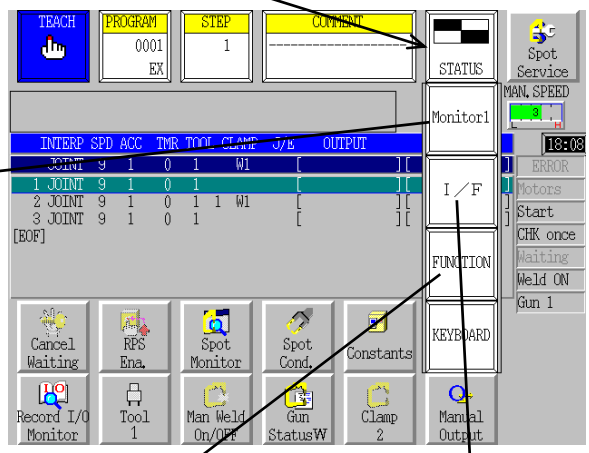
NOTE** The step with either largest step number or END instruction

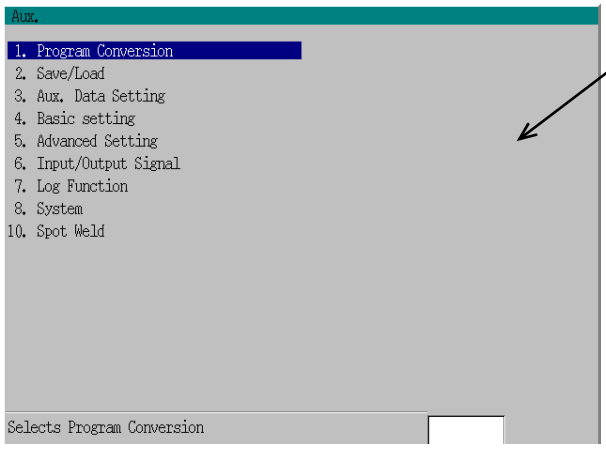
2.5.3 STATUS DISPLAY

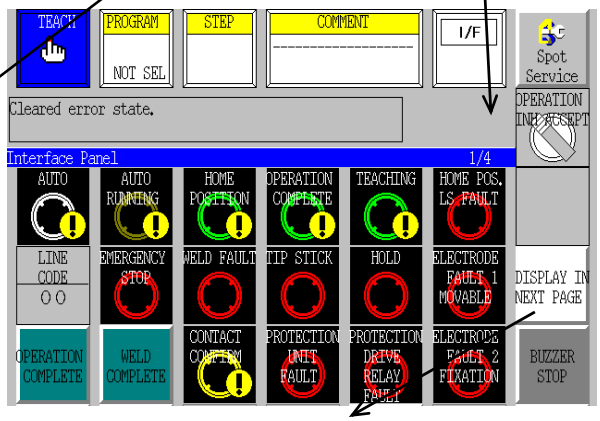
2.5.3.1 FUNCTIONS OF STATUS DISPLAY

The following pull-down menu is displayed when <STATUS> is pressed in teach or repeat mode and screens shown below can be displayed.

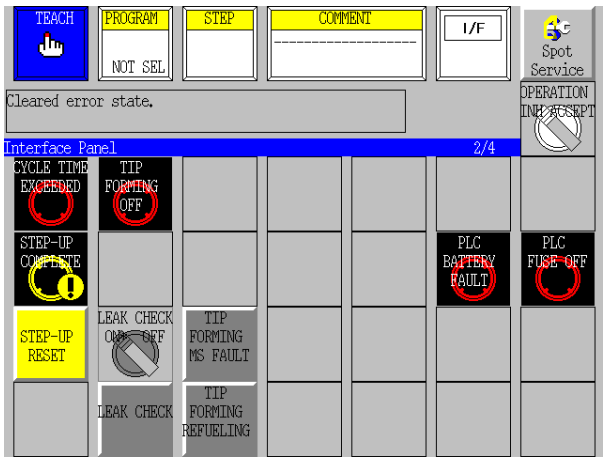








ENABLE+⇩ : Displays next page



[CAUTION]

1. Pressing I/F in the top screen of teach or repeat mode displays the Interface Panel screen. Press I/F key again to close the screen.
2. Display of the screen via external signal can be enabled or prohibited by optional setting.

3.0 MANUAL OPERATION

This chapter explains the procedures for manual operation for both robot arms and their additional axes (servo weld gun, etc.). For additional axes, parameter settings are necessary before using them. For details, see the chapters corresponding to each application.

3.1 STARTING OPERATION

This section explains how to manually operate one of the robot arms connected to a multiple arm controller. For single arm controller, the procedure is the same except for robot and group selection procedures.

Operation procedures:

1. Connect teach pendant to controller.

2. Select the robot for manual operation. Both hardware and software setting are necessary:

   (1) Hardware setting: Connect the teach plug to the desired robot.

   (2) Software (controller) setting: After turning ON the controller power, press <Teach> key on TP and select the robot. Then, press ENABLE + <Teach> and enter 0 (zero) as the group number (individual operation).

[NOTE]

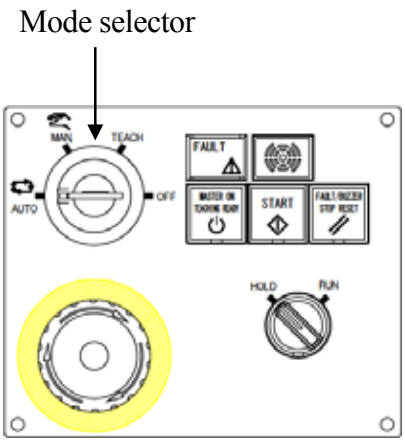
Error occurs when hardware and software setting are different.

3. Set the MODE SELECTOR on the operation panel to TEACH.

4. Press TEACHING READY on the operation panel and confirm Motor power and Teaching Ready lamps lights.
   ON lamps light.

5. Turn HOLD/ RUN to RUN.

6. Holding the Deadman switch turns ON the servo control.

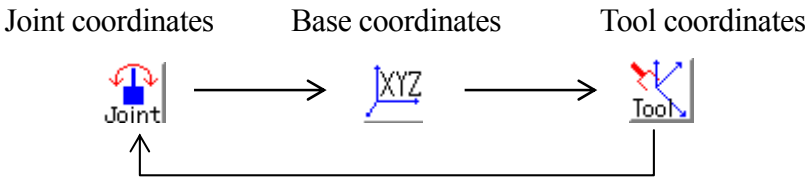


This ends the procedure for getting the selected robot ready for manual operation.

3.2 MANUAL OPERATION OF ARM AXES

There are three types of robot operation modes: joint coordinates based operation, base coordinates based operation, and tool coordinates based operation, depending on which coordinate system the motion is based. This section explains operation procedure for each of the three modes.

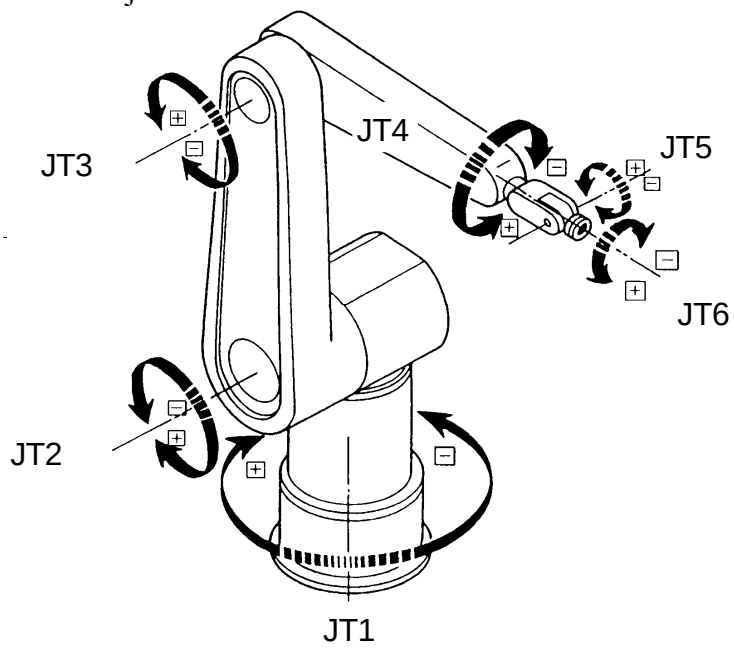
Press COORD / <Manual operation coordinates>to select from joint, base, or tool coordinates. The selection determines the coordinates on which manual operation is based.



Next, press TEACH SPEED and select manual operation speed level from 1 – 5. The speed level changes in order of 1-5 every time the key is pressed. The actual speed is taught to each speed level in <Constant> - [6. Manual/Check speed] – [1. Teach speed] (R56).

3.2.1 OPERATION BASED ON JOINT COORDINATES

In this mode, each joint of the robot can be moved individually via Axis key. For rotational axis, the joint rotates around the joint axis.

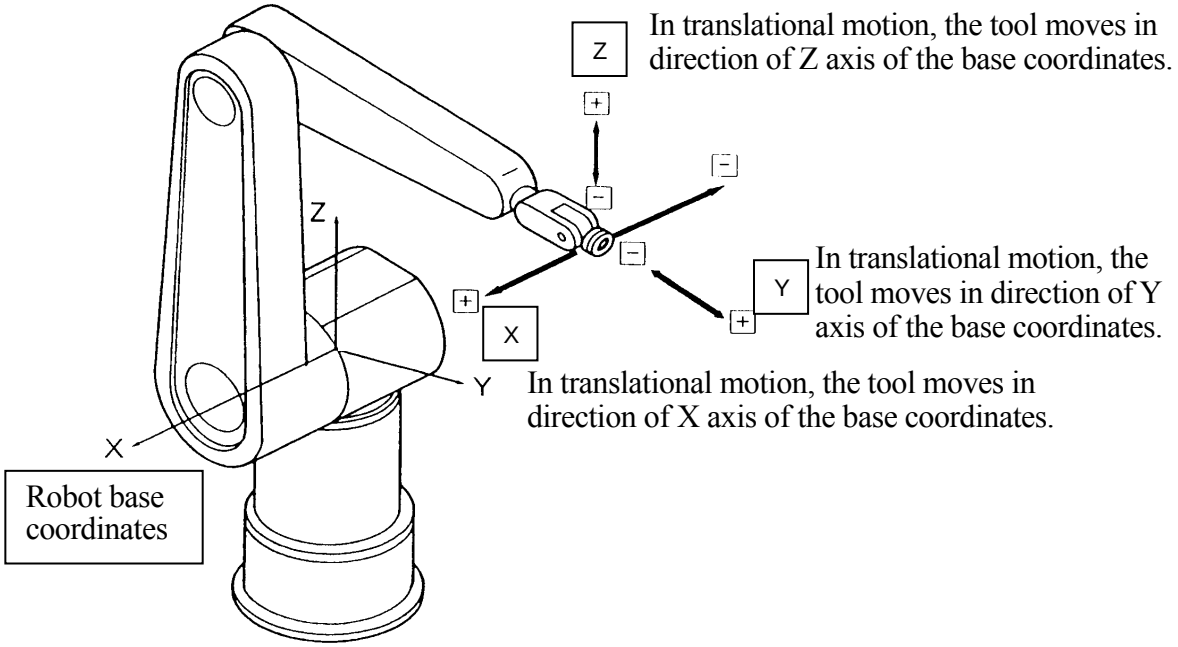


Traverse axis carrying a robot arm can be operated manually like the arm axes via AUX + Axis key.

3.2.2 OPERATION BASED ON BASE COORDINATES

In this mode, robot executes translational or rotational motion as a result of compound motion of robot joints. Pressing [X], [Y], [Z] jogs the tool based on the base coordinates, thus parallel to the base coordinates while keeping the posture of the tool.

Pressing the rotational axes keys [RX], [RY], [RZ] jogs the tool around X, Y, Z axes of the base coordinates while keeping the TCP (Tool Center Point, origin of tool coordinate system) position fixed.

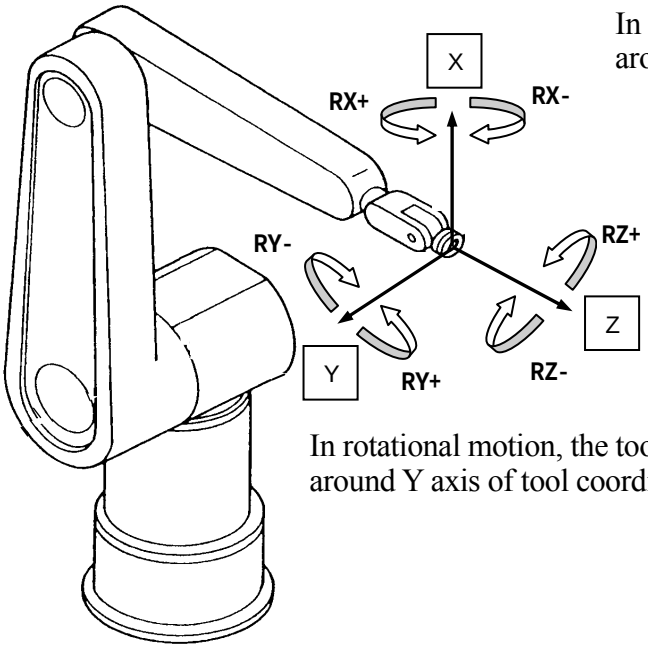


3.2.3 OPERATION BASED ON TOOL COORDINATES

This mode is also a compound motion of robot joints and the robot executes translational or rotational motion. In this mode, pressing X, Y, Z keys jogs the tool parallel to the tool coordinates while keeping the robot tool posture unchanged.

Tool coordinates can be set to desired pose in <Constant> – [3. Auxiliary data] – [3. Tool dimension] (R48), but for convenience, the direction of XYZ axes are fixed for some applications. See the chapters for each application for details.

Pressing the rotational axes keys RX, RY, RZ jogs the tool around X, Y, Z axes of the tool coordinates while keeping the TCP position fixed.



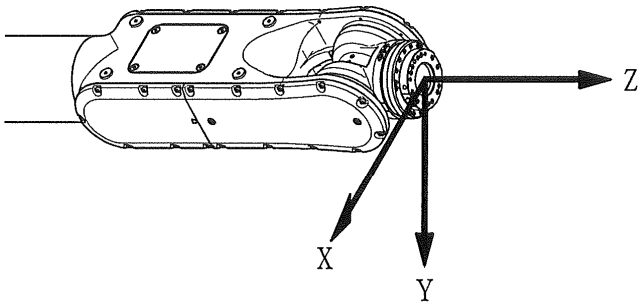
In rotational motion, the tool rotates around X axis of tool coordinates.

In rotational motion, the tool rotates around Z axis of tool coordinates.

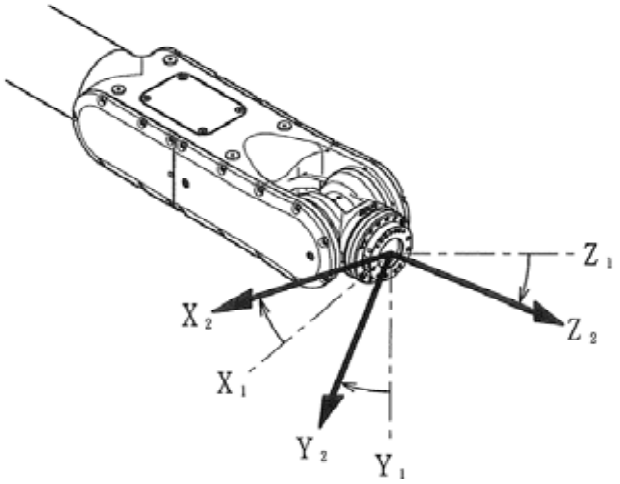
In rotational motion, the tool rotates around Y axis of tool coordinates.

Tool coordinate system is defined on the tool which is installed on JT6. The tool coordinates change whenever the pose of the robot changes (refer to the figures below). Operations based on this tool coordinate system will differ in motion direction depending on the coordinates transformation to the null-tool coordinates.

When forearm is horizontal.



When forearm faces downward.



Tool coordinates also change when wrist orientation changes as shown in figures above, even though only the forearm moves without moving wrist axes.

3.3 MANUAL OPERATION FOR AXES OTHER THAN ARM AXES

This section explains the operation procedure for additional axes other than the arm axes controlled via the controller.

3.3.1 SERVO WELD GUN OPERATION

3.3.1.1 CONNECTING SERVO WELD GUN

Manual gun operation requires gun and controller to be connected in control system as well as hardware mounting to wrist flange.

For connection of gun to controller in control system, press <Gun Status>. Input box for Gun status appears, so enter 4 to set the information to A (connection). At this state, press ENABLE + <Gun Status A>. This executes automatic zeroing of the gun axis*.

For disconnection of the gun**, input 0 in the Gun status input box and set the gun status to R (disconnection). Then, press ENABLE +<Gun Status R>.

NOTE* Gun axis opens and closes for automatic zeroing, so turn the motor power ON and press Deadman. Also, check for any interference with peripheral equipments, etc. before executing this function.

NOTE** In teach mode, executing this disconnection enables operation of joints other than the gun axis, even when the error in the gun axis cannot be released.

3.3.1.2 OPENING / CLOSING OF SERVO WELD GUN

Servo weld gun can be operated manually using Axis or CLAMP key. For operation via Axis keys, press AUX. first and confirm the LED for the key turns on. Press JT7-/JT8- for opening, and JT7+/JT8+ for closing the gun.

Gun axis speed is set at <Constant> - [6. Manual/ Check Speed] - [1. Teach speed], but the speed when closing the gun is limited to 80 mm/s.

Tip force is set at <Spot Service> - [20. Servo weld gun condition]. Enter the desired tip force for [Tip force at Teach] in the screen that appears.

[NOTE]

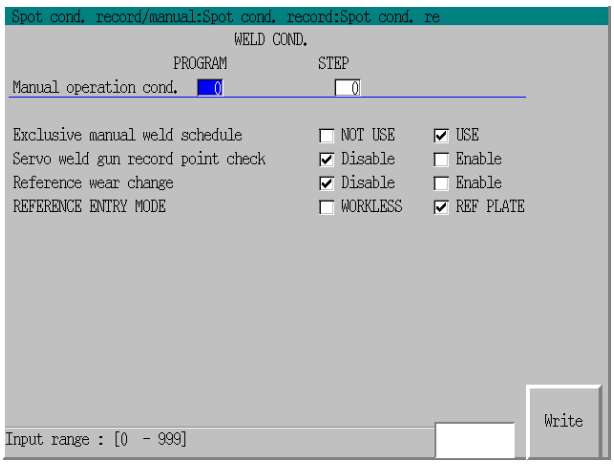
1. When more than one guns are connected to 6 axis robot, Axis keys are basically assigned to the guns in order of JT7, JT8 and so forth.
2. Assignments of keys to guns may differ from above when there are additional axes, such as traverse axis, other than servo weld guns.
3. The gun axis speed for closing motion is limited to maximum of 80 mm/s.

Gun operation using CLAMP key is unique to servo weld gun applications. For details, see Chapter A.

3.3.1.3 MANUAL PRESSURIZING AND WELDING BY SERVO WELD GUN

Follow the procedure below to manually pressurize and weld by servo weld gun. Manual pressurizing and welding can be used to determine weld conditions, etc.

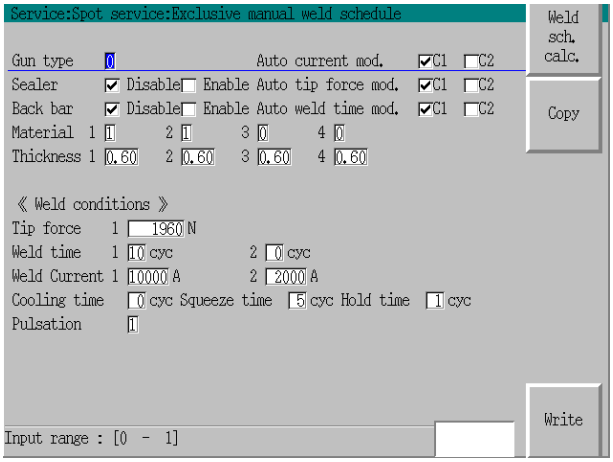
1. Press F key <Spot Condition>. The screen below appears.



In this screen, select whether or not to use the [Exclusive manual schedule]. When selecting [NOT USE], specify the program step with the desired welding conditions in [Manual operation cond.]

When selecting [USE], follow the next procedure to set the weld conditions for manual welding.

2. Press <Spot Service> and select [5 Exclusive manual schedule]. The screen below appears.



In this screen, enter data for the items on the upper half of the screen and press <Weld sch. calc.> to calculate data for the items on the lower half of the screen. You may also directly enter to the items on lower half of the screen.

3. For manual pressurizing, turn OFF welding by pressing ENABLE + <Manual Weld On/Off>. Then press Deadman + ENABLE + CLAMP to pressurize the gun. *

NOTE* 1. Only the moving tip moves here. Fixed tip does not move.
2. Gun pressurizes when clamp signal turns OFF → ON.
3. Gun starts closing at the manual speed set at the step where clamp signal turns ON.
4. Tip force for this gun pressurizing operation is set in <Spot Service> – [20 Servo weld gun condition].

4. For manual welding (electrification), turn ON welding by pressing ENABLE + <Manual Weld ON/OFF>. Then press Deadman + ENABLE + CLAMP to start the manual weld sequence. **

⚠ WARNING

In manual welding, not only does the gun close, but also actual welding is performed using the set conditions (exclusive manual schedule or welding conditions taught at specified step of program).

NOTE** Only the moving tip moves here. Fixed tip does not move. (To perform welding, place the fixed tip so it touches the workpiece.). Welding sequence*** starts after moving tip moves.

NOTE*** Welding sequence is as follows:
1. Servo weld gun pressurizes workpiece.
2. Outputs Welding Start signal.
3. Waits for input of Weld Completion signal.
4. Weld Completion signal is input.
5. Moving tip opens to the position where clamp was turned ON. (Fixed tip does not move).

3.3.2 PAINTING AND SEALING GUN OPERATION

3.3.2.1 MANUAL OPERATION OF GUN

When [Enable] is selected in <Service> - [1 Teach/Repeat condition] -
[2 Spray Enable/ Disable], gun can be operated manually by pressing ENABLE +
<GUN 1/2 MANUAL> (F11, 12) keys in Gun data screen (displayed by pressing ENABLE + →
in Teach mode screen).

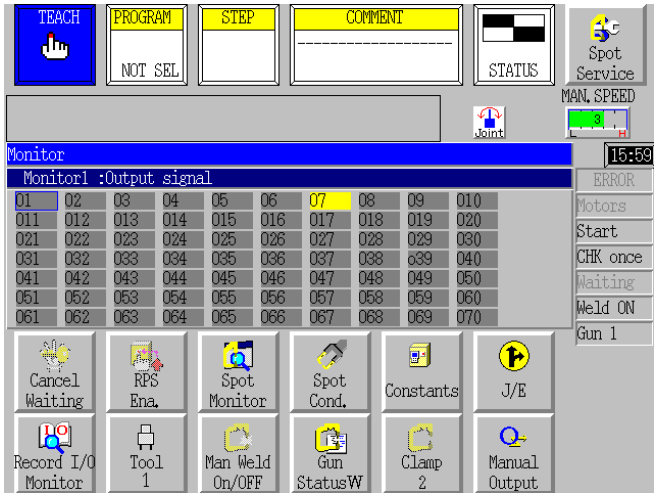
Sealant is actually sprayed from the gun when the sealant is supplied to the gun.

3.4 FORCED SIGNAL OUTPUT VIA TP

In teach mode, general signals can be output manually following the procedure below. Signals defined as dedicated signals cannot be output manually.

Operation procedure:

1. Open O Signal Monitor. (Here, O Signal monitor is displayed as Monitor 1.)



2. Using the SCREEN SELECT key on the top right corner of the TP keys activates the monitor screen.

3. Select the signal to output via the cursor using the cursor keys.

4. The signals are turned ON with Deadman + ENABLE+ ON. Signals that are turned ON are indicated in yellow on the screen.

5. The signals are turned OFF with Deadman + ENABLE + OFF.

[NOTE]

1. The signal forced to turn ON remains ON unless:
(1) forcibly turned OFF or
(2) a step taught to turn OFF the signal is executed in check or repeat mode.

2. Only one signal can be turned ON or OFF manually at a time.

Signal can also be output manually via F12 <Manual Output> key.

4.0 TEACHING

Teaching is defined as programming to make the robots do the required operations. T series controller makes it possible to create program using the combination of following three methods, categorized according to the method used.

1. Robot used: robot actually used (On-line teaching)/ robot actually not used (Off- line teaching)
2. Tools used: Teach pendant (hereafter TP)/ PC/ combination of two devices
3. Instructions used: Block instruction / AS language instructions

As for the instructions used, teaching by block instruction requires preparation of element instructions (interpolation, speed, accuracy, timer, I/O signals, etc.) necessary for each application. Parameter values indicating number and characters for the amount and selection for each element instruction are recorded to each step in the program with position and posture (hereafter pose, combining the two) data. Parameter values for each element instructions are called auxiliary data or "step status" in the sense that they indicate the "status" of the parameters to be "recorded" to each step. To make data modification easier, some element instructions such as speed, accuracy, and timer are recorded indirectly using numbers indicating the amount of the corresponding element. The actual amounts corresponding to each number are set using a different function; constant function.

Auxiliary data to be recorded differs according to the application. Basically, data for robot motion conditions, input/ output control conditions, tool operation conditions when controlling operation tools by the robot controller (servo spot weld gun, servo torch for arc welding, etc.), and other special conditions are recorded as auxiliary data. Parameter values are selected and set via the teach pendant hardware and on-screen keys and buttons. For those applications such as spot welding that requires a large number of auxiliary data and is difficult to set data using dedicated keys, special screens for setting the data for each application are prepared. In this case, some settings are done automatically by entering familiar condition data such as material thickness.

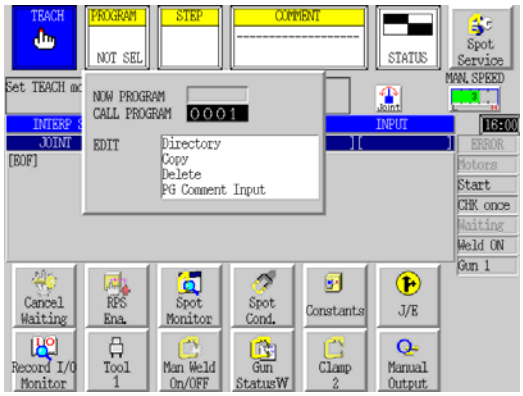
Data transformation is necessary to compensate the difference between robot-to-workpiece pose in off-line and online teaching when pose data is taught off-line.

On the other hand, AS language programming is usually done by inputting the AS instructions directly via the keyboard. AS language programming enables usage instructions not included in ordinary block instruction, therefore may make it unnecessary to add new element instructions even for new application. Refer to the AS language manual for details. In this manual, block teaching is explained using actual robot and teach pendant.

4.1 SELECTING PROGRAM AND STEP NUMBER

Next, select the program number of the program to record the data taught to the robot.

1. Press <Program> on the TP screen or press ENABLE+PROG. Dialog box for program selection appears.
2. Enter the desired program number in [Call program] using Number keys and press ↵.
3. Program corresponding to the entered number is selected.



Step 0 is displayed for new program. To add to existing program, select the last step in the program by pressing <STEP>/ STEP and entering the step number for that step.

[NOTE]

When the selected program already exists, maximum of 7 lines starting from step 1 are displayed on the program display area.

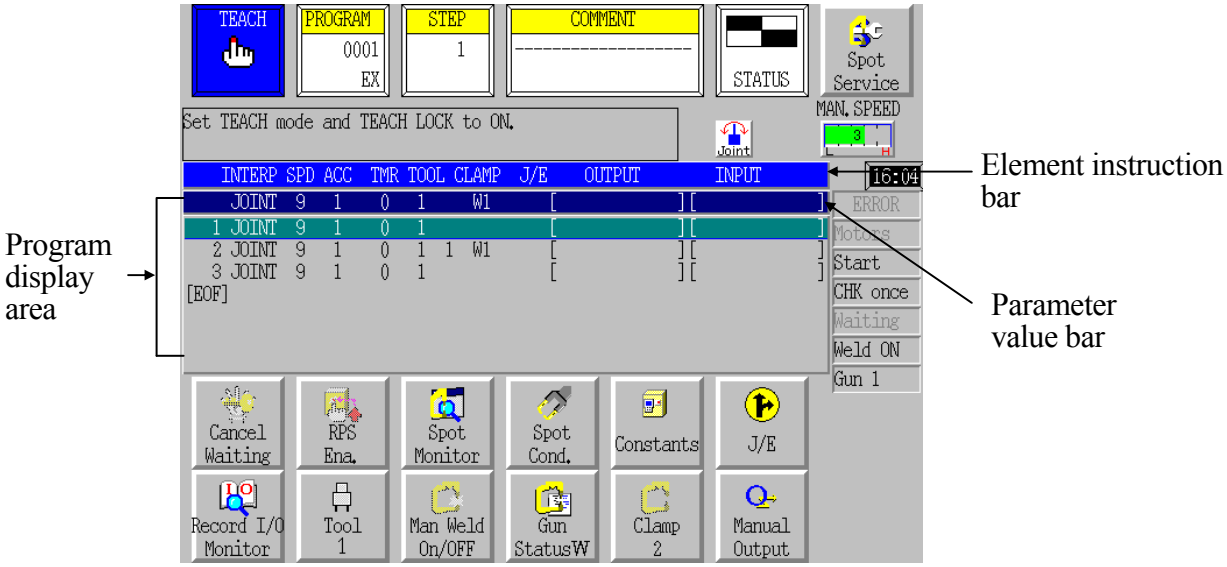
4.2 ELEMENT INSTRUCTIONS AND THEIR PARAMETERS

This section explains the element instructions and procedures for setting their parameters. Element instructions necessary for the application are preset and displayed on the element instruction bar, as shown in the figure below. Under each element instruction, value of the parameter needed for that instruction is displayed.

Some element instructions are not displayed on the element instruction bar due to limited space, although their parameters are displayed on their parameter value (auxiliary data) display bar. For example, in spot weld application using servo weld gun, gun status instruction is not displayed on the element instruction bar, though the set parameter values for the instruction are displayed in the parameter value display bar.

There are also element instructions such as comment instructions and FN instructions that are not displayed even on parameter value bar and require few extra procedures to view/edit the contents.

The parameter values are selected/set using teach pendant keys and <F (function) keys>.



Element instructions, their relating parameter values and setting procedures are summarized in the table below for each application.

Servo spot welding specification

Element intruc-tion	Interpo-lation	Speed	Accu-racy	Timer	Tool	Clamp	Gun Status		J/E	Out-put	Input
Para-meter	Linear/ Joint	0-9	0-4	0-9	1-9	No disp., 1-2	0-11 (R-M)	1-4 (gun)	J/E	1-64 or 1-96	1-64 or 1-96
Setting proce-dure	ENABLE +INTERP	SPD	ACC	TMR	<Tool>	CLAMP <Clamp 2>	<Gun Status>	Num	<J/E>	OUT	IN

Painting and sealing specification

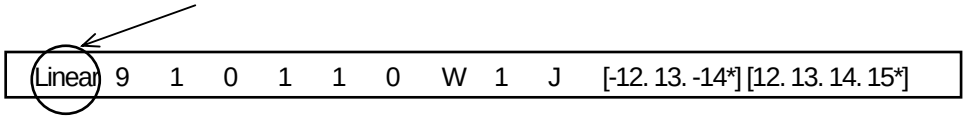
Element intruc-tion	Interpo-lation	Speed	Accu-racy	Timer	Tool	Gun	Work-piece (WK)	J/E	Out-put	Input
Para-meter	Linear/ Joint	0-10	0-4	0-9	1-9	No display,1-2, GS, CC	No display,/ C	J/E	1-64 or 1-96	1-64 or 1-96
Setting proce-dure	ENABLE+ INTERP	SPD	ACC	TMR	<Tool>	ENABLE+ <Gu1/2 >	<Work>	<J/E>	OUT	IN

The next sections explain the element instructions.

4.2.1 INTERPOLATION INSTRUCTION

To set the interpolation mode (linear* or joint**) for the motion from the previous step to the current one, press ENABLE + INTERP.

The display toggles between linear and joint every time the key is pressed.



NOTE* TCP moves along the line connecting the two taught points while changing its posture according to the distance between the two points.

NOTE** TCP moves so that the difference of joint values between the two taught points decrease at the same proportion in all joints. Select this mode when priority is given to the time it takes to move between the two points, rather than the path the robot takes.

For painting and sealing specification:
Select interpolation mode from Joint, Linear, Lin(ear)2*, Cir(cular)1**, and Cir(cular)2***.
The display changes as below each time ENABLE + INTERP. are pressed.

Joint → Linear → Lin2 → Cir1 → Cir2 → Joint

NOTE* TCP moves along a line connecting the two taught points while interpolating the joint values equally among all wrist axes.

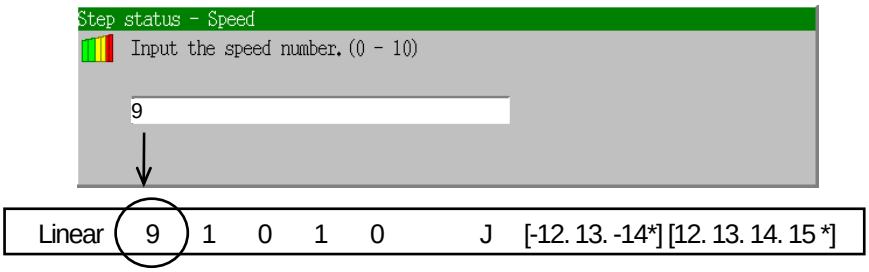
NOTE** The robot takes a circular interpolation motion with this taught point as the start or mid point of the circle.

NOTE*** The robot takes a circular interpolation motion with this taught point as the end point of the circle.

4.2.2 SPEED INSTRUCTION

Pressing SPD displays the screen for speed parameter setting. Press Number keys and enter the speed number (0-9). Press ↵ to confirm the input number. This sets the motion speed level from the previous step to the current step.

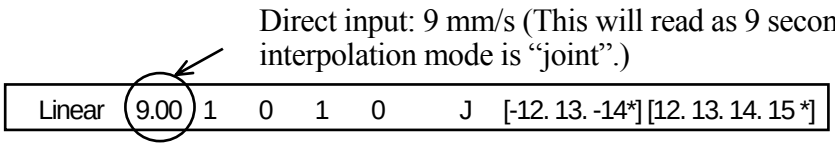
The actual speed represented by the speed number is set in <Constant> →
[3 Auxiliary data] → [1 Speed]. Actual speed is set as a percentage (%) of the maximum speed.



Direct speed setting:
(Available speed level range 0 –10, when optional direct speed setting is enabled.)

Input 10 as the speed number and press ↵. An input box appears so enter the motion speed in unit of second or mm/s using Number keys. Press ↵ to confirm. The unit of speed differs according to the interpolation mode being set.

For joint interpolation mode: motion speed between two taught points, in units of second
For linear/circular interpolation mode: speed of linear motion between taught points, in units of mm/s



[NOTE]

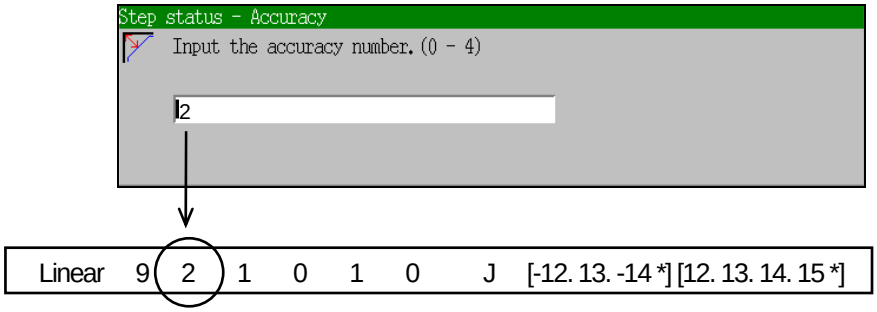
This function is enabled/ disabled by option setting according to the specification.

4.2.3 ACCURACY INSTRUCTION

Pressing ACC displays the screen for accuracy parameter setting. Enter the desired accuracy number (0-4) via the Number keys. Press ↵ to confirm the input number. This sets the level of accuracy needed for axis coincidence with the taught point in the current step.

The actual accuracy represented by the accuracy number is set in <Constant> →
[3 Auxiliary data] → [2 Accuracy]. The accuracy is set as the approaching distance to the object

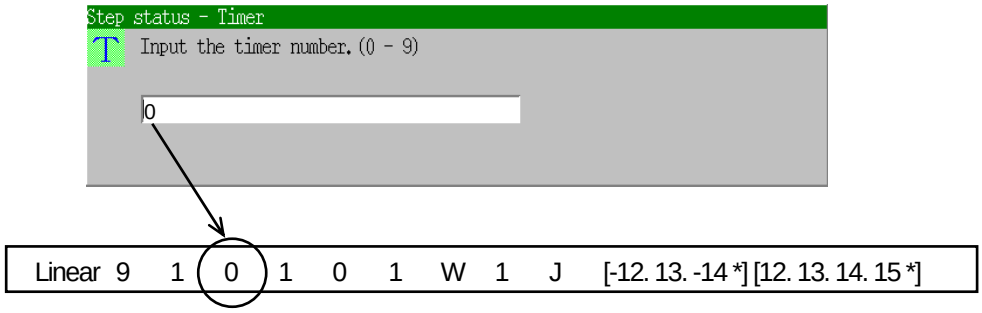
point. When the TCP enters the set accuracy range, it is processed as “axes coincidence”. When accuracy is set to 0, axes coincidence is verified by the current values. When accuracy is set to 1-4, axes coincidence is verified by the command values.



4.2.4 TIMER INSTRUCTION

Pressing TMR displays the screen for timer parameter setting. Enter the desired timer number (0-9) via the Number keys. Press ↵ to confirm the input number. This sets the time to wait after axis coincidence with the taught point in the current step.

The actual waiting time represented by the timer number is set in <Constant> → [3 Auxiliary data] → [5 Timer].



Direct timer setting:
(Available timer level range 0 –10, when optional direct timer setting is enabled.)

Input 10 as the timer number and press ↵. Input box appears so enter the timer value in unit of second using Number keys. Press ↵ to confirm. Acceptable range is 0.0 – 99.9.

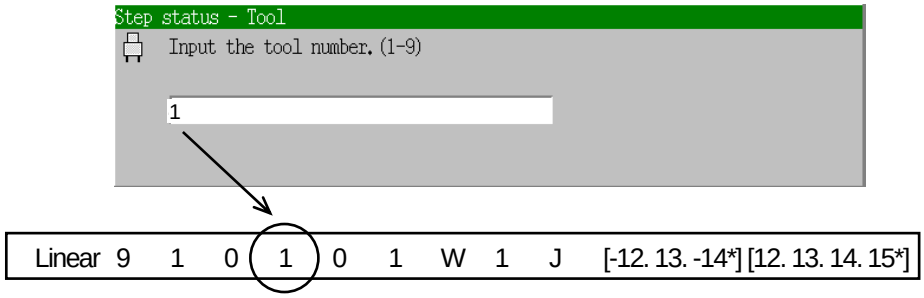
[NOTE]

This function is enabled/ disabled by option setting according to the specification.

4.2.5 TOOL INSTRUCTION

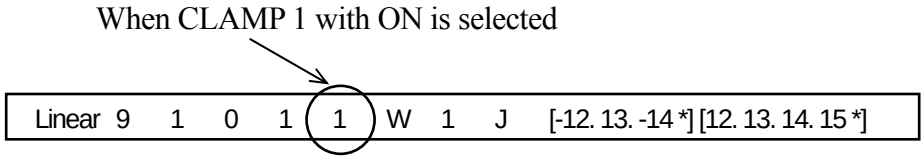
Pressing <Tool> displays the screen for tool parameter setting. Enter the desired tool number (1-9) via the Number keys. Press ↵ to confirm the input number. This sets the tool coordinates used when moving to the taught point.

The tool data represented by the tool number is set in <Constant> → [3 Auxiliary data] → [3 Tool Dimension].



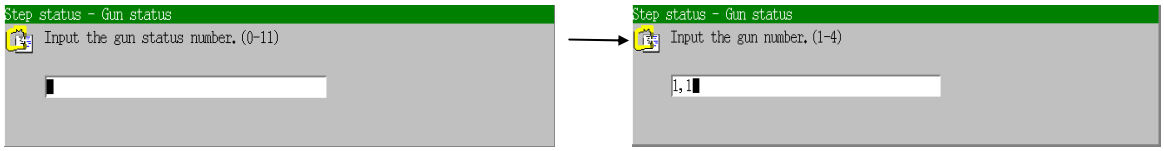
4.2.6 CLAMP1/ CLAMP 2/ CLAMP 3 INSTRUCTION

Set the clamp instruction to be executed after axes coincidence in the taught step by specifying ON/OFF of the signal. To turn ON/ OFF clamp 1, press CLAMP. To turn ON/ OFF clamp 2 and 3, press ENABLE + <CLAMP2> or <CLAMP3>. The signal turns ON/OFF every time the key(s) is pressed. The display on parameter value bar changes between clamp number (1, 2 or 3) and no display corresponding to signal ON/OFF.



4.2.7 ELEMENT INSTRUCTION FOR SERVO WELD GUN SPECIFICATION

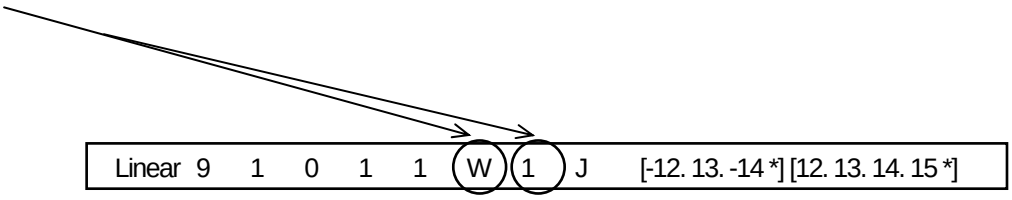
Pressing 〈Gun Status〉 displays the screen for gun status parameter setting*. Select desired control mode in spot welding via Number keys and press ↵. Then, another dialog box for gun number appears, so enter the gun number** via Number and press ↵. This sets the type of control executed after axis coincidence at the taught point of the current step with the gun used in that operation.



NOTE* Alphabets corresponding to the gun status number below are shown on <Gun Status> key and in parameter values display bar for the set gun status.

Gun Status Number	Display	Contents
0	R	Gun disconnection
1	W	Normal weld
2	K	Wear measuring by workless clamping
3	P	Wear measurement by reference plate
4	A	Gun connection
5	L	Leakage check
6	F	Fast pressurizing mode
7	H	Tip dressing
10	C	Weld with copper plate
11	M	Measurement for workpiece deviation

The parameter value bar appears as below when both gun status number and gun number are set to 1.



[NOTE]

1. Normally use clamp 1 and 2, with maximum of 2 servo weld guns.
2. Screen and operation changes are necessary to use more than 3 clamps. Consult Kawasaki when changes are necessary.

4.2.8 ELEMENT INSTRUCTIONS FOR PAINTING AND SEALING SPECIFICATION

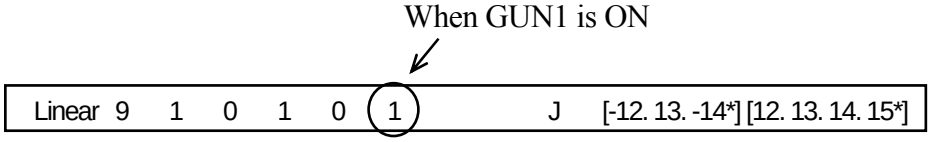
This section explains the element instructions and their parameters unique to painting and sealing specifications.

4.2.8.1 GUN INSTRUCTION

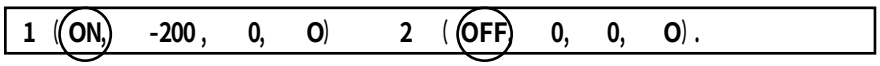
To execute gun instruction in a program, set 3 parameters to control of gun ON/OFF status and signal output timing (gun control information). The set data can be seen in Gun Data screen, displayed by pressing ENABLE + → in Teach mode screen. Gun signal ON/OFF status is also shown in parameter value bar displayed in Teach mode screen.

1. Gun Signal ON/OFF

Set the gun ON/OFF condition. Press ENABLE + <GUN1> or <GUN2> to set ON/ OFF condition of each gun. The ON/OFF status changes every time the keys are pressed. The display on parameter value bar changes between gun number (1 or 2) and no display corresponding to signal ON/OFF.



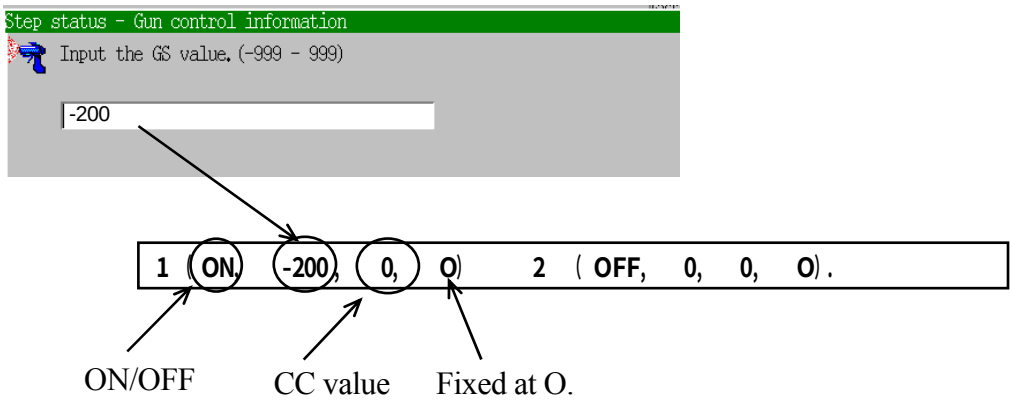
<Display in gun data screen>



2. Gun Control Information (GS value, CC value)

Pressing <GUN1> or <GUN2> displays the screen shown on the next page. Enter the GS

value* via NUMBER and press ↵. Then, input screen for CC value appears. Enter CC value* via NUMBER and press ↵ (CC value is usually fixed at 0). The set gun control information is displayed in the gun data screen (displayed by pressing ENABLE + →).



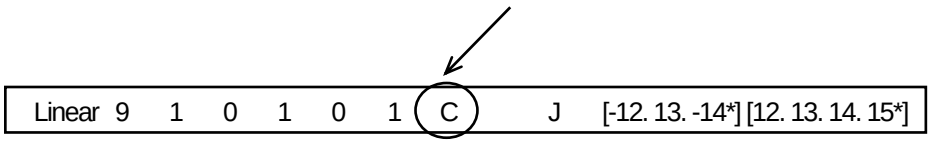
NOTE*

GS: Specifies the distance from the taught point to delay/ advance the timing of Gun signal ON/ OFF. Positive value delays the timing on which the signal is turned ON/ OFF. Negative value advances the timing on which the signal is turned ON/ OFF. Unit of distance is mm. As other means than GS adjustment, auxiliary function 1206 compensates for response delay of spray ON/OFF uniformly across the programmed steps.

CC: Provided for future use. Currently, set 0.

4.2.8.2 WORKPIECE INSTRUCTION (OPTION)

Pressing <Work> toggles the setting between 0 (no display) and C. The display changes between no display and C according to the setting. When the taught point is a point for 3D sensor compensation function (Option), select Workpiece C. If not, select 0 (no display). Currently set status is also displayed on <Work> key.

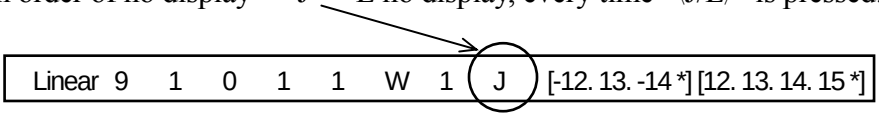


4.2.9 JUMP/ END (J/E) INSTRUCTION

Pressing <J/E> changes the setting of JUMP and END instructions in order of no display (not set) → J →E →no display. These instructions determine how the program steps are executed after the step where these instructions are taught is executed. The instructions are processed as follows:

No display: Executes steps in order. Continues currently executed program.
J: JUMP instruction. Jumps to a different program (selected program).
E: END instruction. Ends program execution.

The display in order of no display → J → E no display, every time 〈J/E〉 is pressed.



JUMP (J) instruction: Processing differs depending on whether RPS is disabled or enabled.

1. When RPS is disabled, JUMP instruction is ignored and the proceeding step is executed.

2. When RPS is enabled, the program is executed as shown in the table below:

		JUMPOFF signal	
		ON	OFF
JUMPON signal	ON	1. JUMP ON signal has precedence over JUMP OFF signal. 2. When JUMP ON signal is input, program selection signal is read and program execution jumps to the designated program. 3. Acceptable range for destination program is 0 – 999. 4. When a non-existing program is selected, error occurs and program execution is stopped. The motor power turns OFF at the same time.	
	OFF	1. Proceeds executing of the next step.	1. Pauses at the step and waits for one of the signals to turn ON.

END (E) instruction : Processing differs depending on whether RPS is disabled or enabled.

1. When RPS is disabled,

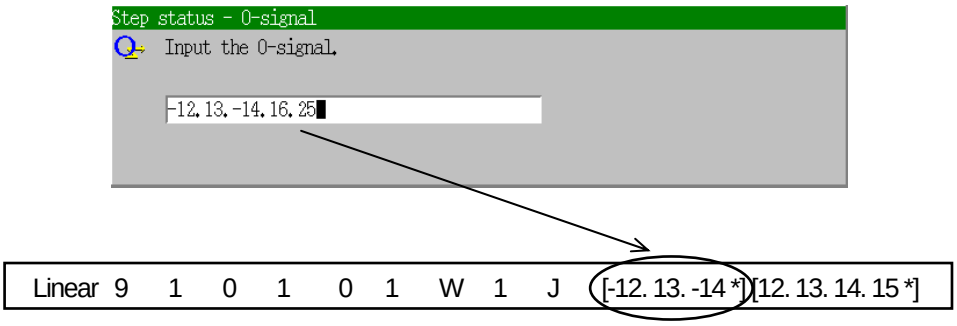
(1) Ignores END instruction and returns to the first step in program.
(2) Steps following the END instruction are also ignored.

2. When RPS is enabled,

(1) When RPSON signal is input, reads program selection signal and jumps to the program specified by the signal.
(2) Acceptable range for designation program is 0 – 999.
(3) When a non-existing program is selected, error occurs and program execution is stopped. The motor power turns OFF at the same time.

4.2.10 OUTPUT (O) INSTRUCTION

Pressing OUT displays the screen for output signal setting. Enter the output signal number via Number keys and press ↵. This sets which signal to output after axis coincidence with the taught point of the current step.



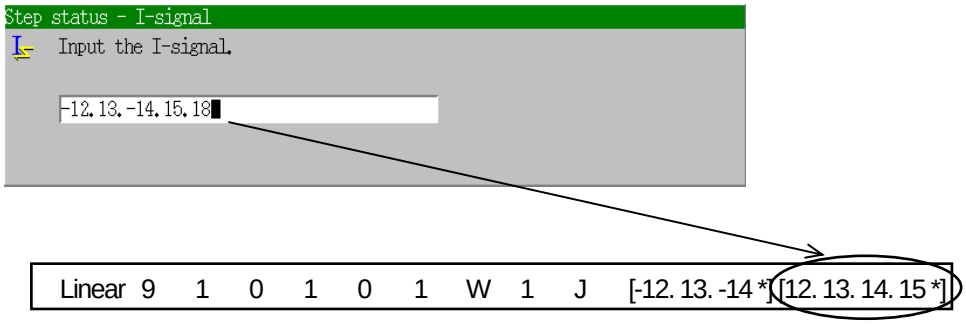
[NOTE]

1. Signal numbers even set randomly are displayed in ascending order by their absolute value from the next time on.
2. For signals to be turned ON, enter with + sign before the signal number, and those turned OFF with -.
3. When setting more than one signal, place a period between the signal numbers.
4. To delete a signal number displayed on the dialog box, move the cursor to the right of the signal number and press BS.
5. To reset all output signal settings, input 0 (zero) as the signal number.
6. To reset all output signals but excluding selected signals, enter signal number 0 (zero) followed by the desired signal numbers (divide between numbers with periods).
   Example: to reset output signals other than 10 and 11: 0. 10. 11
7. * are displayed on the parameter value display bar for signals unable to be displayed due to limited space. All signals set are output at program execution.
8. To specify the order of outputting the signals, record the signals in separate steps.
9. ON instruction is executed right after axis coincidence with the taught step in the current step.
10. OFF instructions are executed after all instructions taught to the step, such as timer or I signal wait instructions are processed.
11. When a signal is taught to be turned ON and OFF in a same step, minimum pulse output of 0.1 sec is guaranteed.

To name the output signal, open the Auxiliary function screen. Select [6 I/O signal] → [6 Signal name] → [1 OX]. Move the cursor to the signal name and press <Character input>. The character input screen appears. Follow the procedures in 4.2.11 Comment Instruction and enter the desired name.

4.2.11 INPUT (I) INSTRUCTION

Pressing IN displays the screen for input signal setting. Enter the input signal number via Number keys and press ↵. This sets the signal to be waited for input after axis coincidence with the taught point of the current step.

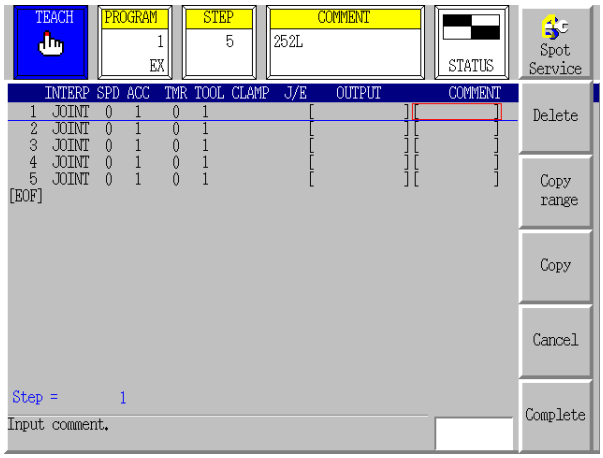


[NOTE]

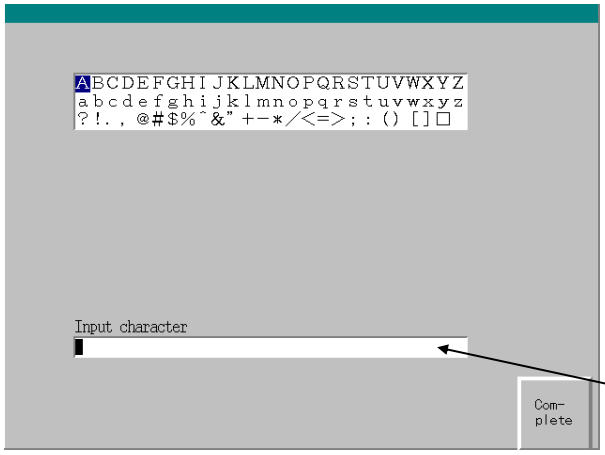
1. Signal numbers even set randomly are displayed in ascending order by their absolute value from the next time on.
2. There is no function to wait for input signal to turn OFF.
3. When setting more than one signal, place a period between the signal numbers.
4. To delete a signal number displayed on the dialog box, move the cursor to the right of the signal number and press BS.
5. * are displayed on the parameter value display bar for signals unable to be displayed due to limited space. All signals set are checked for input at program execution.
6. Search for input signal starts after axis coincidence with the taught step in the current step.
7. In a step more than one signal is recorded, all signals are searched under AND condition. Search cannot be done under OR condition or combination of both.
8. When more than one signal is set, robot waits for all taught signals to turn ON.
9. To specify the order of inputting the signals, record the signals in separate steps.

To name the input signal, open the Auxiliary function screen. Select [6 I/O signal] → [6 Signal name] → [2 WX] → <Character input>. The character input screen appears. Follow the procedures in 4.2.11 Comment Instruction and enter the desired name.

4.2.12 COMMENT INSTRUCTION



Pressing EDIT displays screen edit screen shown on the left. In this screen move the cursor to comment input line and press ↵. The following comment input screen appears.



Comment can be input/ modified only in edit screen. Maximum of 18 characters can be displayed on the comment column. Characters exceeding the display limit is displayed/ modified in [Input character] box in the comment input screen shown in the figure on the left.

Character input procedure differs depending on the type of character input:

1. To enter letters and symbols:
   Select the letter or symbol to enter using the cursor key, and press ↵. The selected letter or symbol appears on the entry line.

2. To enter number:
   Use the number keys on teach pendant.

Press <Complete> to return to Edit screen.

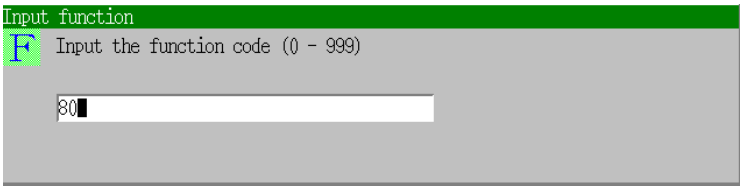
Press EDIT to end the Edit screen.

[NOTE]

1. Comments can be added to all program steps.
2. Comment can be input /edited only in screen edit mode.
3. Comments are displayed only in edit screen except for the comment in the first step of the program. The characters exceeding the display limit are displayed in the [Input character] box in the character input screen.

4.3 FUNCTION INSTRUCTION

Pressing FN displays the screen below. Enter the function instruction number via Number and press ↵. Parameter setting dialog box for the selected function instruction appears. Enter the desired parameter values and press ↵. This sets function (FN) instructions that are not displayed in element instruction bar.



Function (FN) instruction	Function number	Parameter
Unconditional step jump	20	Step number
Conditional step jump	23	Step number, input signal number
Conditional step jump (frequency)	26	Step number, frequency register number, frequency
Unconditional program call	80	Program number
Conditional program call	81	Program number, input signal number
Conditional program call (frequency)	82	Program number, frequency register number, frequency
Comment input	99	Alpha-numeric characters
M signal (ON/OFF)	105	Signal number
Acceleration/ deceleration change	233	Acceleration/ deceleration
Tip dresser	309	Axis number, rotating speed
Tip dresser (2 step rotation control)	312	Axis number, rotating speed
Acceleration change	425	Acceleration
Deceleration change	426	Deceleration
I signal (Input signal setting)	525	I signal number
Signal pulse output	440	O signal number, output time
I signal (Negative logic)	526	I signal number
Load transformation values	550	Transformation values number
Next step	552	Transformation values number
Break motion	553	
Wait specified time (TWAIT)	556	Wait time
Wait specified time (DELAY)	557	Wait time
Function (FN) instruction	Function number	Parameter

Serial communication protocol setting	558	Timer 1, Timer 2, Timer 3, Number of times 1, Number of times 2, BCC, Time out
Serial communication setting	559	Baud rate, Stop bit
Step jump (register)	561	Step number, Register number,
Step jump (M signal condition)	562	Step number, M signal number
Register Count Up	564	Register Number
Switching of acceleration and deceleration (For only the next step)	565	Acceleration/ deceleration
Mutual Wait	591	Wait number
Conveyor Wait	592	Conveyor position
Output of signal dedicated to painting	593	Dedicated signal type, Output level
Output of signal with delay / preout dedicated to painting	594	Dedicated signal type, Output level
BEAD instruction	600	Pump number, cross-sectional area of bead (Sealing specification)
QBEAD instruction	601	Pump number, flow rate (Sealing specification)
PREPRES instruction	602	Gun number, preparatory pressure (Sealing specification)
Flow rate auto adjustment function Enable	603	
Flow rate auto adjustment function Disable	604	

Example

Setting “Call program 80 when input signal I13 turns ON”.

Operation procedure:

1. Press STEP → 2 → ↵. (Select Step 2.)
2. Press FN → 8 → 1 → ↵. (Conditional program call instruction)

3. Press 8 → 0 → ↵. (Sets the program number of the program to call.)

4. Press 1 → 3 → ↵. (Sets the condition (Input signal number).)

After the above procedure, Function instruction is inserted into a program and displayed on the program display screen as shown below.

```
1 Linear 9   1   0   1   1       1      [-12. 13. -14 *] [12. 13. 14. 15 *]
2 Linear 9   1   0   1   1       1      [              ] [11             ]
  FN 81[80. I13]
```

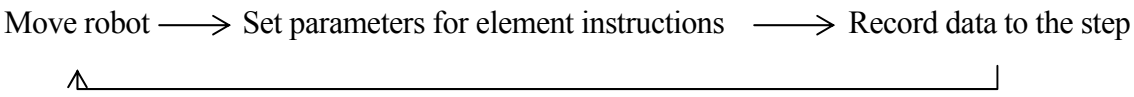
4.4 RECORDING POSE AND AUXILIARY DATA TO A STEP

This section explains the procedure to record the pose and auxiliary data set following the procedures in earlier sections.

4.4.1 NORMAL RECORDING PROCEDURE

Pressing REC records the data to the step after the last step in the program

Repeat the procedures until the program is completed. Step number increments by one every time REC is pressed.

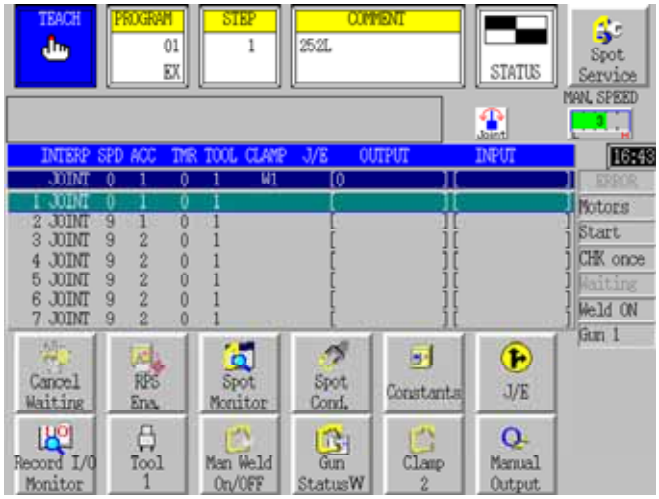


[NOTE]

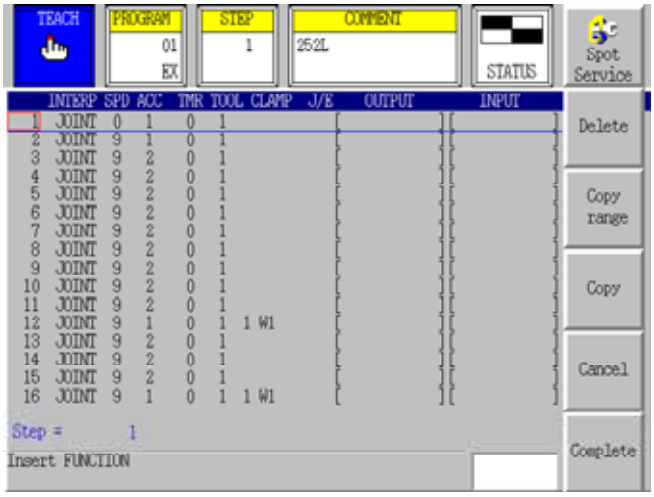
Error occurs when the procedures explained in this chapter are performed in steps other than the last step of the program.

5.0 CHECKING AND MODIFYING PROGRAMS

This section describes the procedure for checking and modifying a taught program. Before checking robot movement in check mode, check the contents of steps as shown below.



1. Check by teach screen
   Check the taught auxiliary data. Press ENABLE + ↓/↑ and check contents of all the steps.



2. Check by edit screen/Hot edit screen
   Check the taught auxiliary and pose data by the edit screen displayed when EDIT is pressed or the Hot edit screen when <Service>-[12 Hot edit] is selected. Display pose data by pressing →/← for left or far right.

3. Check by monitor screen
   To check the contents of step data, such as signals, use the monitor screen. For details, see 7.0 Service Functions − 2./3. Monitor.

5.1 CHECK GO, CHECK BACK

This section describes how to check a taught program in check mode by operating the robot. Press ENABLE + <CHK. SPEED> to change the check speed level (1-5). The actual speed corresponding to each check speed level (1-5) is set in Constant Functions − [6. Manual/Check speed] − [2. Check speed].

First, the procedure for checking the movement of an individual arm is described. For a single arm controller, 1. and 4. below can be omitted.

1. Select the robot to check by pressing <TEACH>→NUMBER→↵.

2. Select a program by pressing <Program> or ENABLE + PROG, and input the program number in the input box that appears. Then, press ↵.

3. Select a step by pressing STEP→NUMBER→↵. If the specified step does not exist, the last taught step of the program is displayed. If there are no recorded steps, step 0 is selected.

4. Display the group selection screen by pressing ENABLE + <TEACH> and select [Individual] by pressing 0.

5. Pressing Deadman + CHECK GO/CHECK BACK executes CHECK GO/BACK in check mode.* CHECK ONCE and CHECK CONTINUE can be switched by pressing CONT. In CHECK ONCE setting, robot proceeds to the next/previous step number each time CHECK GO/CHECK BACK is pressed. In CHECK CONTINUE setting, pressing and holding CHECK GO/CHECK BACK makes the robot execute steps continuously in forward or reverse order, respectively.**

   NOTE* Turn ON motor power and release HOLD, etc. beforehand so that the robot can be operated.

   NOTE** Verify the mode − CHECK ONCE or CHECK CONTINUE − by the status indication on right side of TP screen.

[NOTE]

1. CHECK GO and CHECK BACK can be used only in path priority mode.
2. CHECK BACK checks the program backwards. After checking the selected step, the check procedure goes on to the step before the selected step. Check is executed in the same manner even if a different step is selected.
3. CHECK BACK can also be executed continuously. Robot reaches the taught point regardless of accuracy setting, and then proceeds to the step before. Thus, at steps with rough accuracy setting, the path taken by the robot differs between CHECK GO and CHECK BACK.
4. In checking a weld point, welding is executed at "Weld ON", per the weld condition taught to the step. There is a system switch to select weld ON/OFF.
5. Wear measurement (Workless clamping, Reference plate) is executed with CHECK BACK. However, the data calculated from these measurements are not reflected in the current wear data.

5.2 STEP DATA MODIFICATION

This section describes how to edit a recorded program.

5.2.1 MODIFYING POSE DATA

Use the procedure below when modifying only the pose data without changing the auxiliary data.

1. Select a robot to modify by pressing <TEACH>→NUMBER→↵.
2. Select a program by pressing <Program> or ENABLE + PROG, and input the program number in the input box that appears. Then, press ↵.
3. Select a step by pressing STEP→NUMBER→↵.
4. Press ENABLE + <TEACH>, and select [Individual] by pressing 0.
5. Select the manual operation speed level by pressing MAN. SPEED.
6. Select the operation mode by pressing COORD.
7. Move the desired axes using the axis keys while holding DEADMAN.*
   NOTE* Turn ON motor power and release HOLD, etc. beforehand so that the robot can be operated.
8. Press ENABLE＋MOD.
9. Confirmation message appears. If it is OK to modify the selected step, select [Yes] using the arrow key and press ↵.
10. The pose data is modified.

[NOTE]

The same step is selected before and after this operation. (The next step is not selected automatically.)

5.2.2 MODIFYING BOTH POSE AND AUXILIARY DATA - OVERWRITING THE STEP

This section describes how to edit both pose and auxiliary data simultaneously.

1. Select a robot to overwrite by pressing <TEACH>→NUMBER→↵.

2. Select a program by pressing <Program> or ENABLE + PROG, and input the program number in the input box that appears. Then, press ↵.

3. Select a step by pressing STEP→NUMBER→↵.

4. Press ENABLE + <TEACH>, and select [Individual] by pressing 0.

5. Select the manual operation speed level by pressing MAN. SPEED.

6. Select the operation mode by pressing COORD.

7. Move the desired axes using the axis keys while holding Deadman.*
   NOTE* Turn ON motor power and release HOLD, etc. beforehand so that the robot can be operated.

8. Change the auxiliary data to the desired value(s). See Chapter 4 for setting each auxiliary data.

9. Press ENABLE＋O.WRITE.

10. Confirmation message appears. If it is OK to overwrite the selected step, select [Yes] using the arrow key and press ↵.

11. Both pose and auxiliary data are modified (overwritten) simultaneously.

[NOTE]

The same step is selected before and after this operation. (The next step is not selected automatically.)

Examples of how to overwrite steps in the servo weld gun specification are shown below. These methods also apply in other specifications.

Example 1. Overwriting weld point. Step 10, a weld point, is overwritten below.

1. Execute Step 10 by pressing CHECK GO in STEP ONCE setting. Robot stops after pressurizing and gun opens to the clearance position.

2. In teach mode, move the robot to the desired pose to set the pose data. Set the auxiliary data to the desired value(s).

3. Make the gun pressurize by pressing ENABLE + CLAMP ON.

4. Press ENABLE + O.WRITE to overwrite Step 10.

Example 2. Overwriting a weld point as an escape point, Step 15, a weld point, is changed to an escape point.

1. Execute Step 15 by pressing CHECK GO in STEP ONCE setting. Robot stops after pressurizing and gun opens to the clearance position.

2. Press CLAMP to turn OFF Clamp.

3. Move the robot to the desired escape point using Deadman + AXIS and set the necessary auxiliary data.

4. Press ENABLE + O.WRITE to overwrite Step 15.

5.2.3 MODIFYING BOTH POSE AND AUXILIARY DATA - EDIT SCREEN

This section describes how to edit taught data (auxiliary and pose data) on the Edit screen.

1. Press EDIT to display the Edit screen.

2. Select the items to modify by cursor.

3. Modify data by NUMBER. Methods of inputting data and their available setting ranges vary depending on the type of data being modified.

   (1) Input data items as described below. For Output (O), Input (I) and Comment, see the next page.

      1) Move cursor to each of the items to be modified.

      2) Input the necessary values, following the descriptions below.

Item	Description
Interpolation	Specify interpolation mode. (0: JOINT, 1: LINEAR)
Speed	Specify speed level. (0-9)
Accuracy	Specify accuracy level. (0-4)
Timer	Specify timer number. (0-9)
Tool	Specify tool number. (1-9)
	For the arc weld spec., this setting cannot be changed.
Clamp*	Specify clamp status. (0: No clamp, 1: ON) Specify Gun Status. (0-11: See Chapter 4 for details.)
J/E	Specify J/E instruction. (0: No Jump/End, 1: J, 2: E)
Pose data	Specify joint value data.

      3) Press ↵ and <Complete> after modification.

   (2) Input Output (O), Input (I) and Comment data as described below.

      1) Move cursor to a desired item and press ↵.

      2) Setting screen for the item is displayed. Modify the item inputting values or comments. See Chapter 4 for details.

Item	Description
Output (O)	Currently recorded status is displayed. Specify and modify this numerically.
Input (I)	Currently recorded status is displayed. Specify and modify this numerically.
Comment	Pressing ↵ displays the comment input screen.

3) Press ↵ and <Complete> after modification.

5.2.4 DELETING STEP

This section describes how to delete a specific step in a program.

1. Select the robot by pressing <TEACH>→NUMBER→↵.
2. Select the program by pressing <Program> or ENABLE + PROG, and input the program number in the input box that appears. Then, press ↵.
3. Select the step by pressing STEP→NUMBER→↵.
4. Press ENABLE + DEL.
5. Confirmation message is displayed. If it is OK to delete, select [Yes] and press ↵.
6. Specified step is deleted.

[NOTE]

A step can also be deleted in the Edit screen. Press EDIT to display the Edit screen and press <Delete> after selecting the step to delete.
Pressing ↵ deletes the step.

5.2.5 INSERTING STEP

This section describes how to insert steps in a program.

1. Select the robot by pressing <TEACH>→NUMBER→↵.

2. Select the program by pressing <Program> or ENABLE + PROG, and input the program number in the input box that appears. Then, press ↵.

3. Select the step by pressing STEP→NUMBER→↵.

4. Press ENABLE + <TEACH>, and select [Individual] by pressing 0.

5. Move the desired axes using Deadman + AXIS.*
   NOTE* Turn ON motor power and release HOLD, etc. beforehand so that the robot can move.

6. Set the auxiliary data as desired. See Chapter 4 for details on setting auxiliary data.

7. Press ENABLE + INS to insert the step.

[NOTE]

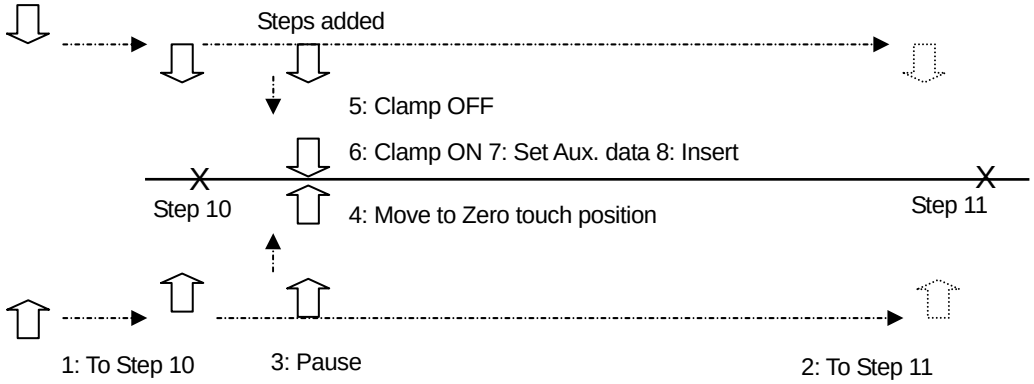
1. The step is inserted before the specified step.
2. The same step is displayed before and after the insertion.
3. When inserting several steps continuously, for each step set the desired conditions then insert the step in this order.

Examples of how to insert steps in the servo weld gun specification are shown below. These methods also apply in other specifications.

Example Operation Procedure 1. Inserting continuous weld points (for servo weld gun)

3 points are inserted between Step 10 (weld start point) and Step 11 (weld end point).

Start point and end point are taught first and then the weld points are added while executing check operation.



1. Execute Step 10 with CHECK GO key in STEP ONCE setting. Robot stops after pressurizing and the gun opens to the clearance.

2. Execute Step 11 with CHECK GO key.

3. While Step 11 is being executed, release CHECK GO to stop robot at the desired position.

4. Move the robot to the pose to be taught via TP.

5. Press CLAMP and turn clamp ON→OFF.

6. Press CLAMP again to pressurize.

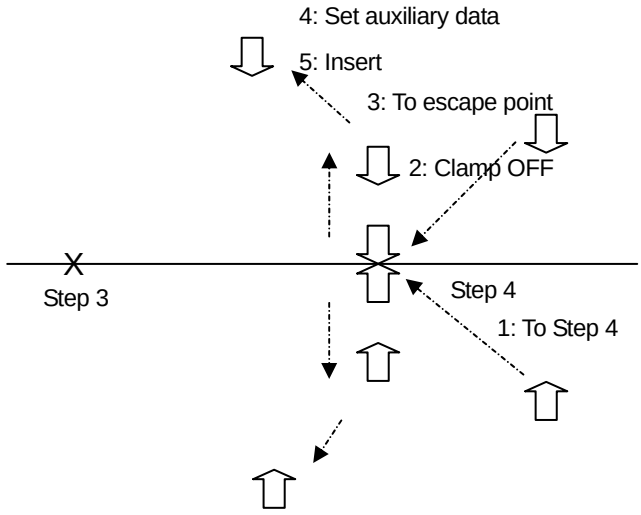
7. Set the necessary auxiliary data.

8. Press ENABLE + INS. The new step is inserted as Step 11, and the original Step 11 becomes Step 12.

Repeat operations 2-8 and add steps in the same way.

Example Operation Procedure 2. Inserting escape point

Escape point is inserted between Step 3 (weld point) and Step 4 (weld point).



1. Execute Step 4 with CHECK GO key in STEP ONCE setting. Robot stops after pressurizing and the gun opens to the clearance position.

2. Press CLAMP and turn clamp ON→OFF.

3. Move the robot to the escape point.

4. Set the necessary auxiliary data.

5. Press ENABLE + INS. The new step is inserted as Step 4 and the original Step 4 becomes Step 5.

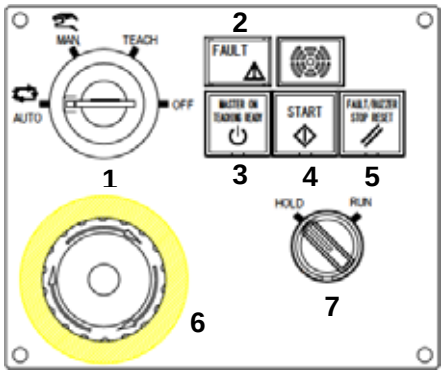
5.3 EDITING DATA OTHER THAN POSE AND AUXILIARY DATA

Various data other than pose and auxiliary data are set depending on the application. These data are checked or modified in Service/Constants/Auxiliary function screens. For details, refer to Chapter A.

6.0 REPEAT OPERATION (MANUAL/AUTO)

This chapter describes how to playback taught operation programs. To operate the robot and peripheral equipment together, set AUTO mode, set MANUAL mode only if operating the robot independent of other peripheral equipment.

6.1 OPERATION IN MANUAL/AUTO MODE



1. Turn the MODE SELECTOR 1 switch on the operation panel to MAN. or AUTO.

2. Turn the MANUAL/AUTO select switch (Teach lock switch) on the teach pendant to AUTO.

3. Turn HOLD/RUN 7 on the operation panel to HOLD.

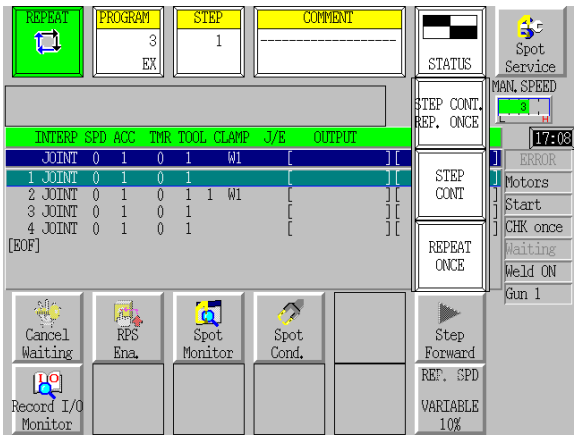
4. Press the MASTER ON 3 on the operation panel.

5. Select the program and step to playback for each robot.
   (1) Press <Rep(peat)> and NUMBER→↵ to select the robot. (for the multi arm controller)

   (2) Press <Program> or ENABLE＋PROGRAM, and NUMBER→↵ to select the program to playback.

   (3) Press STEP and NUMBER→↵ to select the step of the program.

6. Select repeat condition. Pressing <STEP XX./REP. XX.> displays the pull-down menu as shown below. Follow these steps via the pull-down menu.



(1) Press <STEP CONT/ONCE> on the pull-down menu to select whether the program runs continuously or step by step. Pressing this key switches between STEP ONCE and STEP CONT.

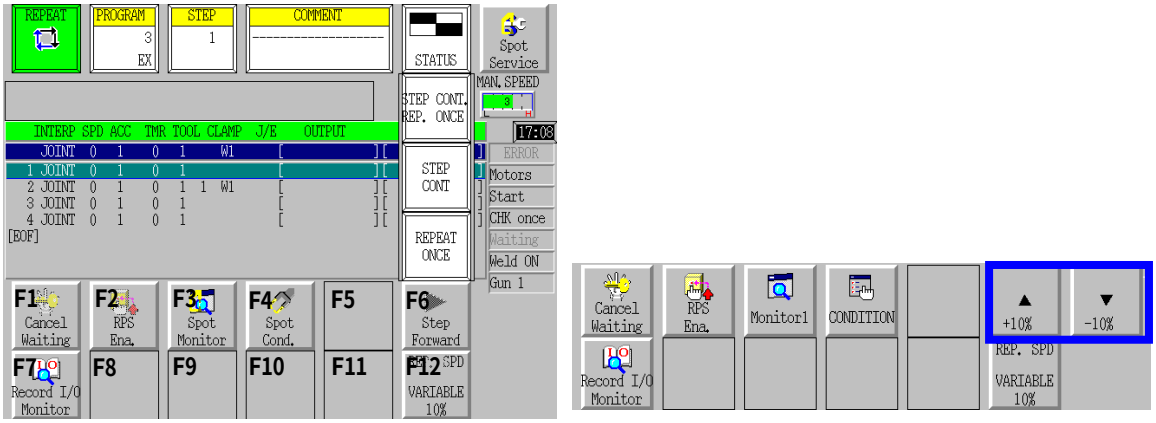
(2) Press <REPEAT CONT/ONCE> on the pull-down menu to select whether the program runs repeatedly or only once. Pressing this key switches between REPEAT ONCE and REPEAT CONT.

(3) Press ENABLE+F2 <RPS Dis./Ena.> (see screen picture below) to enable or disable RPS (Random Program Selection). Pressing this key changes the key display between RPS Ena. and RPS Dis.

7. Set playback speed.

(1) Press ENABLE+F12<REP. SPD VARIABLE >, shown below.

(2) <▲+10 %>/<▼-10 %> appears on screen (see below). Press ENABLE+ <▲+10 %> or <▼-10 %> to set the repeat speed variable to the desired value.

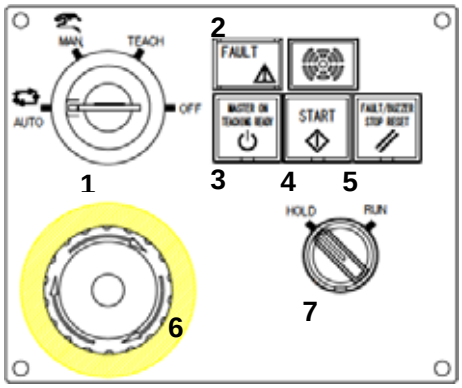


WARNING

1. **Prior to starting playback operation, ensure no one is near the robot and that all obstructions are cleared from the workpiece cell. Confirm all safety devices are functioning, such as safety fence, E-STOP switch, etc.**
2. **Set a slow playback speed for first cycle run. Confirm playback executes safely and desired conditions/standards are met before increasing the repeat speed.**
3. **Unless the arm is disconnected, beware that in repeat operation the multi arm controller drives all arms connected to the controller.**

[NOTE]

1. Setting range: 10 % - 100 % (only settable in 10 % increments).
2. Actual playback speed = Taught speed in program x Repeat speed set here.



8. Press START 4 and turn HOLD/RUN 7 to RUN.

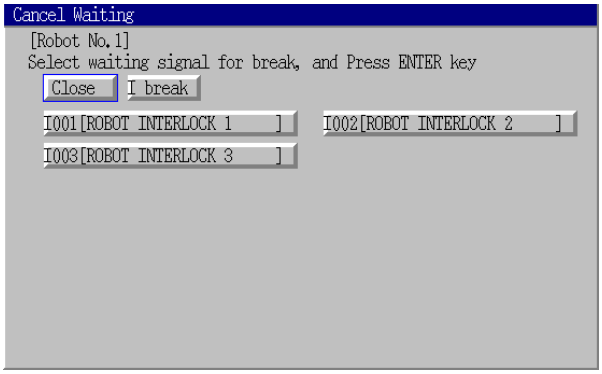
9. Program starts to run. Robot stops after each step, if repeat condition is set to STEP ONCE in step 6. Press ENABLE + F6<Step Forward> (see screen picture above) to execute the next step. Robot executes steps in the program continuously, if repeat condition is set to STEP CONT.

10. After checking the program, increase playback speed with care following step 7 above.

6.2 CANCEL OF WAITING

This section describes how to force the release of standby condition(s) if robot is awaiting input of standby release signals after axes coincide with the taught pose.

1. When the robot is waiting in standby after axes coincide, pressing ENABLE＋F1<Cancel Waiting> (see screen picture above) displays Wait Break screen (see below). The current waiting conditions (waiting signals) are displayed here.



2. Move the cursor to the waiting signal to cancel. Select [I break] to cancel all displayed waiting signals at the same time.

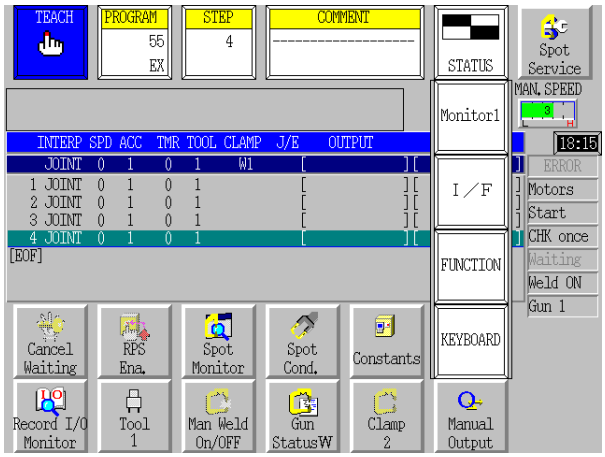
3. Press ↵. The selected waiting signal is canceled and displayed in red*.

NOTE* If [I break] is selected, pressing ↵ cancels all displayed signals and the Wait Break screen closes automatically.

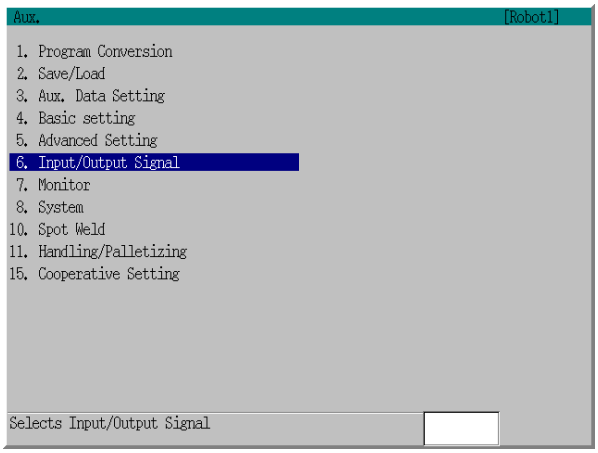
4. Select [Close] and press ↵ to close the screen.

6.3 RANDOM PROGRAM SELECTION (RPS)

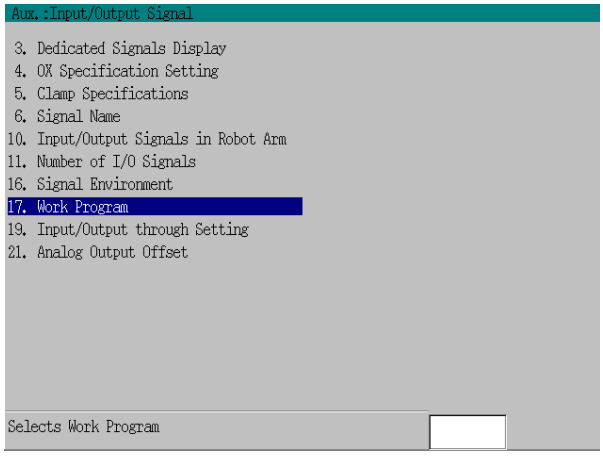
This section describes how to specify the destination program the robot jumps to when the J/E instruction is executed while RPS mode is enabled. For detailed explanation of J/E instruction, refer to chapter 4.



1. Press <STATUS> to display the pull-down menu as shown in the left figure. Then, press <FUNCTION> on the pull-down menu.



2. Select [6. Input/output signal] and press ↵.



3. Select [17. Work program] and press ↵.

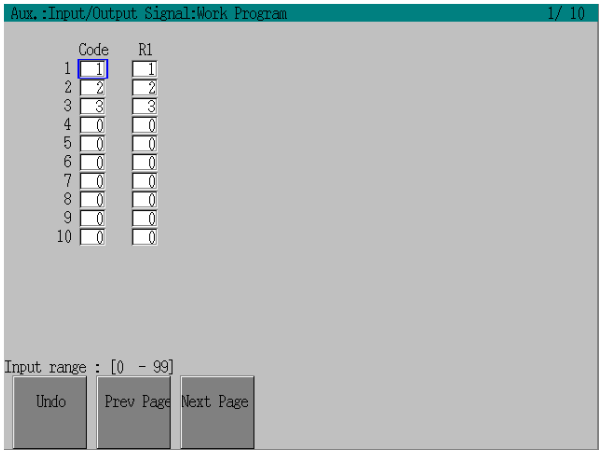
4. Enter the following information to the Code (RPS Code) and R1 – R4 boxes on the screen below.

Code (RPS Code): Program selection code (Setting range: 0-99)
R1 – R4: Destination program number (Setting range: 0-999)

(1) Move the cursor to the desired box and input Program selection code and/or destination program number using NUMBER.

(2) Press ↵ to set.

(3) Press RESET to close the screen.



Setting example

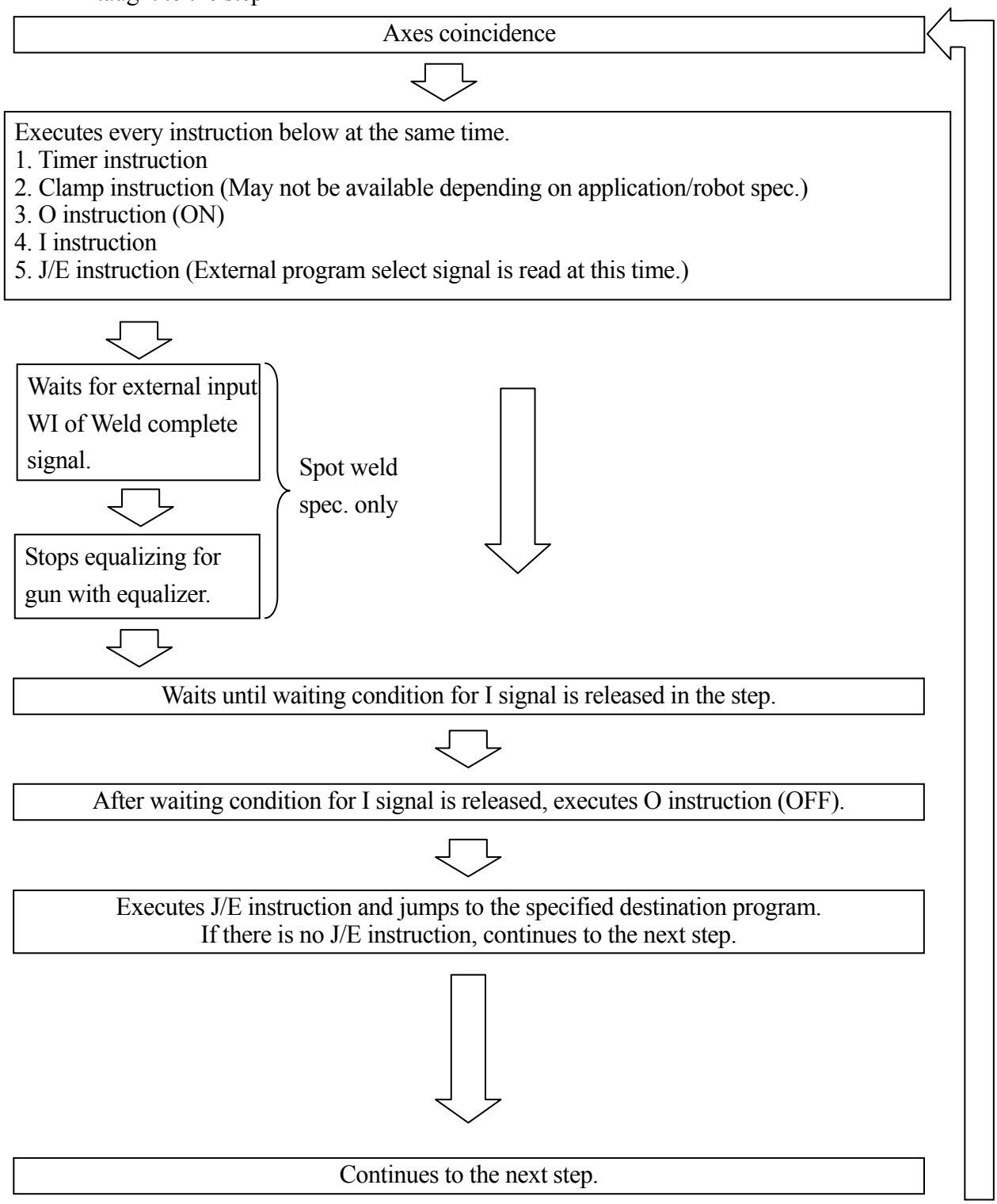
Code	R1
1	1
10	18

If the Program Selection signals are input for code 10:
Robot1 executes program no.18.

6.4 EXECUTION ORDER OF TIMER, CLAMP, J/E, O/I INSTRUCTIONS

If timer, clamp, J/E or I/O instructions are taught in a step, these instructions are executed in the following order*.

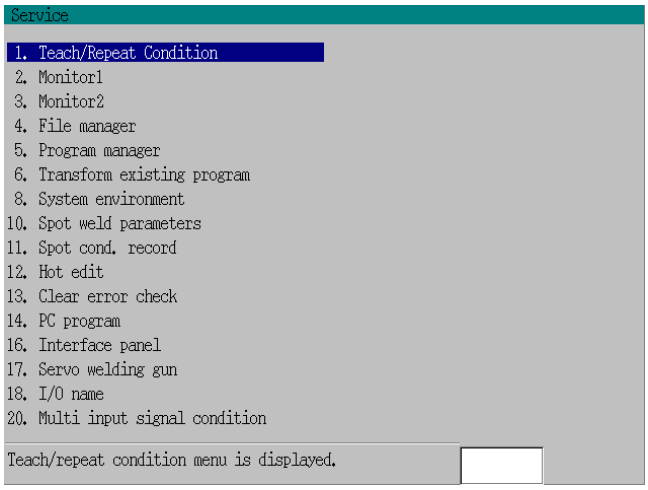
NOTE* The flowchart below outlines the order of execution for the instructions. This order and the executed instructions may vary depending on robot specification and the information taught to the step



7.0 SERVICE FUNCTIONS

The service functions are shown in the menu below, categorized by control functions such as various condition monitors, copying/saving/loading of programs, and program data conversion. To use each function, follow the guide message displayed at the bottom of the screen.

Pressing ENABLE + <Service> displays the screen below. Move cursor to the desired item and press ↵ to display its screen. Or, input the item number in the box on the bottom right of the screen and then press ↵.



The screen on the left is for spot welding specification. For other specifications, items 10, 11 and 17 are not displayed.

Spot welding specifications have their own dedicated service function screen, which is displayed by pressing <Spot service>. (<Spot service> displays the same service functions shown in 10 in the table.)

Desired service function screen can be also displayed by inputting into the R code input box, its R code number shown on the following pages. Press R on the start-up screen to display the R code box.

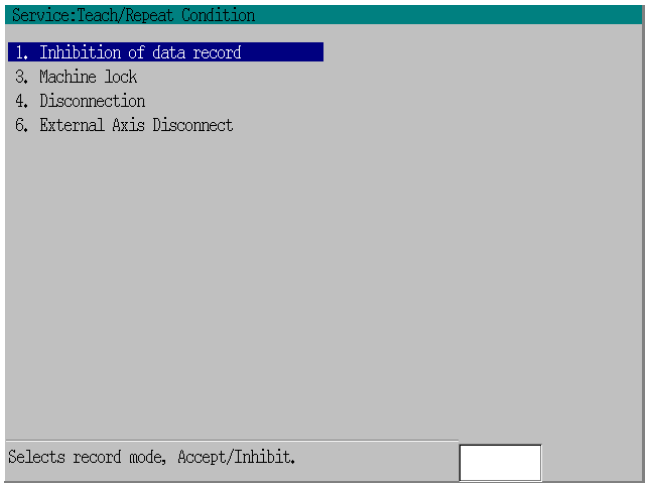
Set alphanumeric data by pressing Number keys or selecting <Character> on the input screen displayed by pressing <Input> and pressing ↵. After inputting data and pressing ↵, press <Complete> to record the entry. On the number input screen, input the number, press ↵ then press <Complete>.

Main Menu Item No.	Service function	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
1	Teach/Playback	1	Inhibit record			R71
		3	Machine lock	1	Machine lock	
		4	Disconnection			
		6	Separating external axes	1	Separating external axes	
2	Monitor 1	1	Monitor OFF			
3	Monitor 2	2	Axis data monitor			
		3	Error log monitor			
		4	Weld error log monitor			
		5	Input signal			
		6	Output signal			
		7	Integer variable			
		8	Spot welding monitor	1	Weld condition result	
				2	Welder condition monitor	
				3	Counter & auto modification monitor	
		9	I/O name monitor			
		10	Location & speed display	1	Joint angle	
				2	XYZOAT	
				3	Joint command	
				4	Joint deviation	
				5	Joint encoder value	
				6	Joint speed	
				7	XYZOAT including external axis	
				9	XYZOAT command	
				10	Motor current	
				11	Motor speed	
				14	Motor current command	
				15	Encoder original data	
				40	Joint torque values	
		11	Operation logging			
		12	Recorded I/O monitor			
		13	Dedicated input signals monitor			
		14	Dedicated output signals monitor			
		20	Step monitor			
		21	Cooperation monitor			

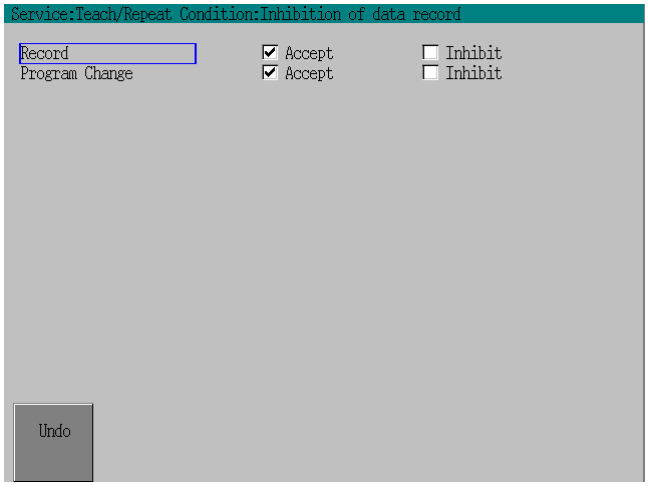
Main Menu Item No.	Service function	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
2	Monitor 1	22	I/O monitor			
3	Monitor 2	24	DIAG monitor			
		25	Internal signal			
		27	PC program			
		28	T controller safe circuit monitor			
		55	Warning log monitor			
		56	Overload warning log			
		57	Servo Weld Gun Monitor/ Air Purge Input Signal Monitor			
		58	Air Purge Output Signal Monitor			
		91	Analog Input Monitor			
		92	Analog Output Monitor			
		95	Motion Area Monitor			
		96	Safety Function Status			
		97	Safety Input Signal Monitor			
		98	Safety Output Signal Monitor			
4	File manager	1	Save (R10)			
		2	Load (R11)			
		3	File/ folder operate			R12
		10	Autosave configuration (R210)	1	Save data1	
				2	Save data2	
				3	Save data3	
				4	Display of autosave log	
		14	Other settings			R211
5	Program manager	1	Kill program			
		2	Change program name			
		11	Set protect program function			
6	Transform	1	Step copy (Transfer data)			(R3)
		2	Inverse step copy (Inverse program copy)			(R89)
		3	Joint shift			R81
		4	XYZ shift			R80
		5	Tool shift			R82
		7	Mirror conversion			R6
		8	Data conversion	1	Start data transformation	
			(R9)	2	Register tool coordinates	
				3	Measure tool coordinates	
				4	Compensate for gravity	

Main Menu Item No.	Service function	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
6	Transform	8	Data conversion	9	Bit shift	R109
8	System environment	1	Memory Available			R70
		2	Software Version			R90
10	Spot weld parameters	1	Weld schedule editor			
		2	Weld counters			
		3	Welder parameters			
		4	Weld schedule auto modification			
		5	Exclusive manual weld schedule			
		20	Servo weld gun condition			
		21	Servo weld gun tip force adjustment			
		22	Comp data for gun deflection			
		23	Workpiece nonexistence detection			
		30	Servo weld gun characteristics			
		51	Tip dress	1	Use condition of tip dress	
				2	Tip Dresser Conditions	
				3	Tip Dresser Conditions (2step)	
11	Spot cond. record	1	Spot condition record			
12	Hot edit					
13	Clear error check	1	Check Sum Error			R78
		2	Battery Error Check			R806
14	PC Program	1	START (PCEXECUTE)			
		2	ABORT (PCABORT)			
		3	STOP (PCEND)			
		4	CONTINUE (PCCONTINUE)			
		5	KILL (PCKILL)			
		6	STATUS (PCSTATUS)			
16	Interface panel					R131
17	Servo welding gun	1	Gun Axis Brake Release Mode			R162
		3	Workless Trial Run			R60
		4	Servo Weld Gun Parameter			R97
18	I/O name	1	OX (Output)			
		2	WX (Input)			
		3	INT (Internal)			
20	Multi input signal condition	1	Multi input signal condition			
21	Maintenance Support	1	Error List			
90	User Option	10	Common			

1. Teach/Playback condition

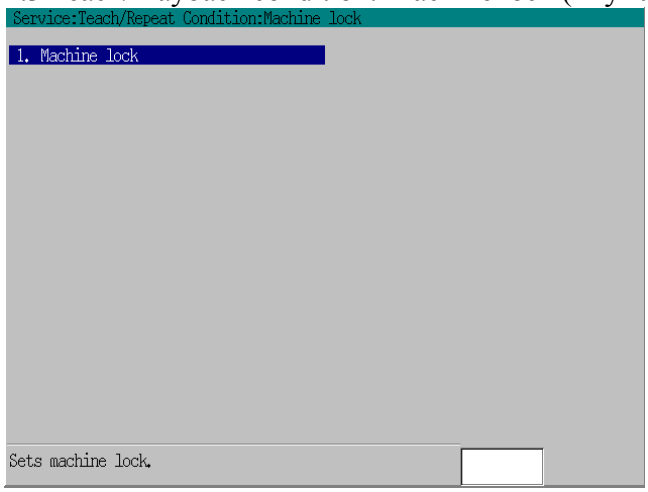


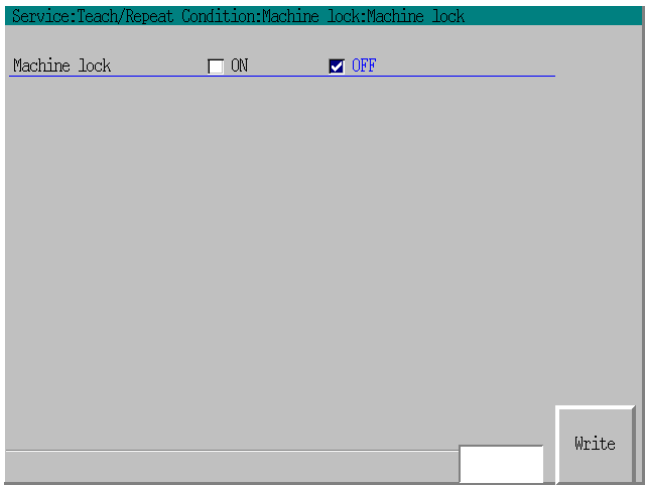
1.1. Inhibition of data record



Recording and program modification can be inhibited to avoid overwriting the taught program accidently. Select whether or not to allow record or program change.

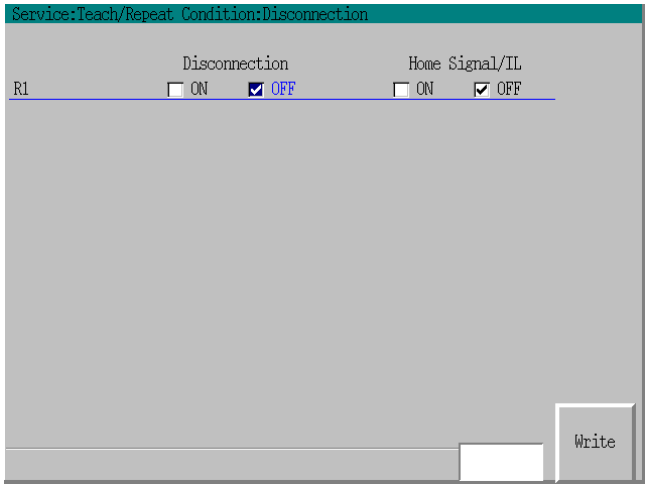
1.3 Teach/Playback condition: Machine lock (Dry run)





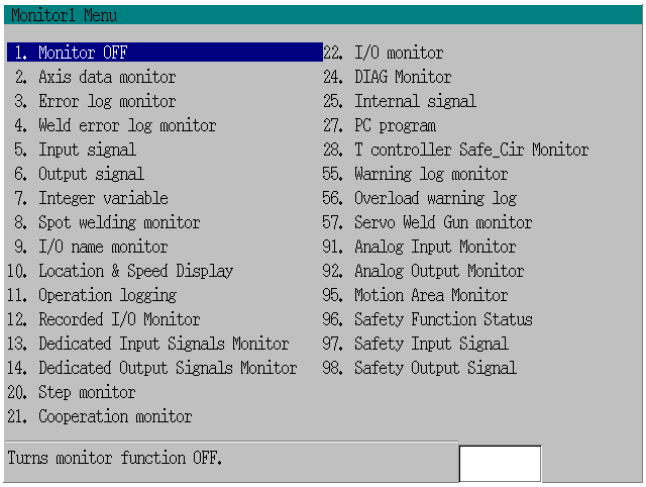
Select ON to execute a program without actually operating a robot.

1.4. Disconnection



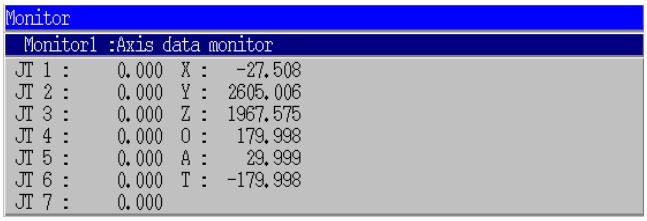
Select [Disconnection] ON for the relevant robot if disconnection of the robot is required due to failure, etc. When set ON, controller completely stops control of the robot and outputs no errors for the robot. When [Home signal/IL] is ON, all home and interlock signals of the robot are output even if robot is disconnected.

2. Monitor 1/ 3.Monitor 2



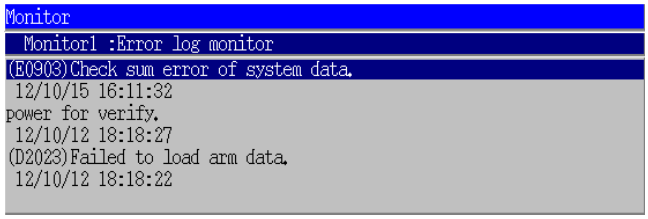
[8. Spot welding monitor] is displayed only in spot welding specification, and is not displayed in other specifications. Each of the monitor displays accessed from this menu update in real time as the robot moves, program is executed, etc.

2./ 3.2. Axis data monitor



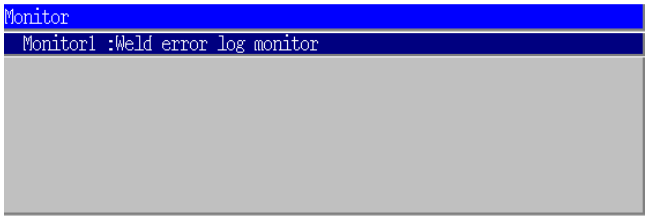
Displays current pose information (position and posture) by joint displacement values and transformation values, X, Y, Z, O, A, and T.

2./3.3. Error log monitor



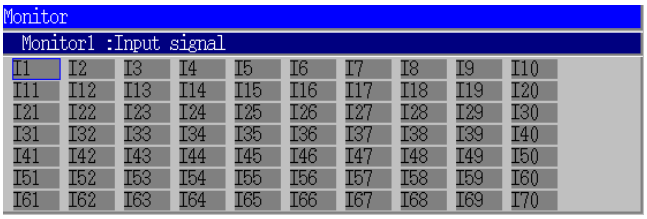
Displays the error log.

2./3.4. Weld error log monitor



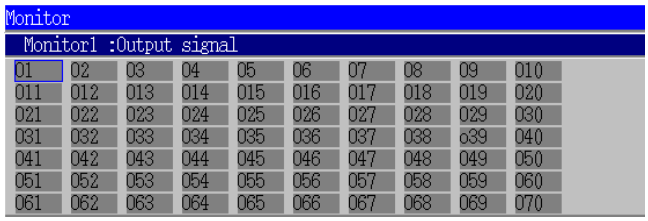
Displays the log of spot welding related errors.

2./3.5. Input signal



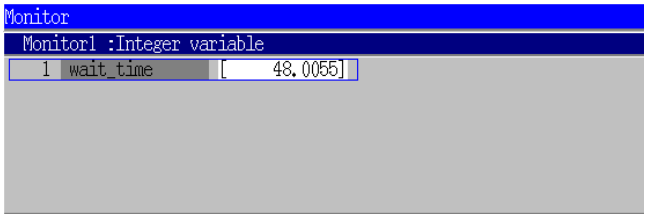
Displays the input signal status.

2./3.6. Output signal



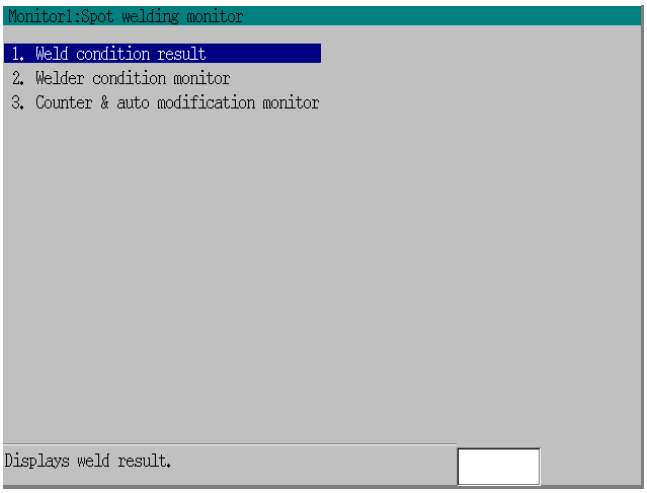
Displays output signal status via color. Signals can be forced to output using this screen.

2./3.7. Integer variable



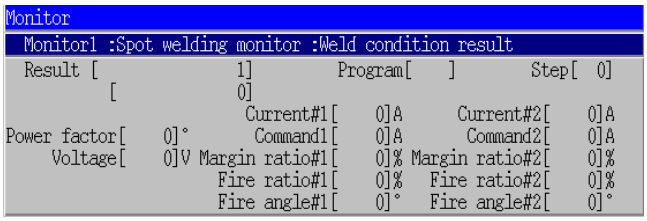
Displays the list of integer variables.

2./3.8. Spot welding monitor



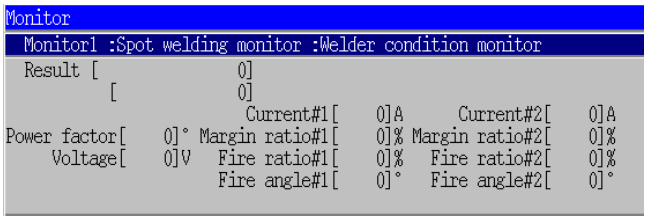
This screen is dedicated to spot welding specification. But, screen and menu constants vary according to the robot specification. Display this screen by selecting [Welding monitor] for each specification.

2./3.8.1. Weld condition result



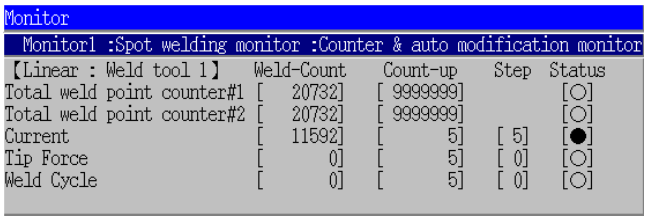
For each weld step in the program, displays the input/output data between welder and robot in the first and second welds.

2./3.8.2. Welder condition monitor



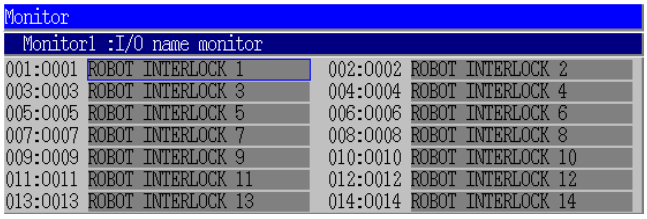
Displays the weld monitor data for the last weld.

2./3.8.3. Counter & auto modification monitor



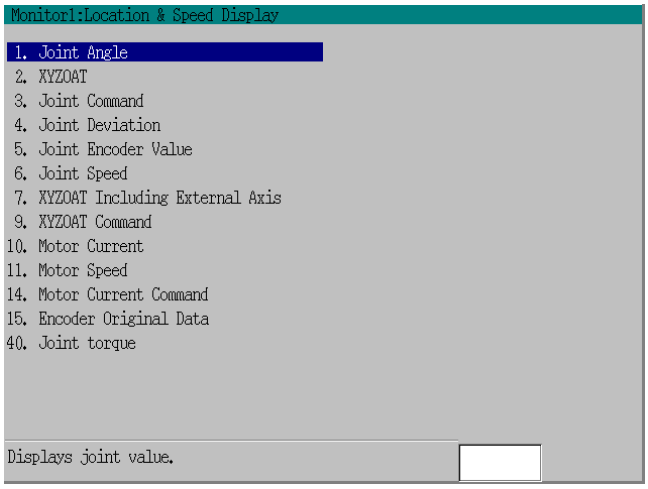
Displays the gun status.

2./3.9. I/O name monitor



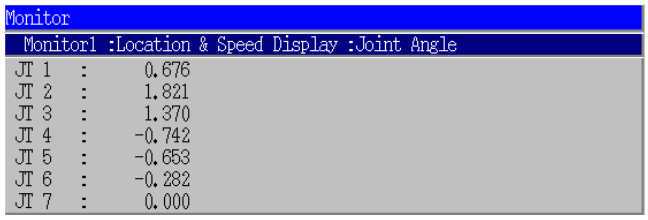
Displays the list of names set to each signal. Signals without a name are not displayed.

2./3.10. Location & speed display



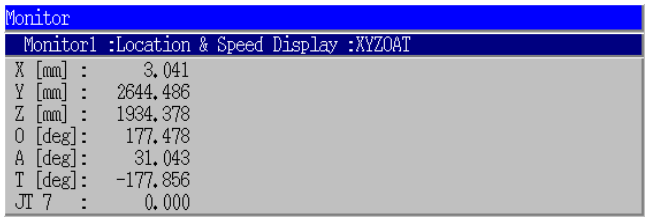
Options in this menu screen display robot information such as pose and speed.

2./3.10.1. Joint angle



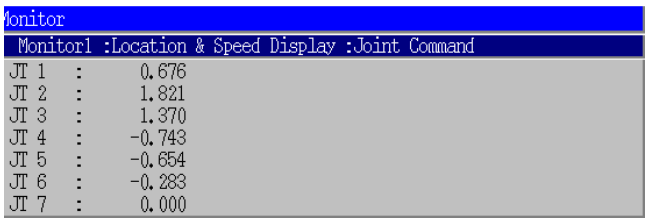
Displays the current joint angles.

2./3.10.2. XYZOAT



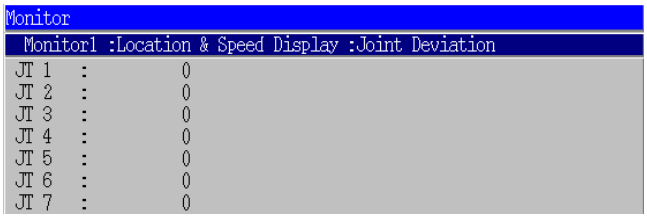
Displays the transformation values of the tool center coordinates relative to the base coordinates.

2./3.10.3. Joint command



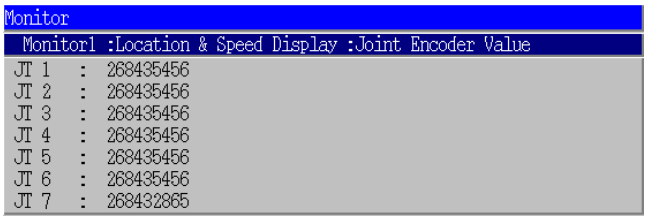
Displays joint command values.

2./3.10.4. Joint deviation



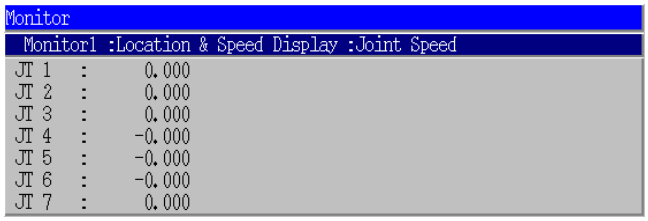
Displays joint deviation.

2./3.10.5. Joint encoder value



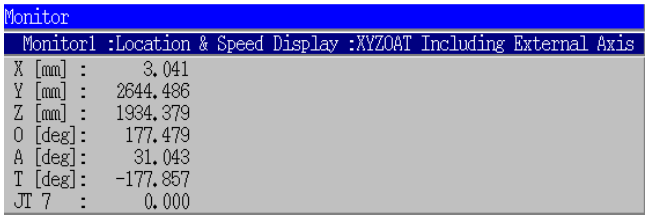
Displays current encoder values for each joint.

2./3.10.6. Joint speed



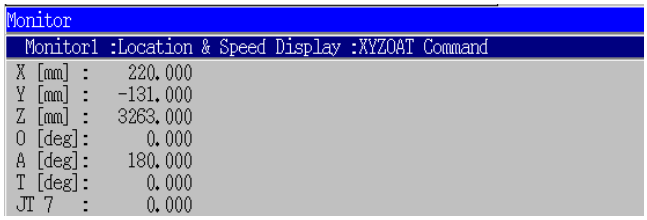
Displays joint speeds.

2./3.10.7. XYZOAT including external axis



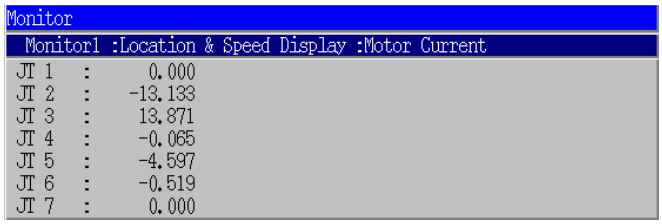
Displays the transformation values of tool coordinates relative to the world coordinates, incorporating the motion of the external axis.

2./3.10.9. XYZOAT command



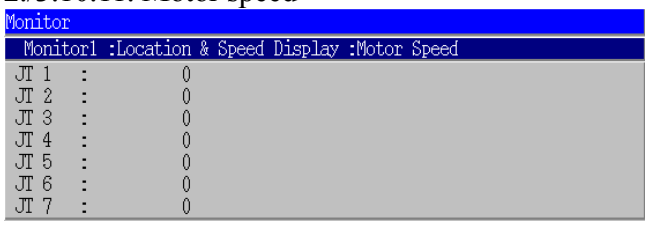
Displays the pose command values for tool coordinates.

2./3.10.10. Motor current



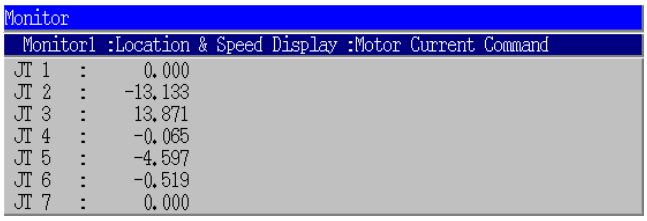
Displays motor current of axis as the current value of the q-coordinate axis.

2./3.10.11. Motor speed



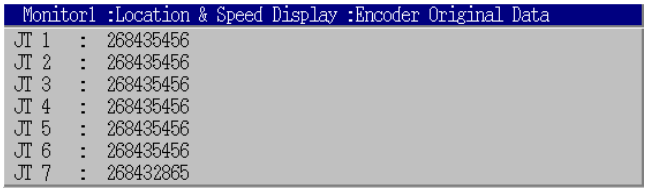
Displays motor speeds of each axis.

2./3.10.12. Motor current command



Displays motor current command values of the q-coordinate axis to each axis motor.

2./3.10.13. Encoder original data

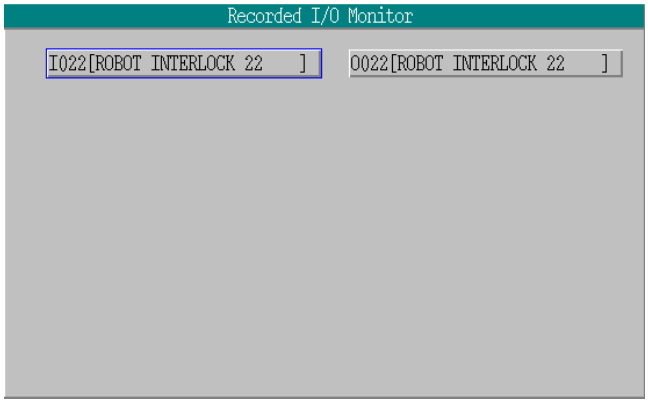


Displays encoder original data of each axis.

2./3.11. Operation logging

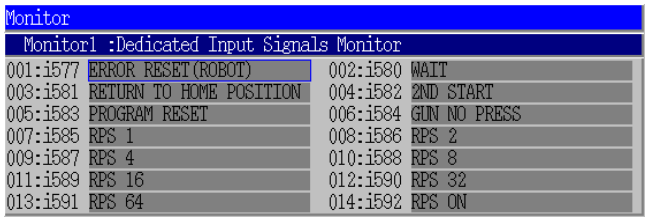
Displays the operation log.

2./3.12. Recorded I/O monitor



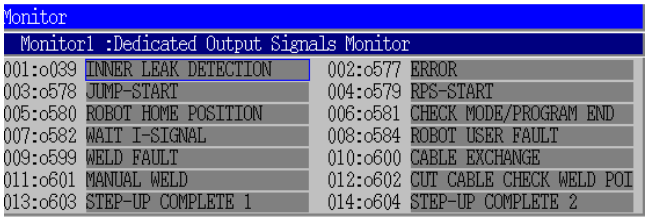
Displays the numbers and names of the I/O signals taught in the selected steps.

2./3.13. Dedicated input signals monitor



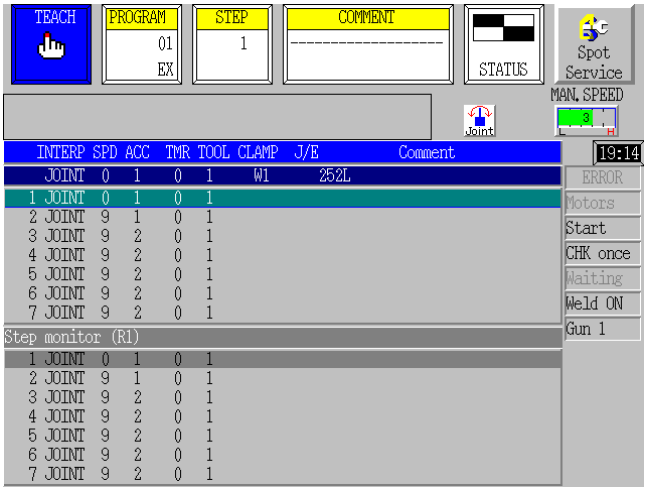
Displays the dedicated input signals currently set.

2./3.14. Dedicated output signals monitor



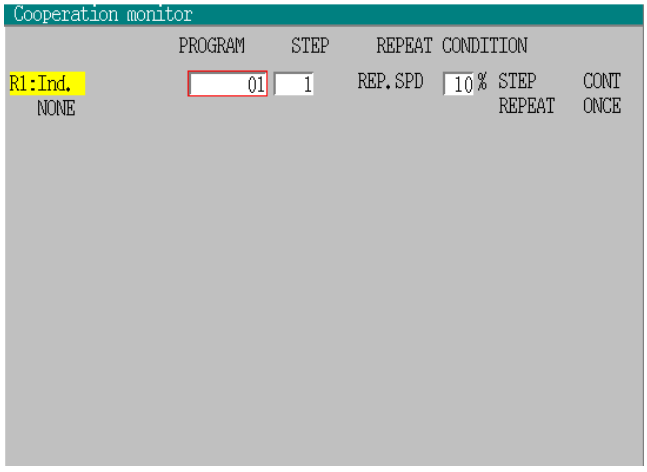
Displays the dedicated output signals currently set.

2./3.20. Step monitor



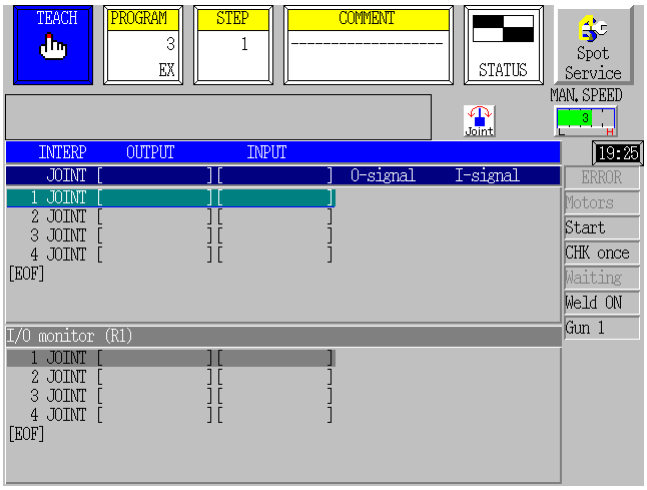
In multi-arm control, enables the program contents for two robots to be displayed simultaneously.

2./3.21. Cooperation monitor



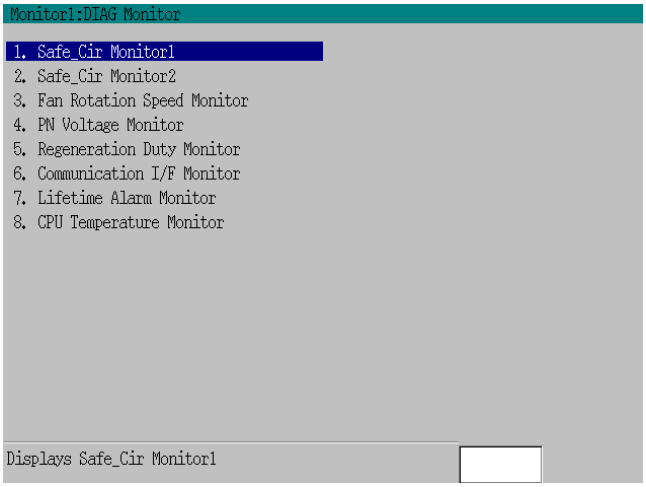
Displays the cooperative conditions of each robot in multi-arm control.

2./3.22. I/O monitor



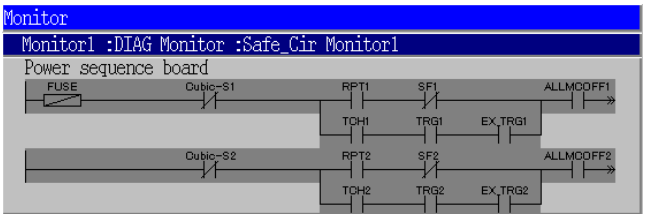
Displays the I/O signal status for each robot in multi-arm control.

2./3.24 DIAGMonitor



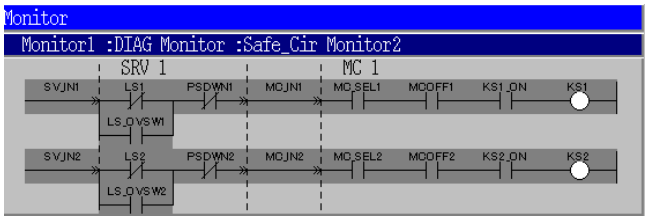
This is a menu screen to select the hardware to display the monitors.

2./3.24.1 DIAG Monitor: Safe(ty) circuit monitor 1



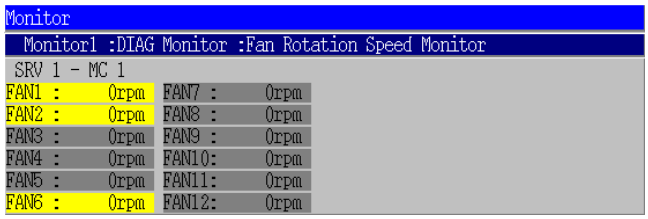
Displays the input status of the safety circuit.

2./3.24.2 DIAG Monitor: Safe(ty) circuit monitor 2



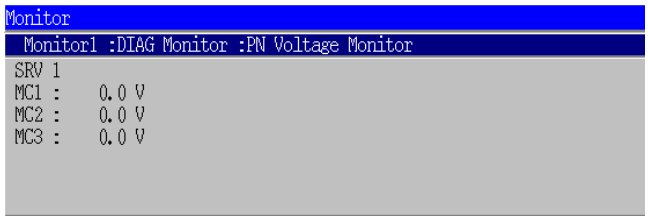
Displays the safety circuit of the selected MC unit.

2./3.24.3 DIAG Monitor: Fan Rotation Speed Monitor



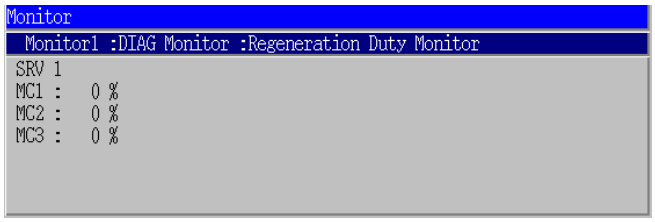
Displays the number of fan rotation of the selected MC unit.

2./3.24.4 DIAG Monitor: PN Voltage Monitor



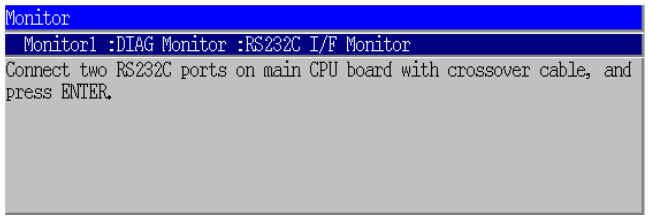
Displays the PN Voltage.

2./3.24.5 DIAG Monitor: Regenerative Duty Monitor



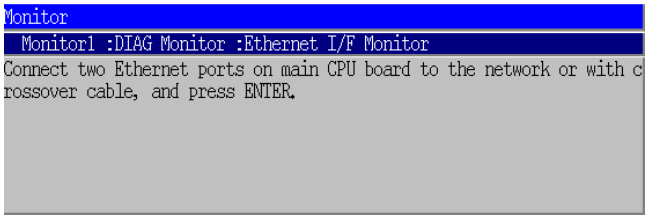
Displays the regenerative duty.

2./3.24.6.1 DIAG Monitor: RS232C I/F Monitor



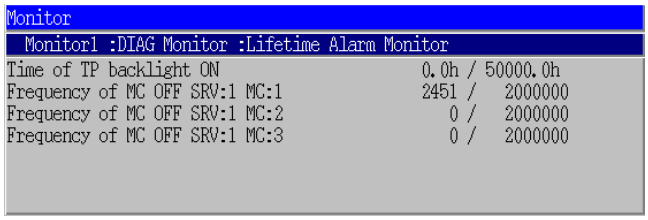
Displays RS232C I/F.

2./3.24.6.2 DIAG Monitor: Ethernet I/F Monitor



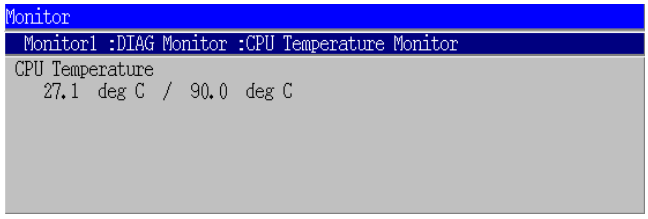
Displays Ethernet I/F.

2./3.24.7 DIAG Monitor: Lifetime Alarm Monitor



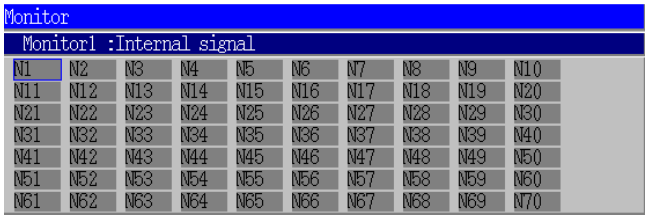
Displays the status of lifetime alarm.

2./3.24.8 DIAG Monitor: CPU Temperature Monitor



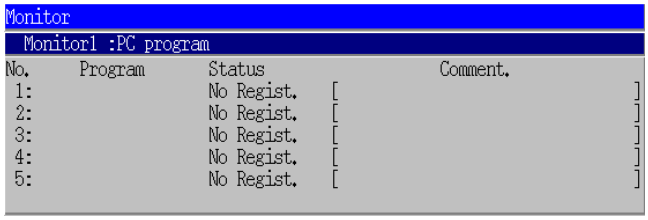
Displays the CPU temperature status.

2./3.25 Internal Signal Monitor



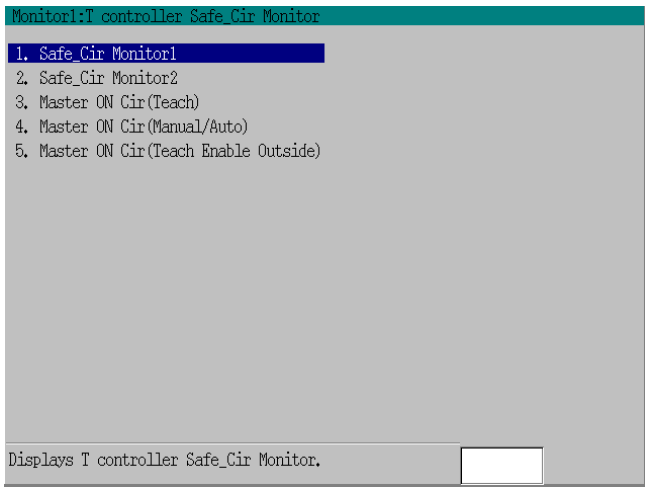
Displays the status of internal signals.

2./3.27 PC Program Monitor



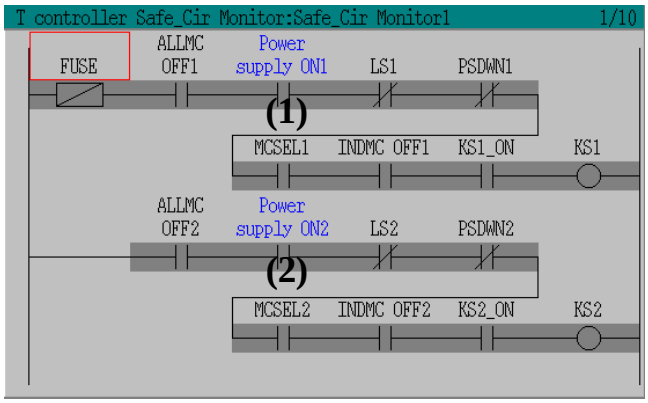
Displays the execution status of PC programs.

2./3.28 Safe(ty) Cir(cuit) Monitor



Displays the signals of T series controller power sequence. Displays for safety circuit input monitor 1, 2 and Master ON circuit (Teach, Manual/ Auto, Teach Enable Outside (safety fence)).

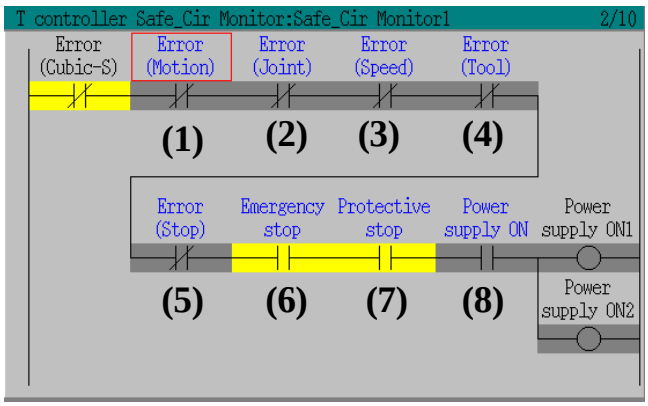
2./3.28.1.1 Safety Circuit Monitor 1



(1) Moves to power supply ON screen (Item 2./3.28.1.2)

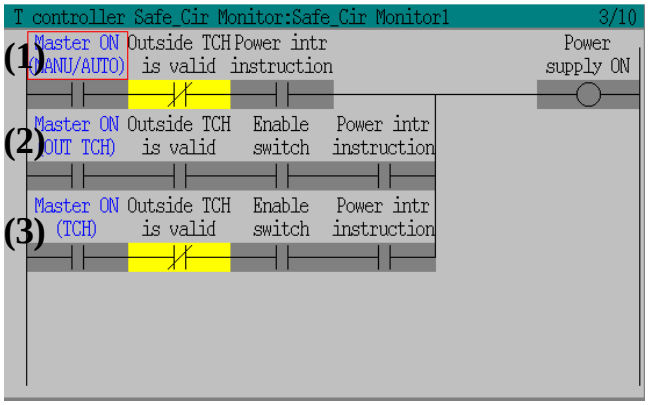
(2) Moves to power supply ON screen (Item 2./3.67.1.2)

2./3.28.1.2 Safety Circuit Monitor 1: Power Supply ON 1



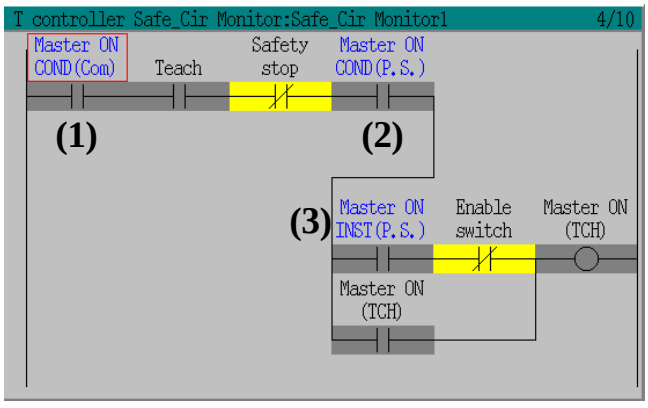
(1) Moves to motion area monitor screen (Item 2./3.28.1.11)
(2) Moves to joint monitor screen (Item 2./3.28.1.12)
(3) Moves to speed monitor screen (Item 2./3.28.1.13)
(4) Moves to tool direction monitor screen (Item 2./3.28.1.14)
(5) Moves to stop monitor screen (Item 2./3.28.1.15)
(6) Moves to emergency stop screen (Item 2./3.28.1.16)
(7) Moves to protective stop screen (Item 2./3.28.1.17)
(8) Moves to power supply ON screen (Item 2./3.28.1.3)

2./3.28.1.3 Safety Circuit Monitor 1: Power Supply ON 2



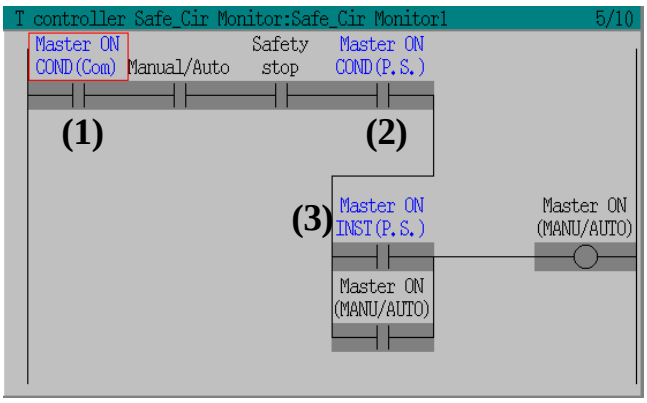
(1) Moves to Master ON (Manual/ Auto) screen (Item 2./3.28.1.5)
(2) Moves to Master ON (Teach enable outside safety fence) screen (Item 2./3.28.1.6)
(3) Moves to Master ON (Teach) screen (Item 2./3.28.1.4)

2./3.28.1.4 Safety Circuit Monitor 1: Master ON (Teach)



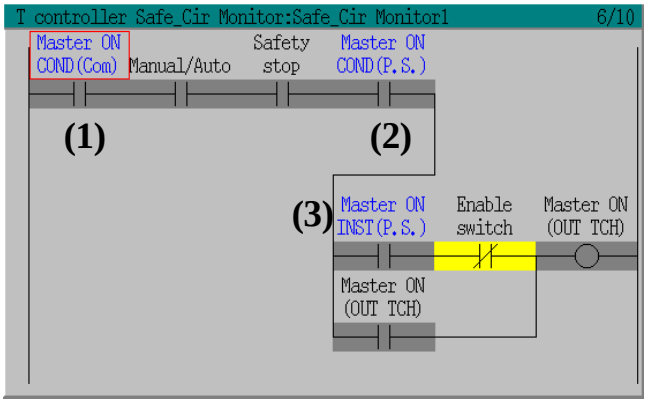
(1) Master ON Condition (Common) (Item 2./3.28.1.7)
(2) Master ON Condition (P.S.) (Item 2./3.28.1.8)
(3) Master ON Instruction (P.S.) (Item 2./3.28.1.9)

2./3.28.1.5 Safety Circuit Monitor 1: Master ON (Manual/ Auto)



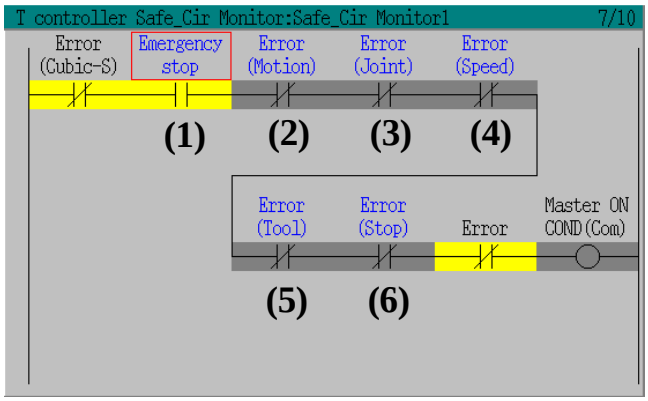
(1) Master ON Condition (Common) (Item 2./3.28.1.7)
(2) Master ON Condition (P.S.) (Item 2./3.28.1.8)
(3) Master ON Instruction (P.S.) (Item 2./3.28.1.9)

2./3.28.1.6 Safety Circuit Monitor 1: Master ON (Teach Er



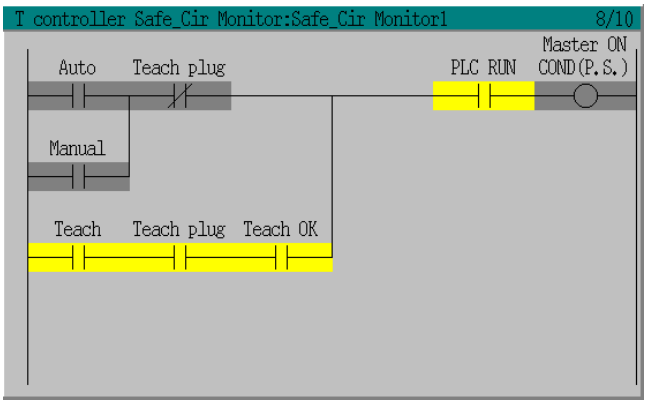
(1) Moves to Master ON Condition (Common) (Item 2./3.28.1.7)
(2) Moves to Master ON Condition (P.S.) (Item 2./3.28.1.8)
(3) Moves to Master ON Instruction (P.S.) (Item 2./3.28.1.9)

2./3.28.1.7 Safety Circuit Monitor 1: Master ON Condition (Common)



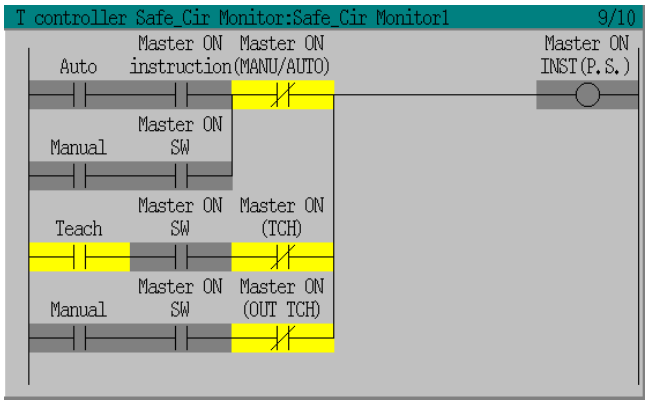
(1) Moves to emergency stop screen (Item 2./3.28.1.10)
(2) Moves to motion area monitor screen (Item 2./3.28.1.11)
(3) Moves to joint monitor screen (Item 2./3.28.1.12)
(4) Moves to speed monitor screen (Item 2./3.28.1.13)
(5) Moves to tool orientation monitor screen (Item 2./3.28.1.14)
(6) Moves to stop monitor screen (Item 2./3.28.1.15)

2./3.28.1. 8 Safety Circuit Monitor 1: Master ON Condition (P.S.)



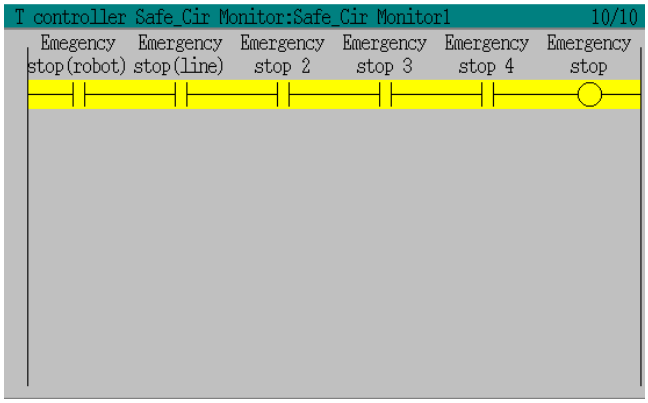
Displays the circuit information for Master ON condition (P.S.).

2./3.28.1.9 Safety Circuit Monitor 1: Master ON Instruction (P.S.)



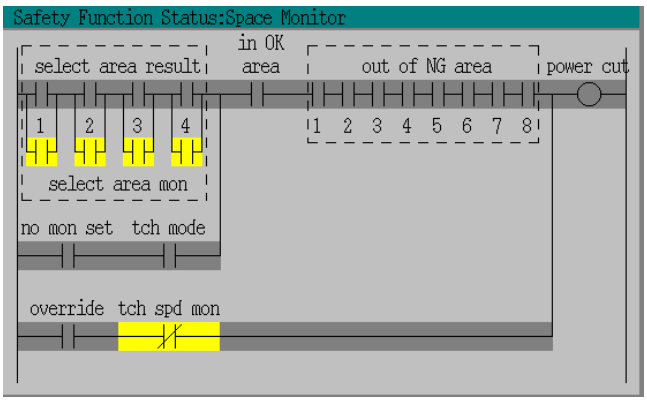
Displays the circuit information for Master ON instruction (P.S.).

2./3.28.1.10 Safety Circuit Monitor 1: Emergency Stop



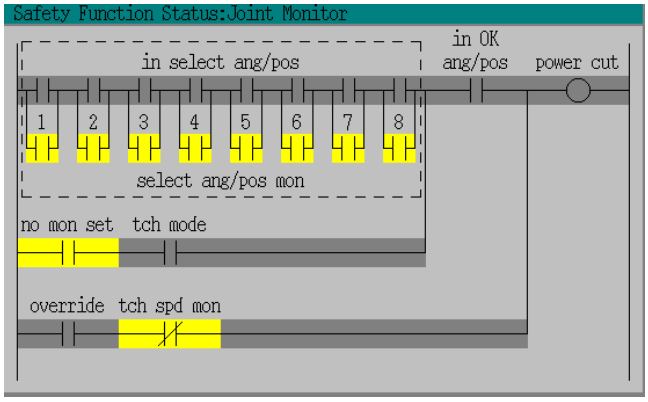
Displays the detailed information for Emergency Stop.

2./3.28.1.11 Safety Circuit Monitor 1: Space Monitor



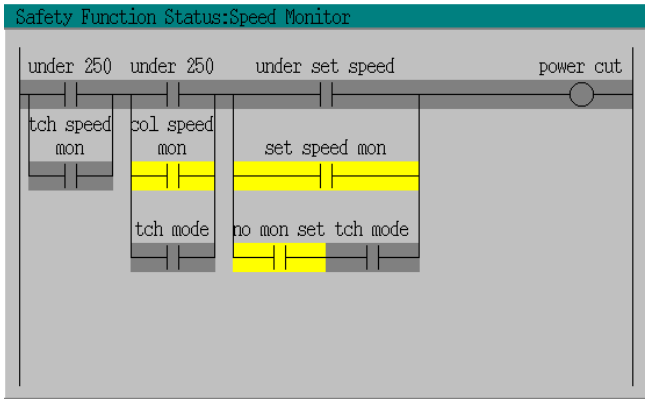
Displays the circuit information for motion area monitoring.

2./3.28.1.12 Safety Circuit Monitor 1: Joint Monitor



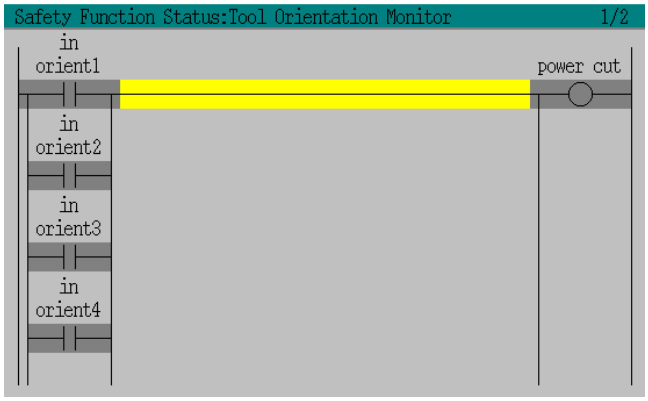
Displays the circuit information for joint monitoring.

2./3.28.1.13 Safety Circuit Monitor 1: Speed Monitor



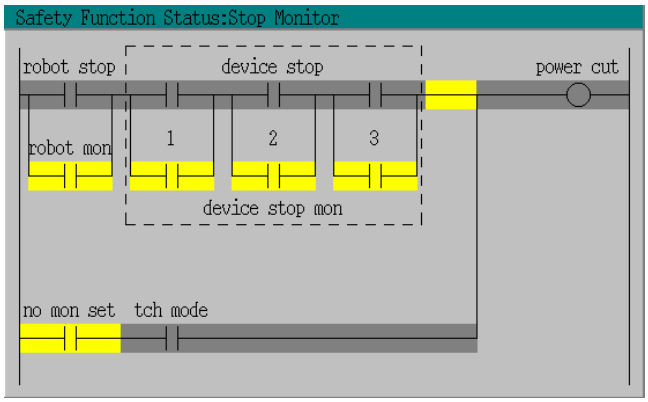
Displays the circuit information for speed monitoring.

2./3.28.1.14 Safety Circuit Monitor 1: Tool Orientation Monitor



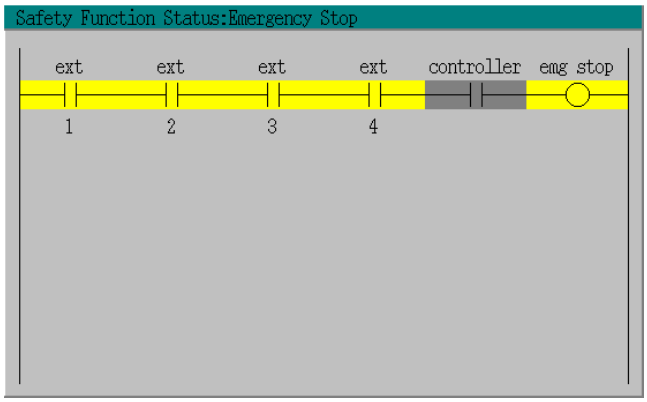
Displays the circuit information for toll orientation monitoring.

2./3.28.1.15 Safety Circuit Monitor 1: Stop Monitor



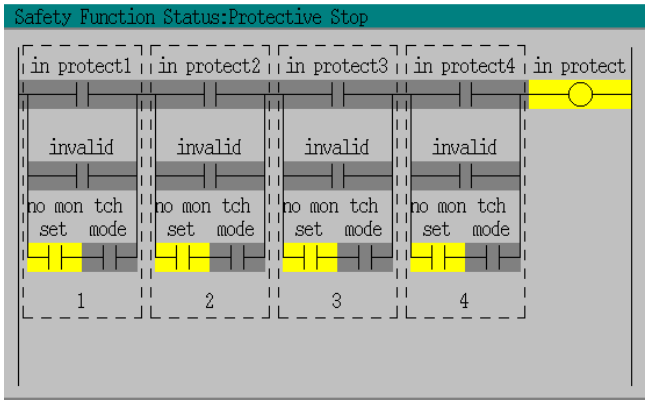
Displays the circuit information for stop monitoring.

2./3.28.1.16 Safety Circuit Monitor 1: Emergency Stop



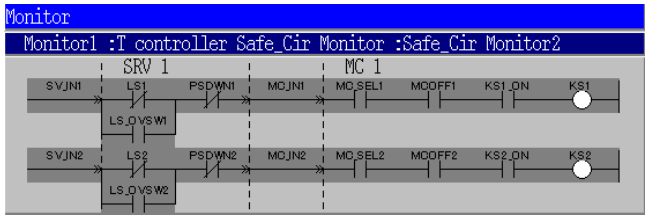
Displays the circuit information for emergency stop.

2./3.28.17 Safety Circuit Monitor 1: Protective Stop



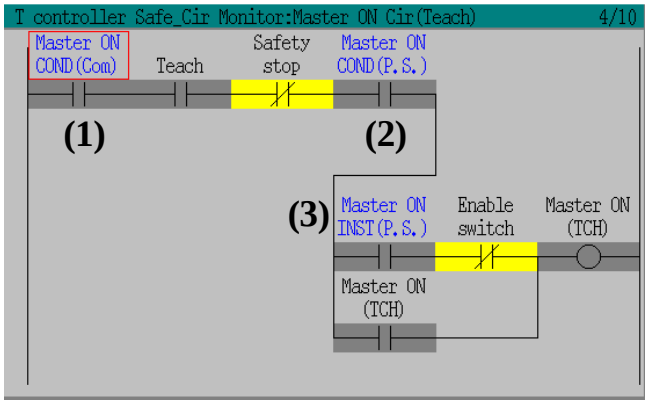
Displays the circuit information for protective stop.

2./3.28.2 Safety Circuit Monitor 2



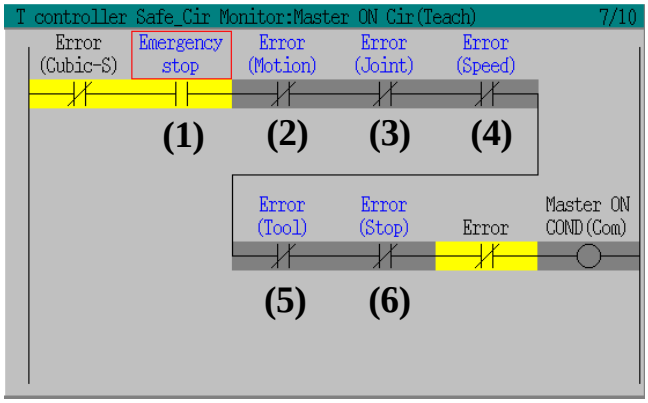
Displays the safety circuit of the selected MC unit.

2./3.28.3.1 Master ON Circuit (Teach)



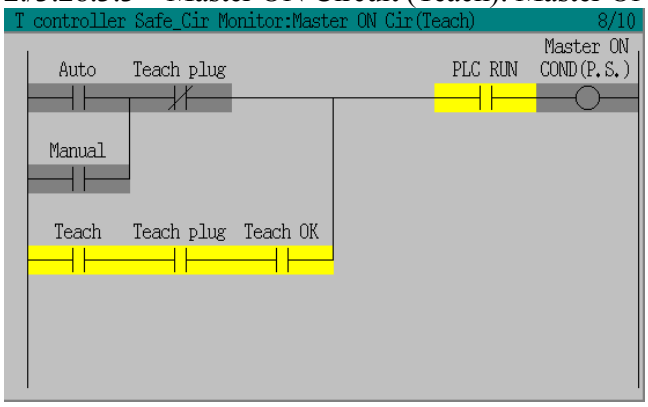
(1) Moves to Master ON Condition (Common) (Item 2./3.28.3.2)
(2) Moves to Master ON Condition (P.S.) (Item 2./3.28.3.3)
(3) Moves to Master ON Instruction (P.S.) (Item 2./3.28.3.4)

2./3.28.3.2 Master ON Circuit (Teach): Master ON condition (Common)



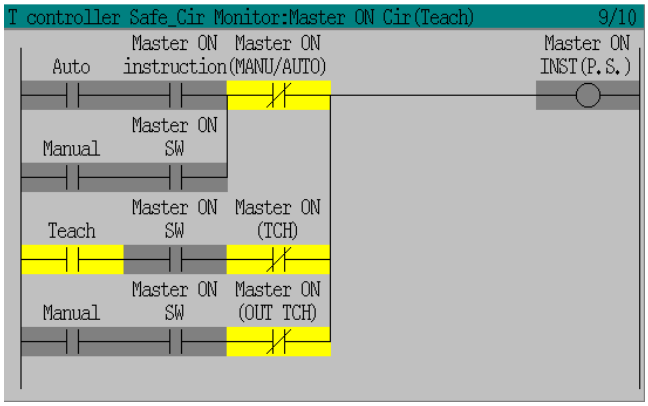
(1) Moves to emergency stop screen (Item 2./3.28.1.10)
(2) Moves to motion area monitor screen (Item 2./3.28.1.11)
(3) Moves to joint monitor screen (Item 2./3.28.1.12)
(4) Moves to speed monitor screen (Item 2./3.28.1.13)
(5) Moves to tool orientation monitor screen (Item 2./3.28.1.14)
(6) Moves to stop monitor screen (Item 2./3.28.1.15)

2./3.28.3.3 Master ON Circuit (Teach): Master ON conditic



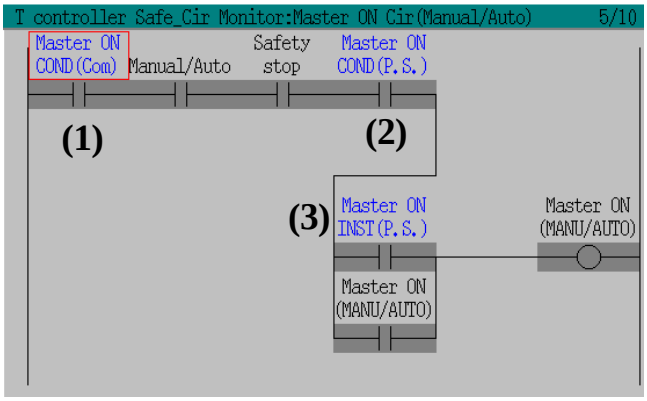
Displays the detailed information for Master ON condition (P.S.).

2./3.28.3.4 Master ON Circuit (Teach): Master ON isntruction (P.S.)



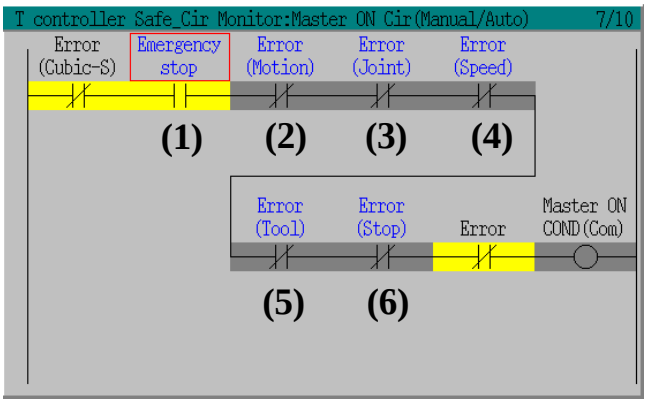
Displays the circuit information for Master ON instruction (P.S.).

2./3.28.4.1 Master ON (Manual/ Auto)



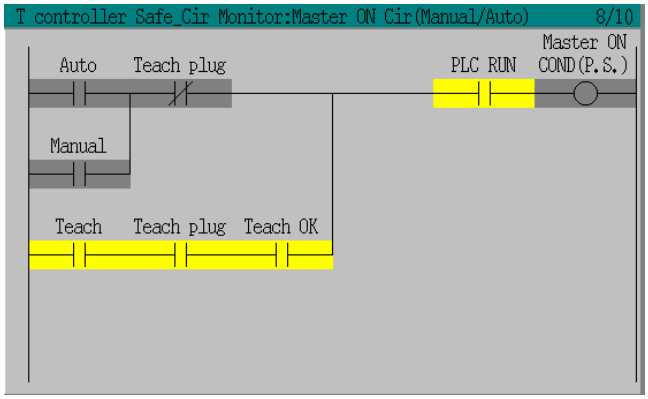
(1) Moves to Master ON Condition (Common) (Item 2./3.28.4.2)
(2) Moves to Master ON Condition (P.S.) (Item 2./3.28.4.3)
(3) Moves to Master ON Instruction (P.S.) (Item 2./3.28.4.4)

2./3.28.4.2 Master ON (Manual/ Auto): Master ON Condition (Common)面



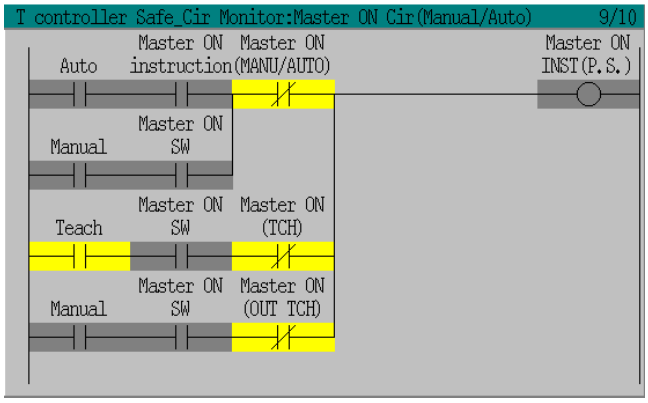
(1) Moves to emergency stop screen (Item 2./3.28.1.10)
(2) Moves to motion area monitor screen (Item 2./3.28.1.11)
(3) Moves to joint monitor screen (Item 2./3.28.1.12)
(4) Moves to speed monitor screen (Item 2./3.28.1.13)
(5) Moves to tool orientation monitor screen (Item 2./3.28.1.14)
(6) Moves to stop monitor screen (Item 2./3.28.1.15)

2./3.28.4.3 Master ON (Manual/ Auto): Master ON Cond



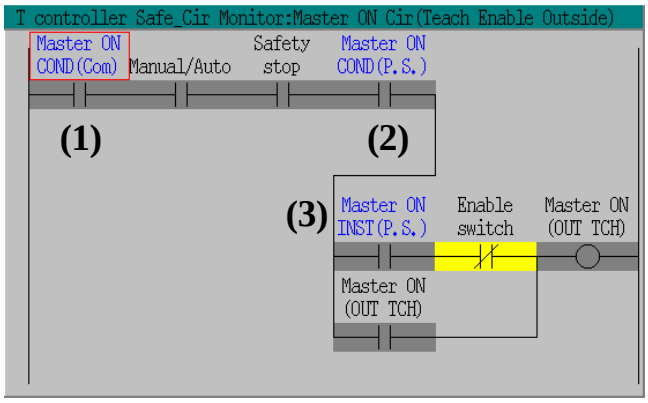
Displays the circuit information for Master ON condition (P.S.).

2./3.28.4.4 Master ON (Manual/ Auto): Master ON Instruction (P.S.)



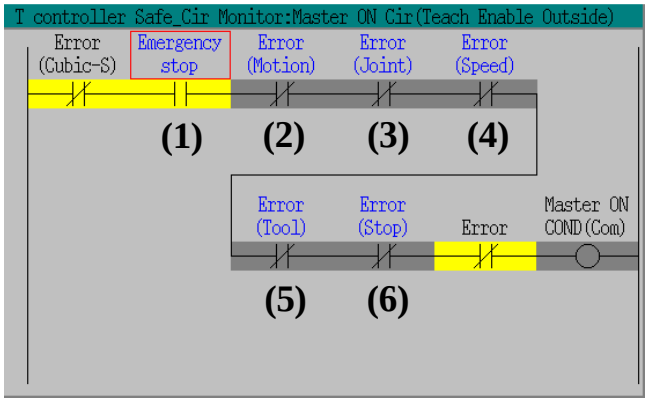
Displays the circuit information for Master ON instruction (P.S.).

2./3.28.5.1 Master ON Circuit (Teach Enable Outside (safety fence))



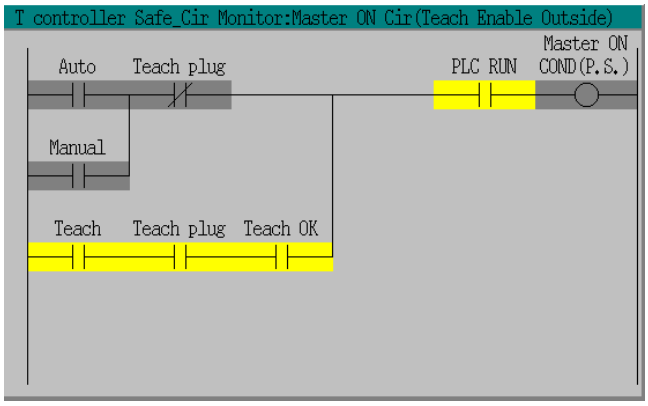
(1) Moves to Master ON Condition (Common) (Item 2./3.28.5.2)
(2) Moves to Master ON Condition (P.S.) (Item 2./3.28.5.3)
(3) Moves to Master ON Instruction (P.S.) (Item 2./3.28.5.4)

2./3.28.5.2 Master ON Circuit (Teach Enable Outside): Master ON Condition (Common)



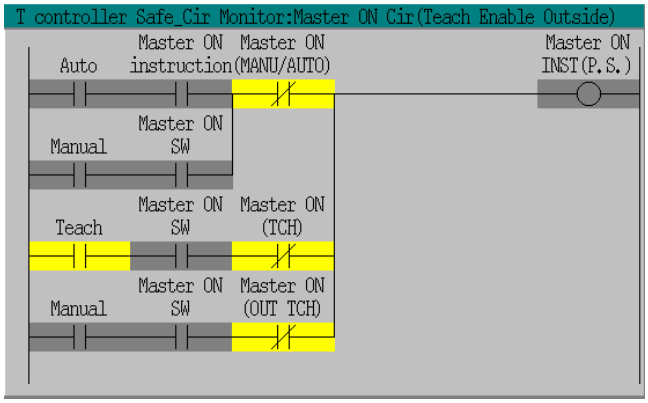
(1) Moves to emergency stop screen (Item 2./3.28.1.10)
(2) Moves to motion area monitor screen (Item 2./3.28.1.11)
(3) Moves to joint monitor screen (Item 2./3.28.1.12)
(4) Moves to speed monitor screen (Item 2./3.28.1.13)
(5) Moves to tool orientation monitor screen (Item 2./3.28.1.14)
(6) Moves to stop monitor screen (Item 2./3.28.1.15)

2./3.28.5.3 Master ON Circuit (Teach Enable Outside): Master ON Condition (P.S.)



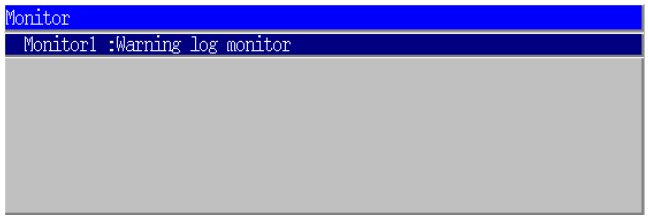
Displays the circuit information for Master ON condition (P.S.).

2./3.28.5.4 Master ON Circuit (Teach Enable Outside): Master ON Instruction (P.S.)



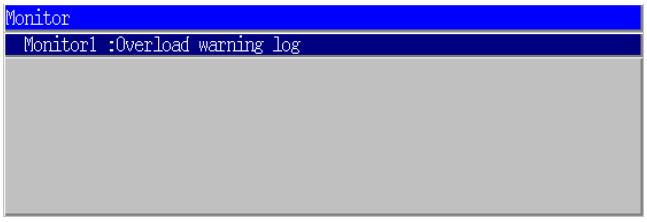
Displays the circuit information for Master ON instruction (P.S.).

2./3.55. Warning log monitor



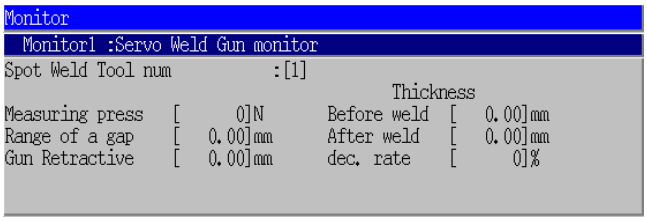
Displays the warning log.

2./3.56. Overload warning log



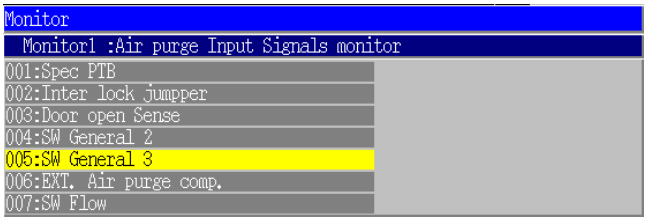
Displays the log of torque overload warnings.

2./3.57 Servo Weld Gun Monitor (For servo gun application)



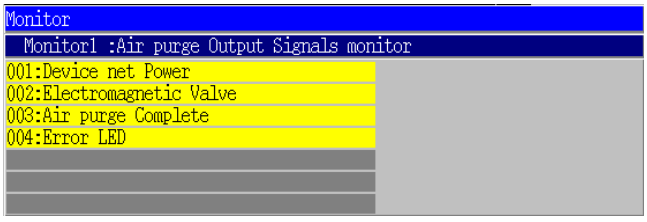
Displays servo weld gun status.

2./3.57 Air Purge Input Signal Monitor (For painting application)



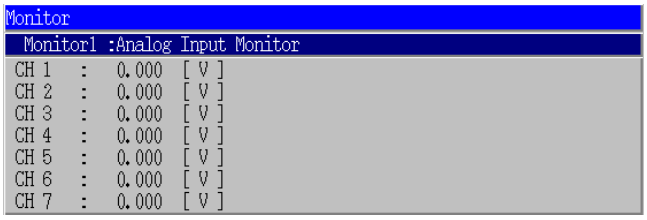
Displays the input signals dedicated for anti-explosive painting application.

2./3.58 Air Purge Output Signal Monitor (For painting application)



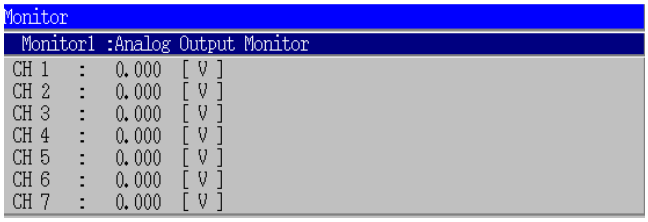
Displays the output signals dedicated for anti-explosive painting application.

2./3.91 Analog Input Monitor



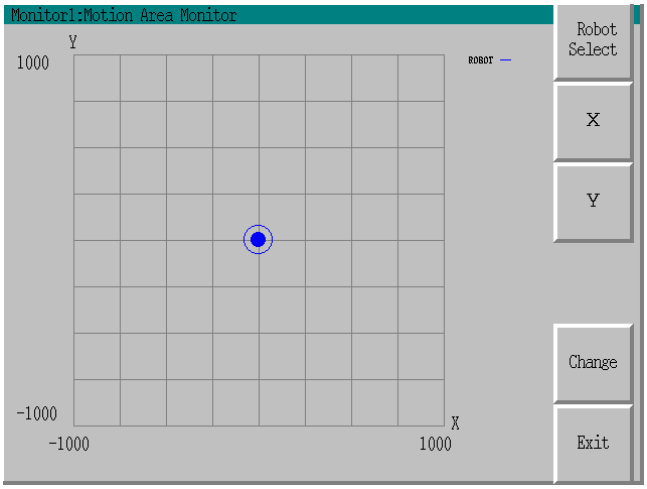
Displays analog input status.

2./3.92 Analog Output Monitor



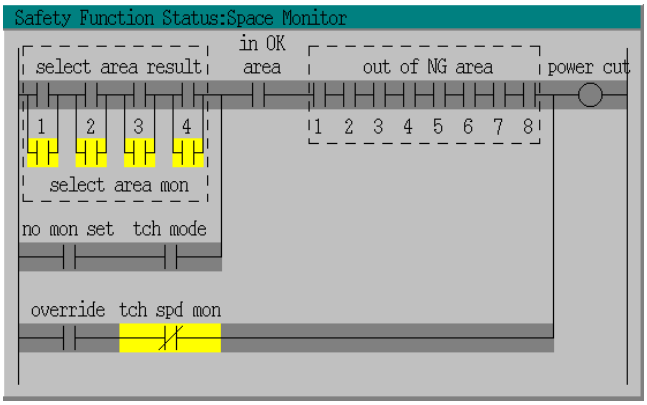
Displays analog output status.

2./3.95 Motion Area Monitor



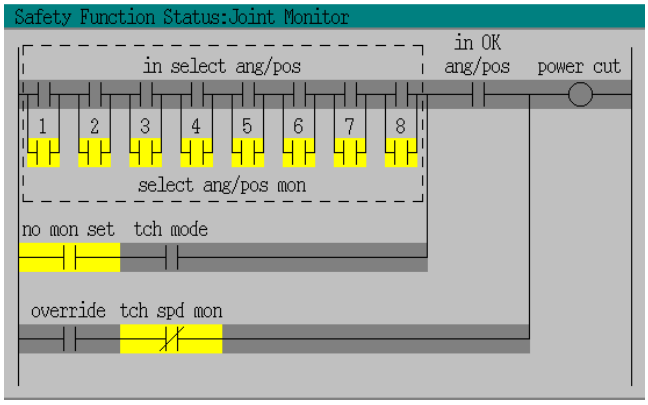
Displays the current status of the motion area.

2./3.96.1 Safety Function Status: Space Monitor



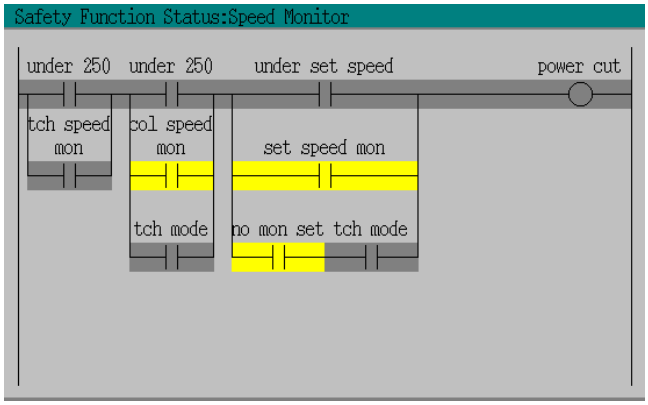
Displays the signals for space monitor.

2./3.96.2 Safety Function Status: Joint Monitor



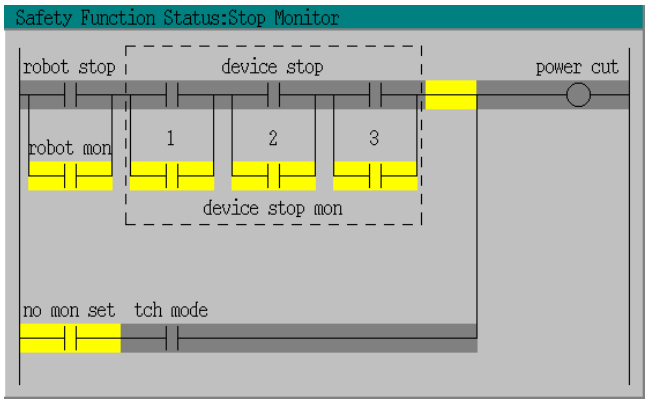
Displays the signals for joint monitoring.

2./3.96.3 Safety Function Status: Speed Monitor



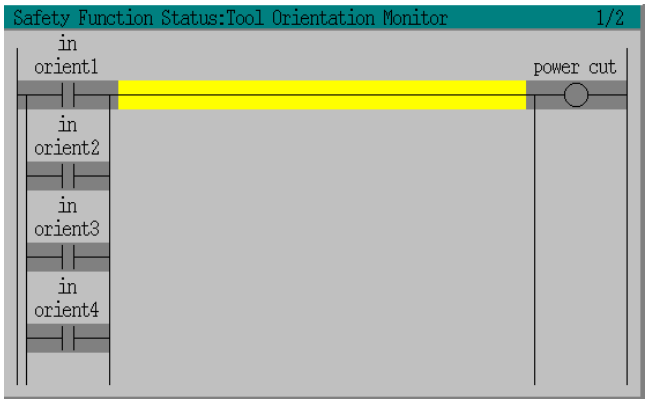
Displays the signals for speed monitoring.

2./3.96.4 Safety Function Status: Stop Monitor



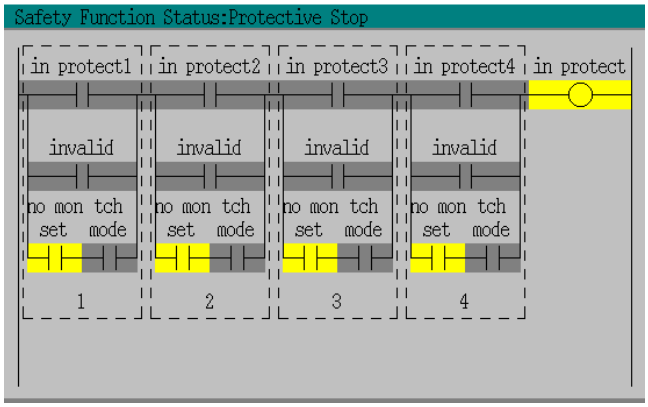
Displays the signals for stop monitoring.

2./3.96.5 Safety Function Status: Tool Orientation Monitor



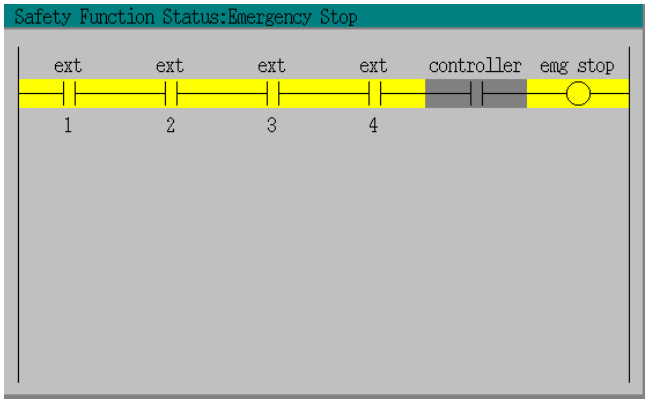
Displays the signals for tool orientation monitoring.

2./3.96.6 Safety Function Status: Protective Stop



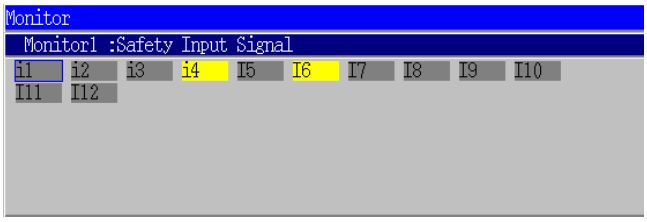
Displays the signals for protective stop.

2./3.96.7 Safety Function Status: Emergency Stop



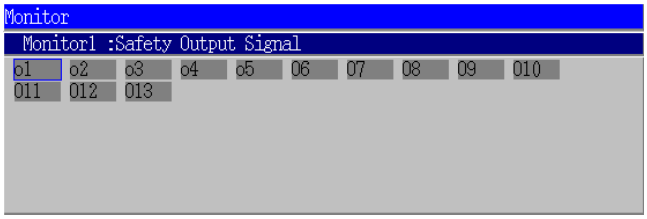
Displays the signals for emergency stop.

2./3.97 Safety Input Signal Monitor



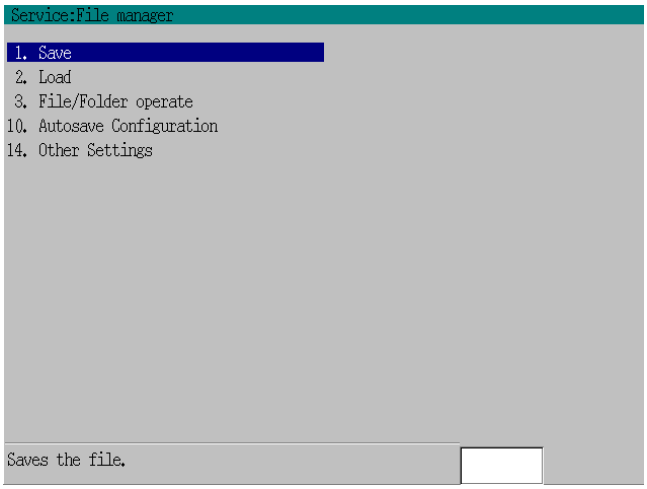
Displays the status of safety input signals.

2./3.98 Safety Output Signal Monitor



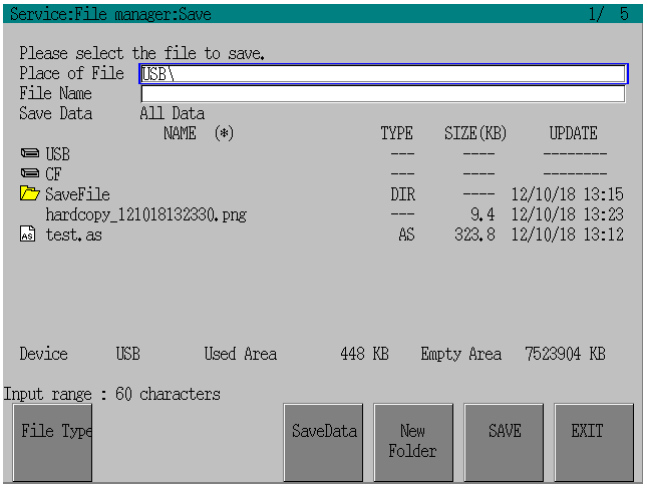
Displays the status of safety output signals.

4. File Manager

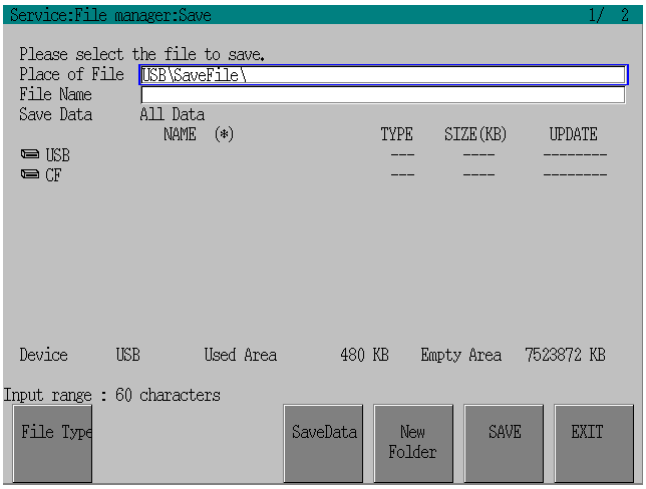


4.1. Save

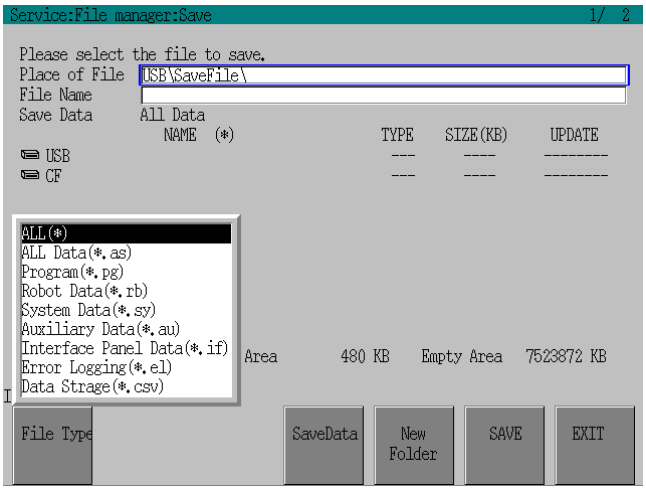
This function saves programs and other data in the controller memory to USB memory or compact flash card (hereinafter called CF) in file unit. USB memory is inserted into the USB port inside the accessory panel on the controller. CF is built in the controller.



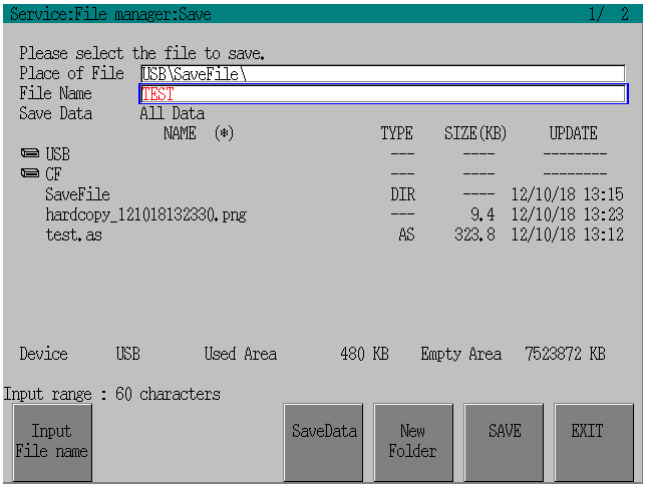
1. Select the desired device. Move cursor to [USB] and press ↵ to select USB memory, or to [CF] and press ↵ to select CF. USB memory is selected by default when screen opens.



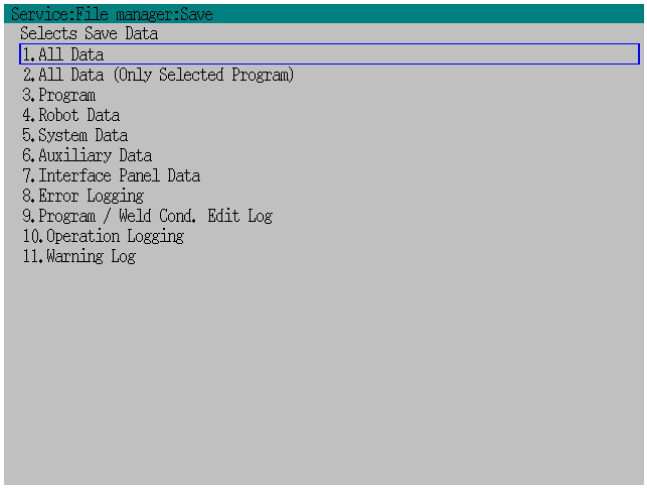
2. Select the desired folder to save the data to. Move cursor to desired folder with 📂 and press ↵ to open the folder. Confirm the specified folder name is displayed in [Place of File]. Pressing R moves back to the parent folder.



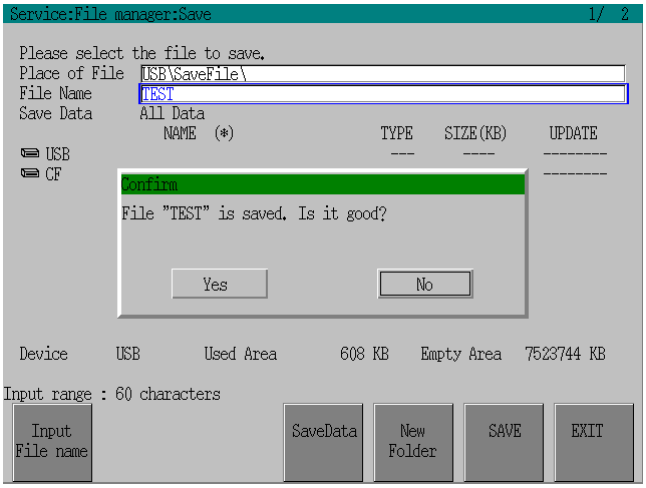
3. Move cursor to [Place of File], and press <File Type> in lower left portion of screen. Select the desired file type from the pull-down menu and press ↵.



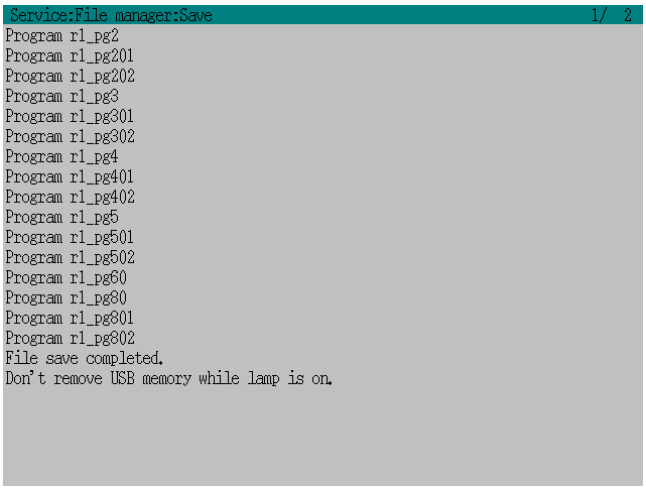
4. Select the desired file name from the list of file names. Or, move cursor to [File Name] and press <Input File name> in lower left portion of screen. Input file name via the keyboard screen, and press ↵.



5. Screen at left appears by pressing <SaveData>. Select the desired file type.



6. If setting is correct, press <SAVE>. Confirmation box is displayed. Select [Yes] to execute or select [No] to cancel.



7. Saving finishes when “File save completed.” is displayed. Remove the USB flash memory after the access lamp has turned OFF.

Selectable file types are below.

All Data
Saves all programs and other data in controller memory to the USB/CF memory.

All Data (Only selected program) (*.as)
Saves all data of the specified program with the specified file name* to USB/CF memory.

Program (*.pg)
Saves the specified program data to the file with the specified name* to USB/CF memory. If the saved program calls other programs (subroutines), the called programs are also saved.

Robot Data (*.rb)
Saves system data such as dedicated signal setting data and zeroing data, etc. to the file with the specified name* to USB/CF memory.

System Data (*.sy)
Saves system data with the specified file name* to USB/CF memory.

Auxiliary Data (*.au)
Saves parameter values of element instructions (auxiliary data) such as speed, accuracy, timer, tool, etc., taught by block teaching with the specified file name* to USB/CF memory.

Interface Panel (*.if)
Saves data of devices set on the interface panel screen with the specified file name* to USB/CF memory.

Error Logging (*.el)
Saves the error history of the last 1000 entries in memory, including error code, message, date, time, under the specified file name* to USB/CF memory.

Data Storage (*.csv)
Saves the data storage data with the specified file name* to USB/CF memory.

NOTE* A file name (number) must be specified when storing data to USB/CF memory. Enter a name (number) for file identification, but a file extension, such as AS, PG, AU, RB is automatically added to the file name (number) according to the selected file type. (The file extension does not need to be input.)

If a file is identified with the same file number, or name, as an existing file, a backup file is automatically created. "B" is added to the extension of the original file name indicating a backup file. (i.e..BAS) Only one backup file is created, if additional files of the same name are specified, the backup file data is overwritten.

The settings for reading data from USB memory to the PC vary depending on PC. Be sure your PC is installed with the appropriate USB memory-compatible driver.

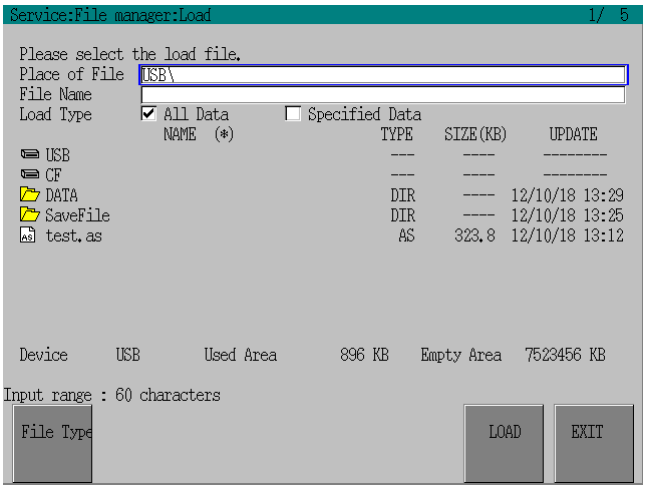
[NOTE]

The error message below may appear when an error occurs while writing data to a file, for example when USB memory is full.

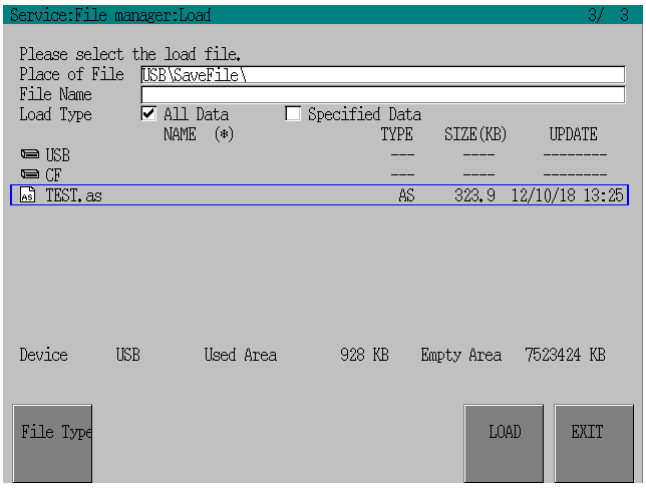
Data write error. (USB/CF)

4.2. Load

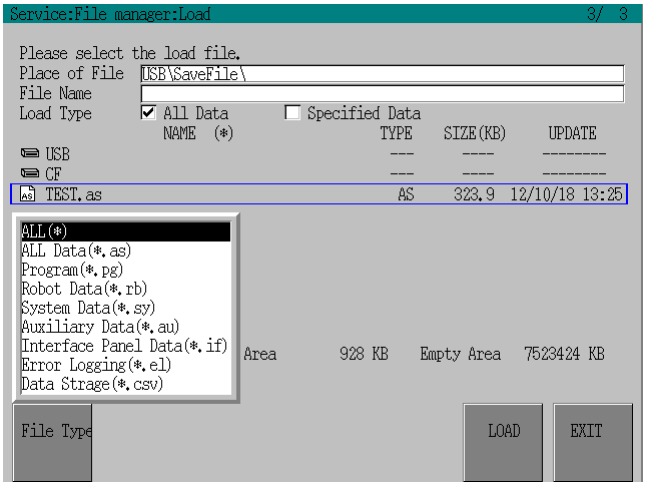
This function loads the data saved as files in the external memory device to the controller memory. Use either a USB memory device or the CF as external memory device.
USB memory is inserted into USB port inside the accessory panel on controller. CF is built in the controller and has capacity of about 20 MB.



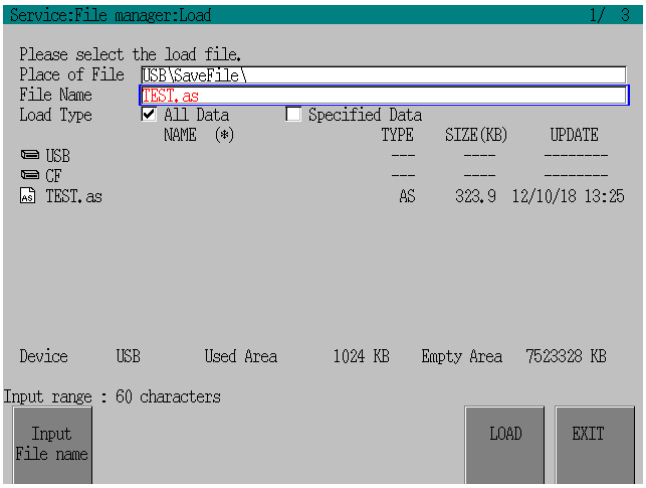
1. Select the desired device. Move cursor to [USB] and press ↵ to select USB memory, or to [CF] and press ↵. USB memory is selected by default when screen is displayed



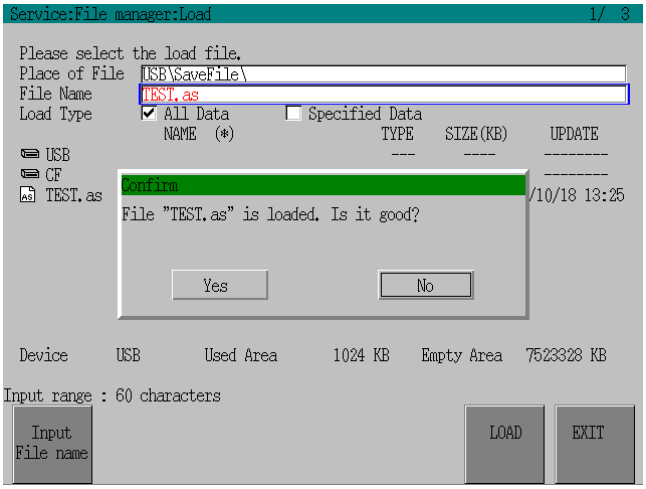
2. Select the folder that includes the file to be loaded. Move cursor to desired folder with 📂 and press ↵ to open the folder. Confirm the specified folder name is displayed in [Place of File]. Pressing R moves back to the parent folder.



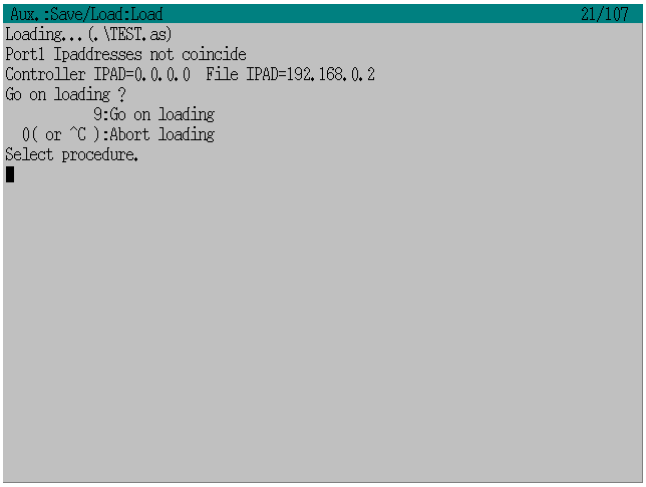
3. Move cursor to [Place of File], and press <File Type> in lower left portion of screen. Select the desired file type from the pull-down menu and press ↵.



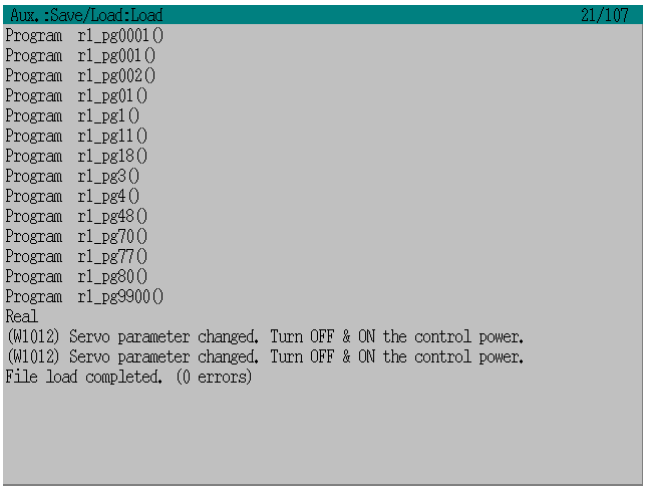
4. Select the desired file to be loaded from the list. Or, move cursor to [File Name] and press <Input File name> in lower left portion of screen. Input file name via keyboard screen and press



5. If the setting is correct, press <LOAD>. Confirmation box is displayed. Select [Yes] to execute or select [No] to cancel.



6. Confirmation message is displayed. Input 0 (No) to cancel loading of the robot data. Input 1 (Yes) to load the robot data.



7. Loading finishes when "File load completed." is displayed. Remove the USB flash memory after the access lamp has turned OFF.

Selectable file types are below.

All

Loads all programs and other data in the memory to the controller memory.

All Data (Only selected program) (*.as)

Loads all data of the specified program with the specified file name* to the controller memory.

Program (*.pg)

Loads the specified program data to the file with the specified name* to controller memory. If the program calls other programs (subroutines), the called programs are also loaded.

Robot Data (*.rb)

Loads the system data such as dedicated signal setting data and zeroing data, etc. to the file with the specified name* to the controller memory.

System Data (*.sy)
Loads system data with the specified file name* to controller memory.

Auxiliary Data (*.au)
Loads parameter values of element instructions (auxiliary data) such as speed, accuracy, timer, tool, etc., taught by block teaching with the specified file name*to the controller memory.

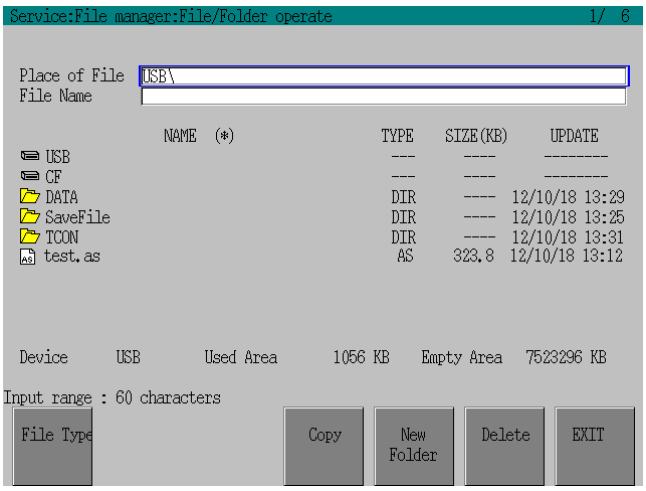
Interface Panel (*.if)
Loads data of devices set on the interface panel screen with the specified file name* to the controller memory.

Error Logging (*.el)
Loads the error history data up to the last 1000 entries in the USB/CF memory , including: error code, message, date, time with the specified file name*to the controller memory.

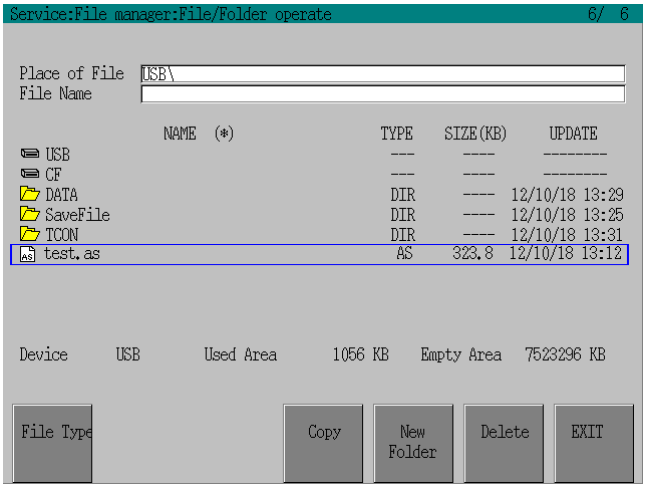
NOTE* A file name (number) must be specified when loading data to controller memory.
Enter a name (number) for file identification, but a file extension, such as AS, PG, AU, RB is automatically added to the file name (number) according to the selected file type. (The file extension does not need to be input.)

4.3. File/Folder Operate

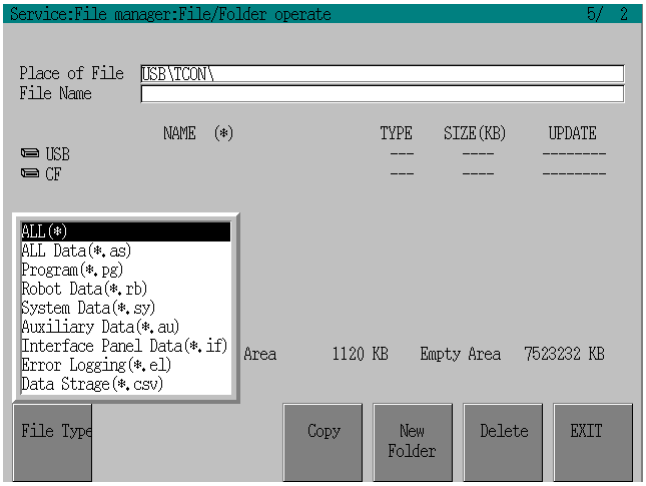
This function executes copy, deletion, and renaming of the file or folder in the external memory device. Use either a USB memory device or the CF as external memory device. USB memory is inserted into USB port inside the accessory panel on controller. CF is built into the controller and is approximately 20 MB.



1. Select the desired device. Move cursor to [USB] and press ↵ to select USB memory, or to [CF] and press ↵. USB memory is selected by default when screen is displayed.

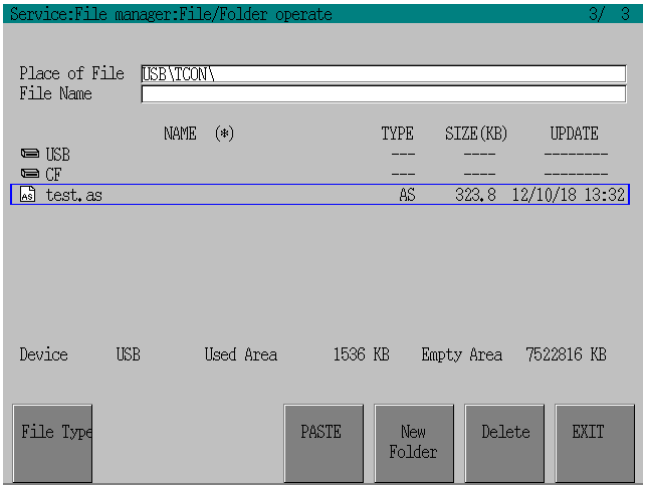


2. Select the folder that includes the desired file. Move cursor to desired folder with 📂 and press ↵ to open the folder. Confirm the specified folder name is displayed in [Place of File]. Pressing R moves back to the previous folder.

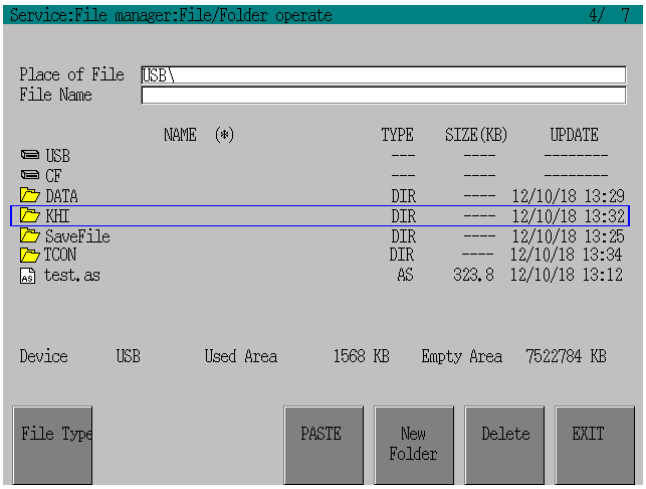


3. Move cursor to [Place of File], and press <File Type> in lower left portion of screen. Select the desired file type from the pull-down menu and press ↵.

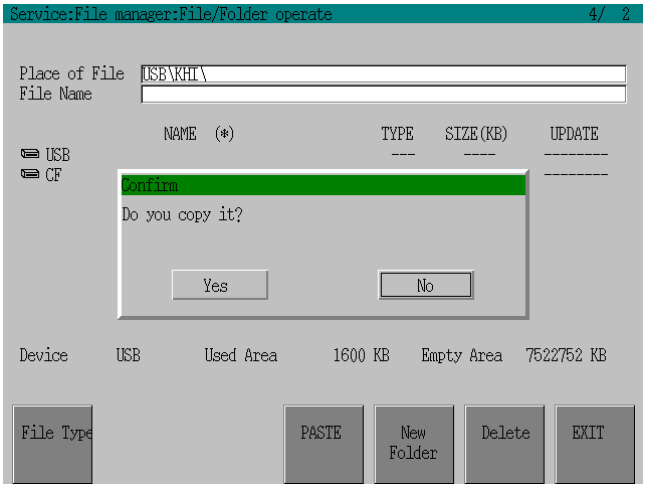
Copy



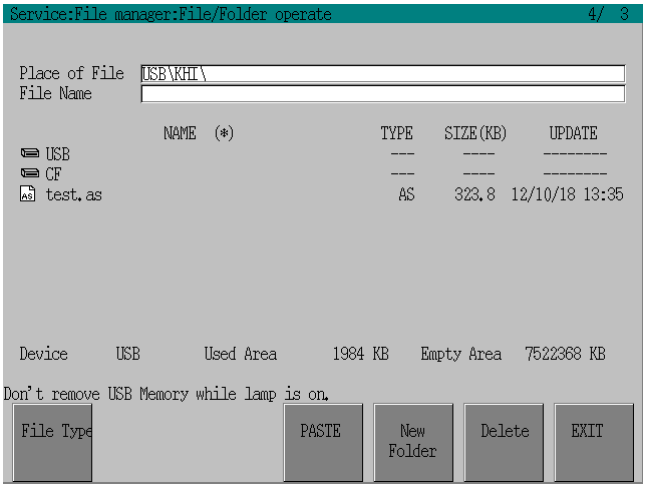
1. Move cursor to the desired file or folder name and press <Copy>.



2. Move cursor to the desired destination folder name and press ↵.

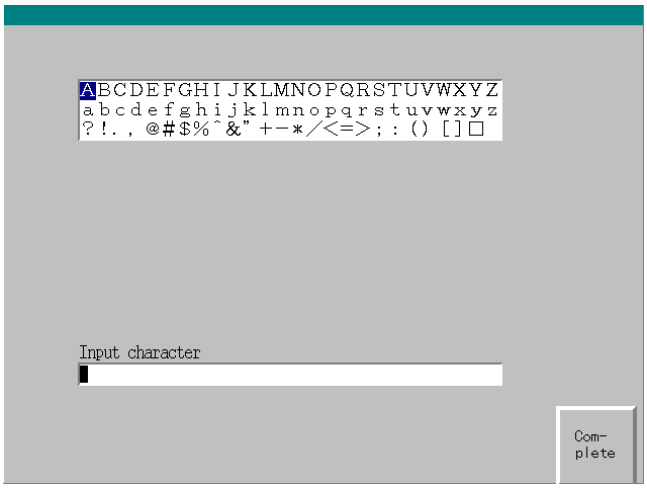


3. Pressing A+<PASTE> displays confirmation box . Select [Yes] to execute.



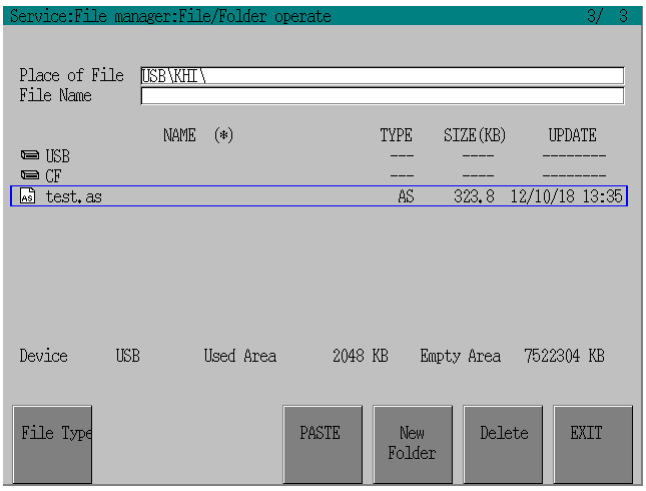
4. The file or folder is copied into the specified folder.

New Folder

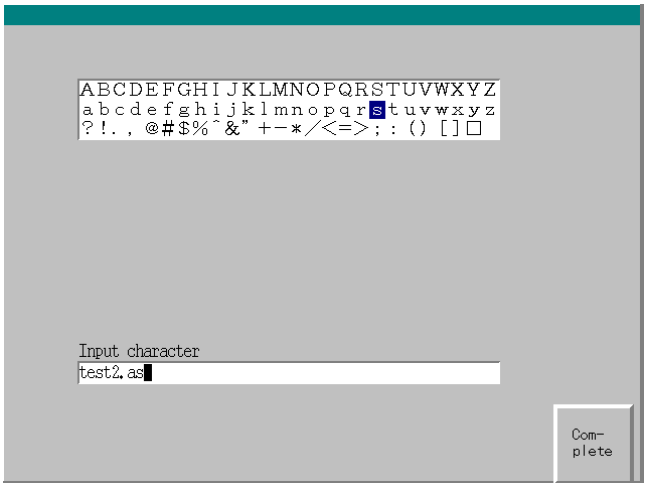


Pressing <New Folder> displays keyboard screen. Input a folder name and press <ENTER>

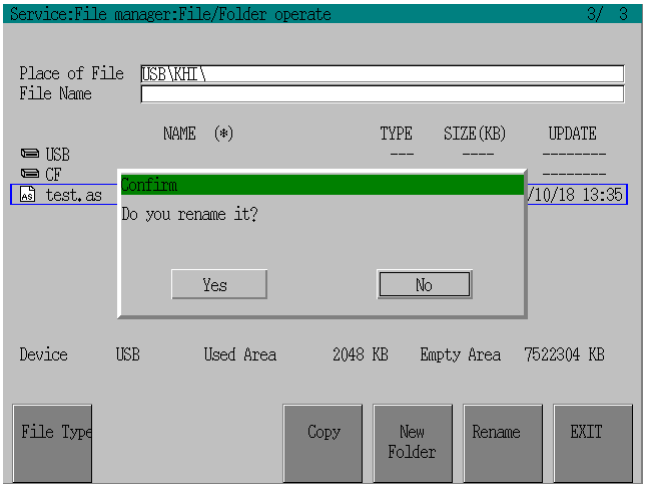
Rename



1. Move cursor to the desired file or folder and press <Rename>.

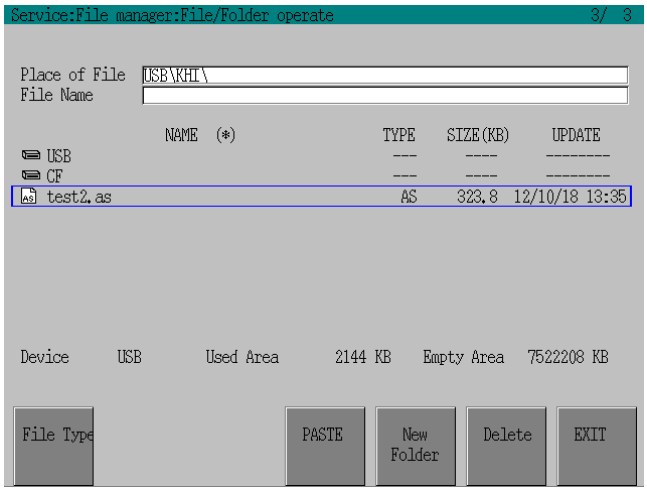


2. The keyboard screen is displayed. Input a new name and press <ENTER>.

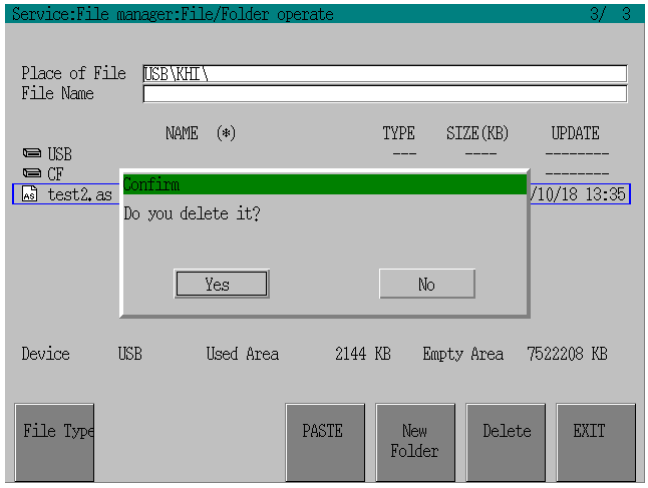


3. Confirmation box is displayed. Select [Yes] to execute.

Delete

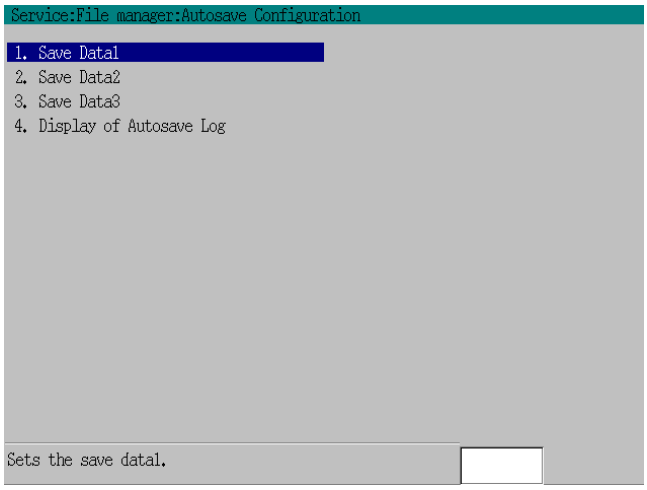


1. Move cursor to the desired file or folder and press Enable+<Delete>.



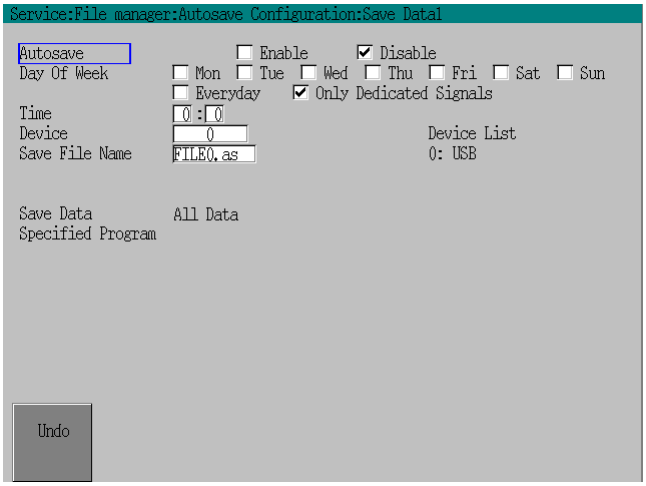
2. Confirmation box is displayed. Select [Yes] to execute.

4.10. Autosave configuration



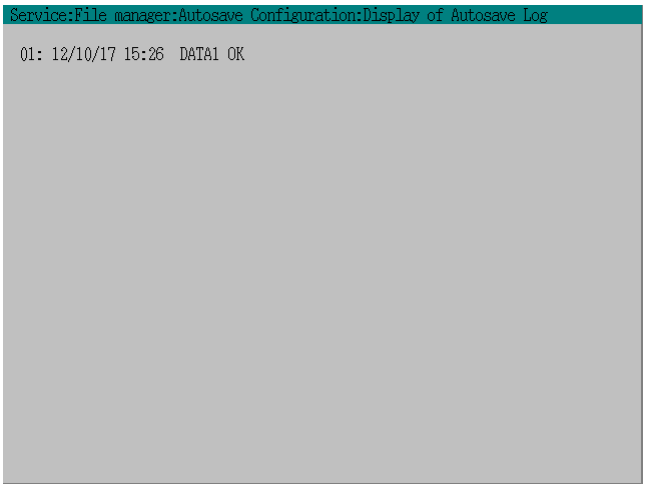
Automatically saves data stored in controller memory to the USB flash memory under the specified conditions. Three autosave conditions are available. Also, the autosave log can be displayed.

4.10.1./2./3. Save data 1/2/3



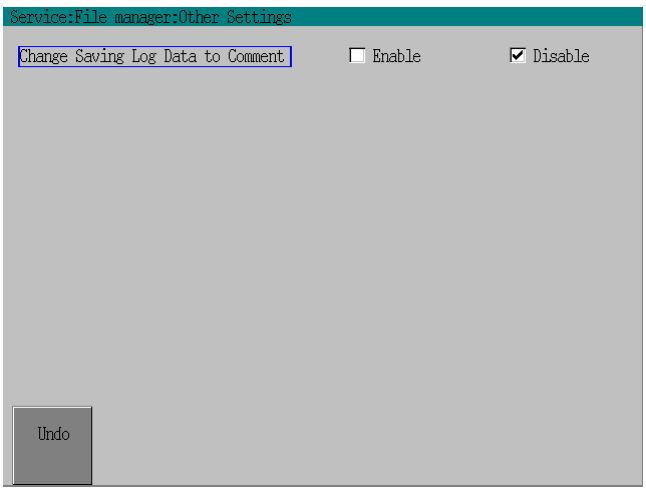
Sets the timing and conditions for saving data automatically. For details, see Chapter 12.

4.10.4. Display of autosave log



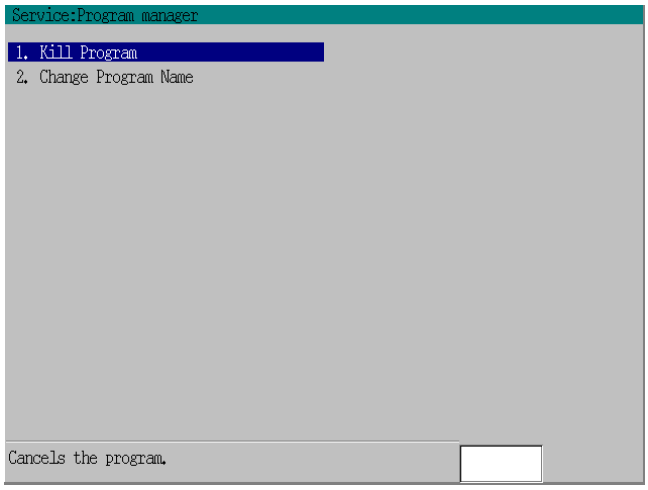
Displays the log history of automatically saved data.

4.14. Other settings

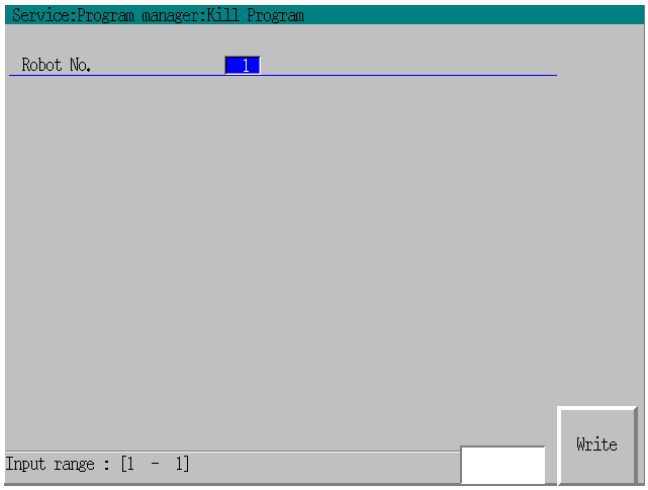


Selecting [Enable] prompts the operator to add a comment.

5. Program manager

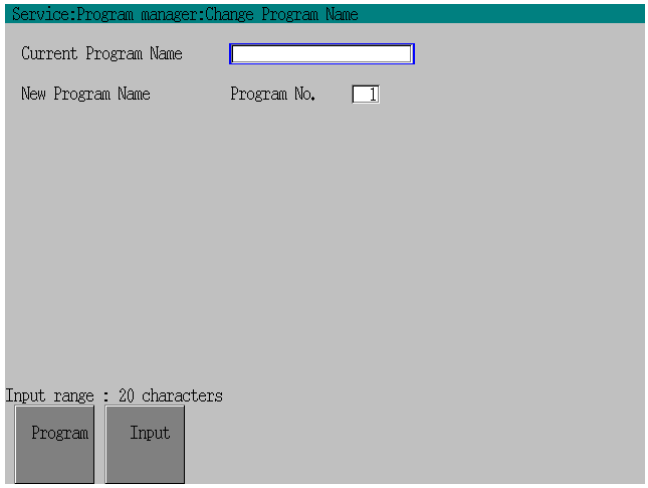


5.1. Kill program



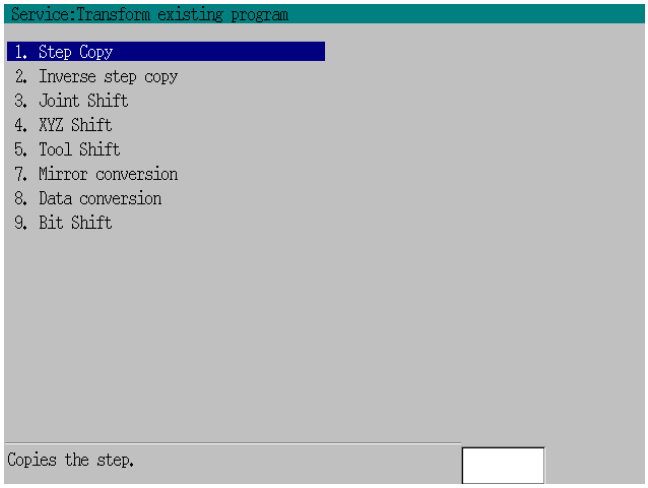
Initializes the program stack for the selected specified robot. For single-arm control, input 1 to Robot No., and press <Yes> after pressing <Complete>.

5.2. Change program name



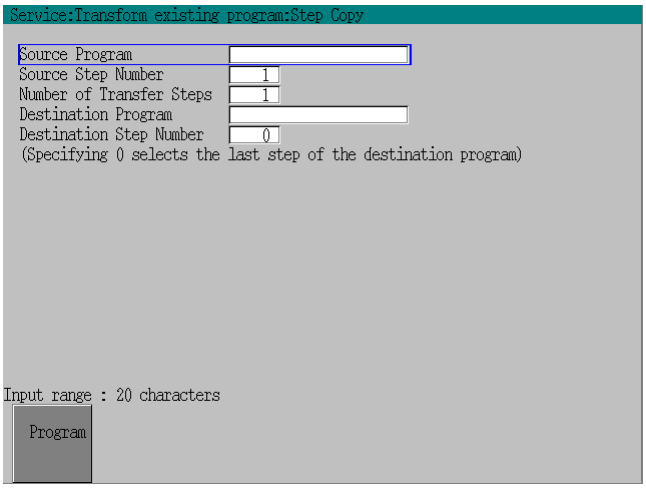
Changes a program name to a desired program number. To change a program name, press <Program> and select the program to be renamed from the list displayed.

6. Transform existing program



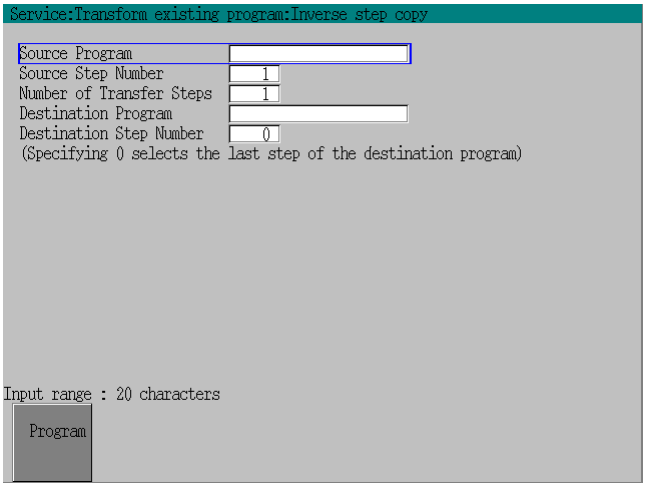
Screen on the left is for spot weld specification. In other specifications, the screen specific to that specification is displayed.

6.1. Step copy



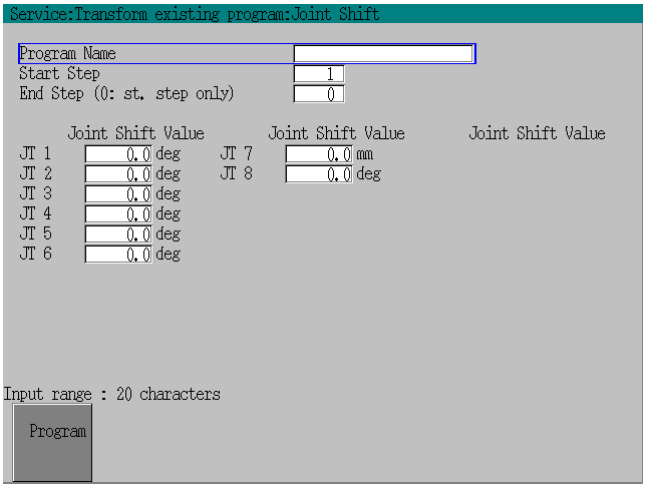
Allows program step(s) to be copied between programs or to a different step within the same program.

6.2. Inverse step copy



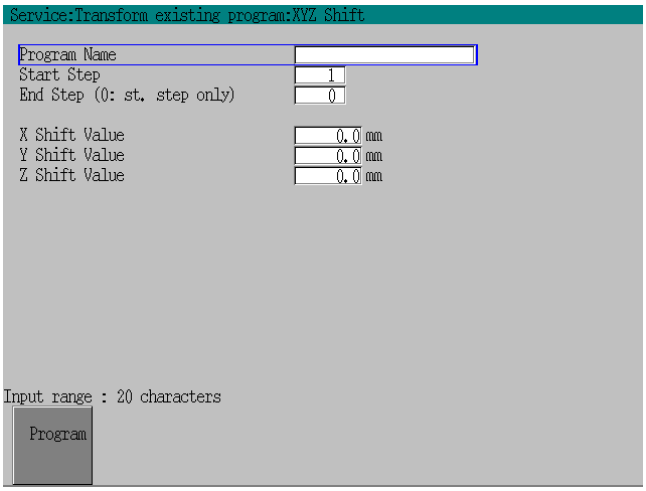
Allows steps in the source program to be copied to the specified range in the destination program in reverse order.

6.3. Joint shift



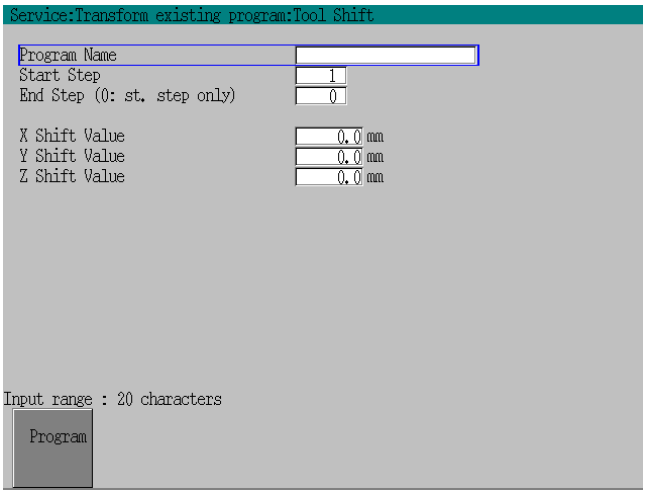
Shifts the joint value data of each axis in a range of block teaching steps.
Specify degrees for rotational axes and mm for linear axes.

6.4. XYZ shift



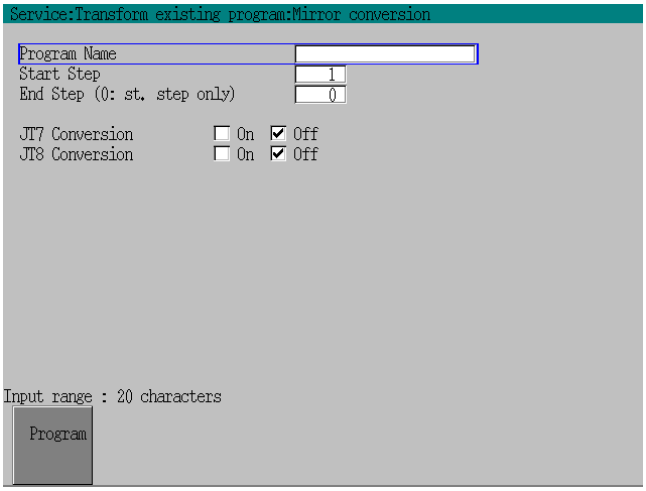
Shifts the pose data taught in block teaching steps along the X, Y, and Z axes of the robot base coordinates.

6.5. Tool shift



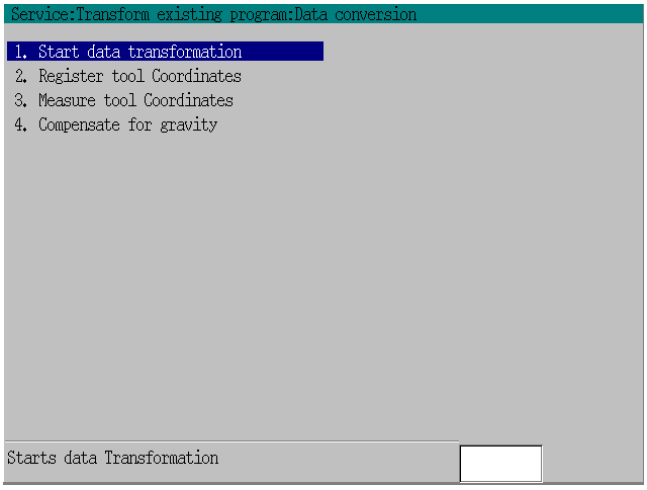
Shifts the pose data taught in block teaching steps along the X, Y, and Z-axes of the robot tool coordinates.

6.7. Mirror conversion



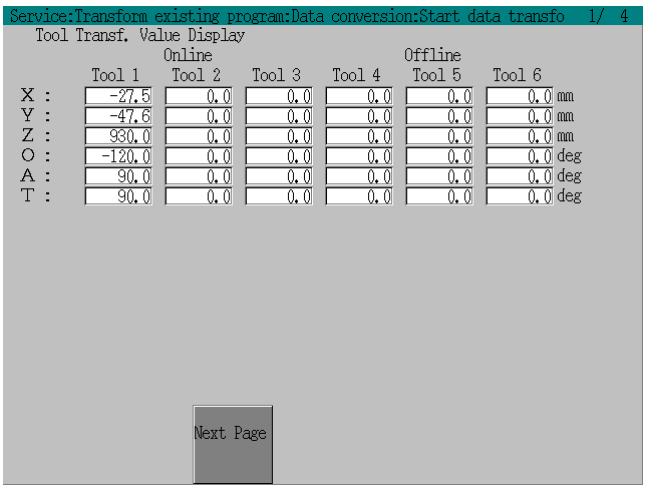
Transforms taught pose data into a mirror copy, symmetrical against the robot's YZ plane. It is possible to make mirror symmetric data without actual operation of a robot, if the shape of the workpiece is mirror-symmetric against the YZ plane.

6.8. Data conversion



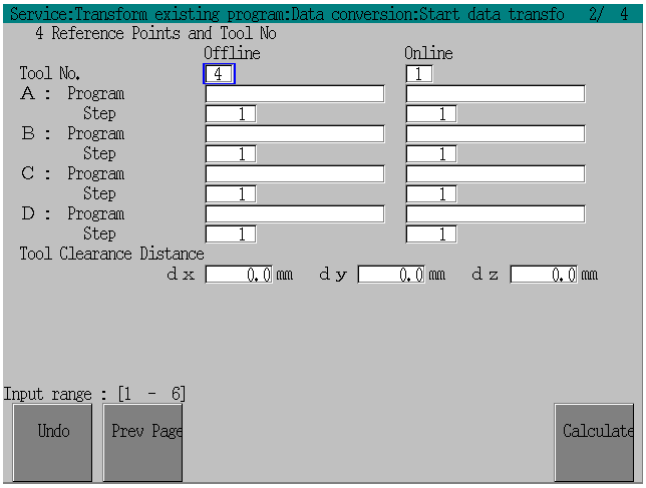
Transforms offline data taught in an off-line machine or CAD (ROSET) system into data that is executable by an on-line machine.

6.8.1. Start data transformation



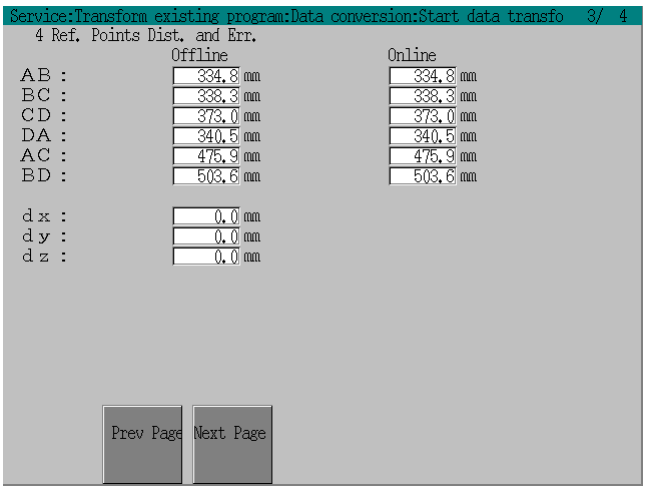
Displays online and offline tool data by selecting [1. Start data transformation]. Tools 1, 2, 3 are specified for use online. Tools 4, 5, 6 are specific for the offline machine.

(6.8.1. Start data transformation <page 2>)



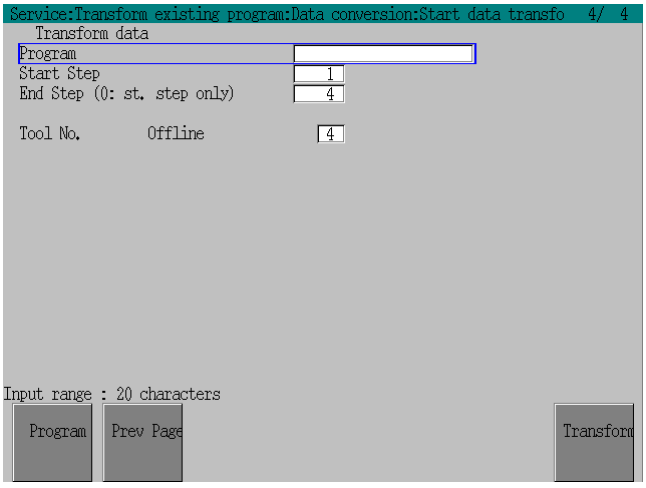
To convert an offline program for use on online robot, input tool/program/step Nos. of the four reference points taught on the workpiece for both lines, then press <Calculate>. Set dx, dy, dz as clearance distances for the tool on the X, Y, Z-axes of the base coordinates, this prevents collision when checking after tool replacement.

(6.8.1. Start data transformation <page 3>)



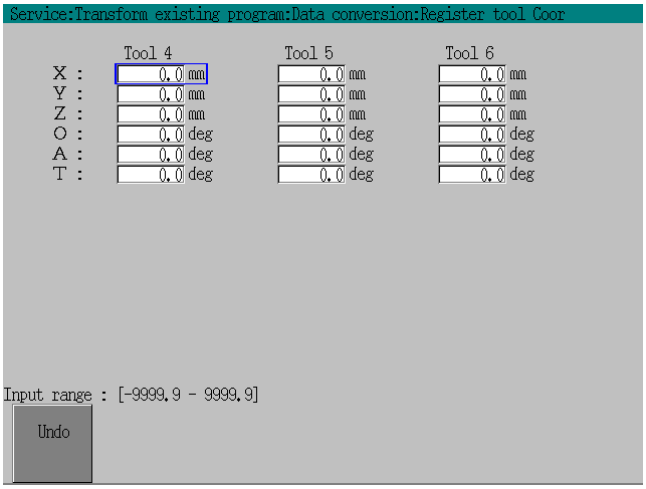
Displayed by pressing <Next Page> in screen 2/4 after recording the four reference points. Displays distances between reference points in both offline and online. The dx, dy, dz values represent the difference between the base coordinate x, y, z values calculated for point D from the conversion matrix determined by data input above and the x, y, z values actually measured for point D.

(6.8.1. Start data transformation <page 4>)



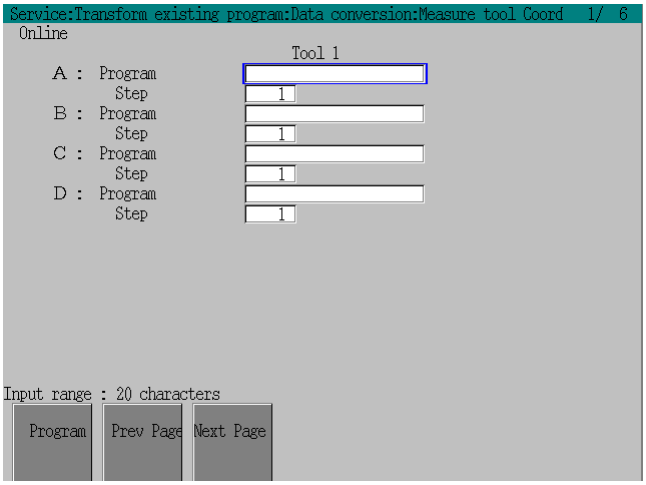
If there are no problems with the displayed results, press <Next Page> in screen 3/4, set necessary data on the left screen, and press <Transform> to transform data.

6.8.2. Register tool coordinates



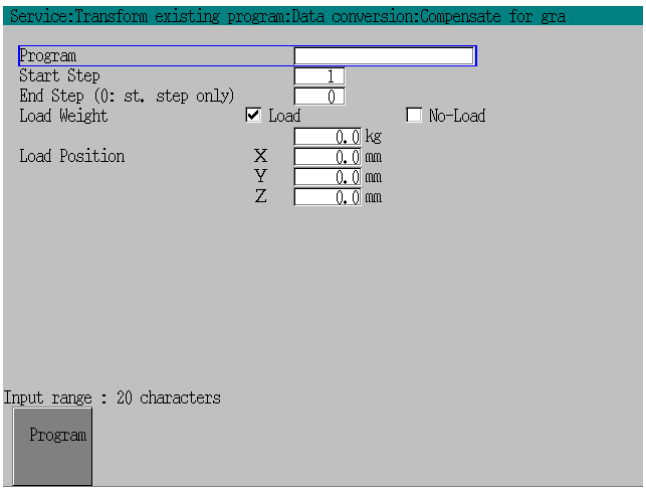
Allows setting/changing the tool data of the offline tools by selecting [2. Register tool coordinates].

6.8.3. Measure tool coordinates



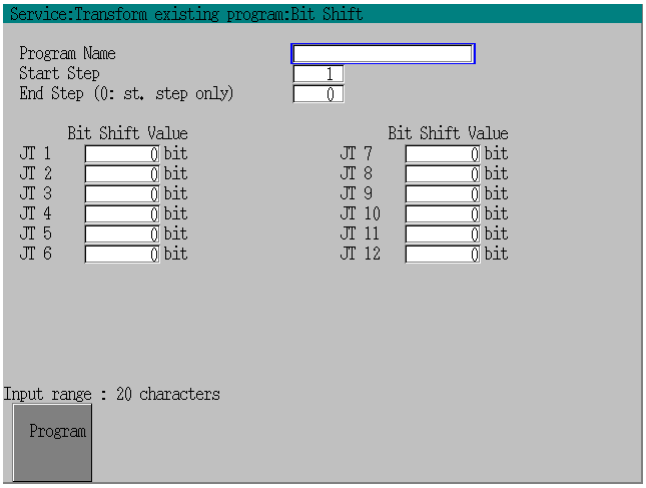
Registers the taught data of reference points A, B, C, D for automatic tool data setting. Select [3. Measure tool coordinates], then press ↵. The tool data is automatically registered.

6.8.4. Compensate for gravity



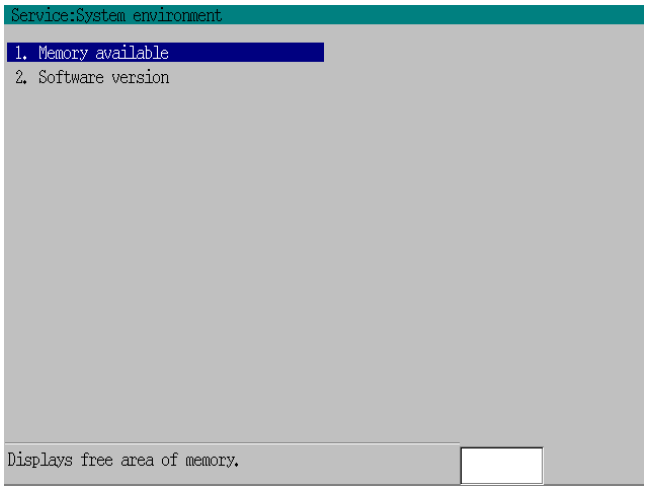
Transforms pose data of the program based on the offline CAD data into data that reflects actual gravity and payload. Select [4. Compensate for gravity], set desired parameters and press ↵. X, Y, Z values for Load Positing define tool center of gravity in the tool coordinates.

6.9. Bit shift

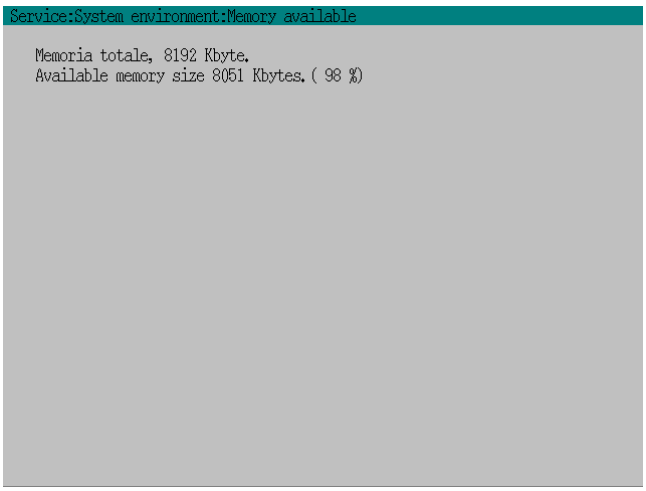


Shifts taught joint displacement value data in bits.

8. System environment

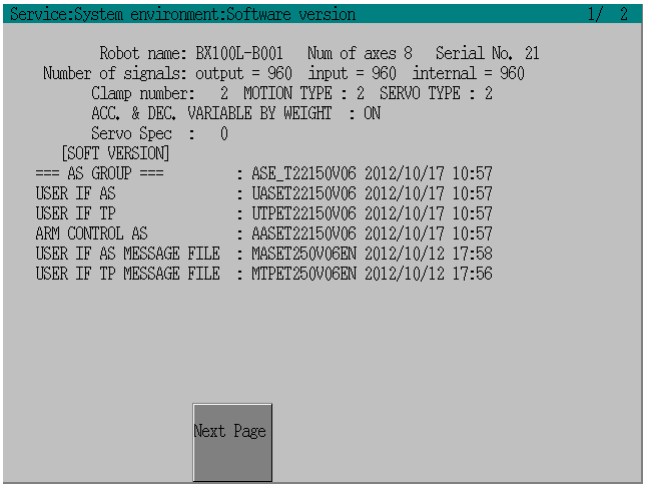


8.1. Memory available



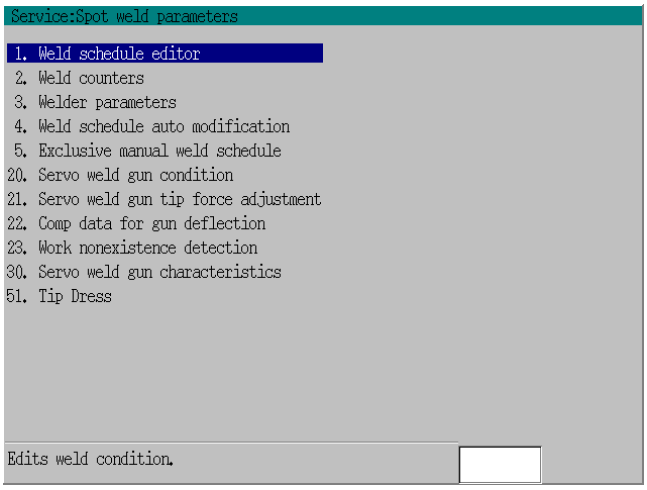
Displays memory available for programming or recording variables. Available memory is displayed as a percentage (%) of the total byte capacity of the memory.

8.2. Software version



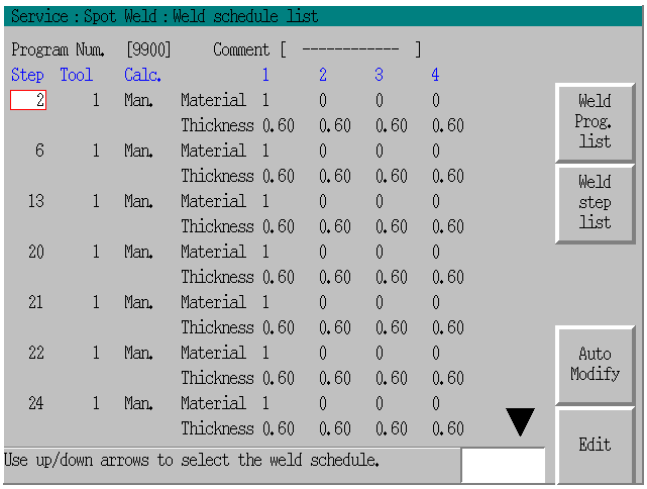
Displays the following information: the software versions installed in the robot controller and teach pendant, the robot model, serial No., total number of I/O signals available.

10. Spot weld parameters



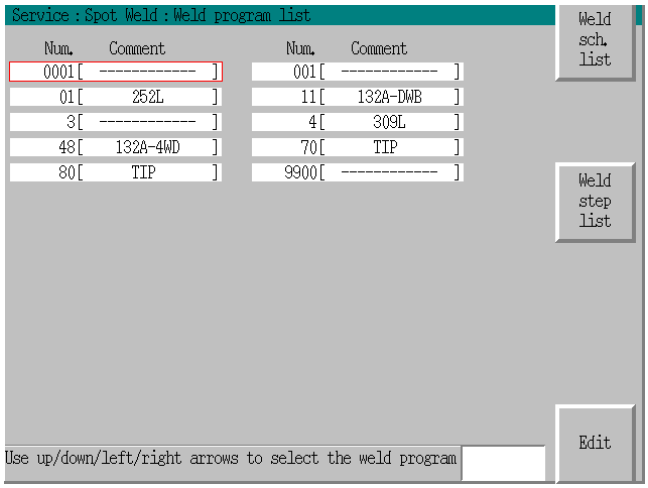
Pressing <Spot service> displays the menu screen for setting the spot weld parameters. For other specifications, pressing <Relevant service> displays the setting screen specific to that application.

10.1. Weld schedule editor

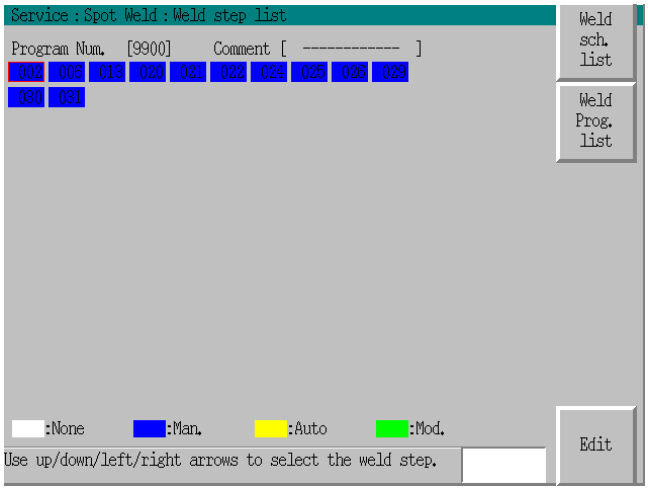


Displays all the weld steps of the selected program, and edits their weld conditions collectively.

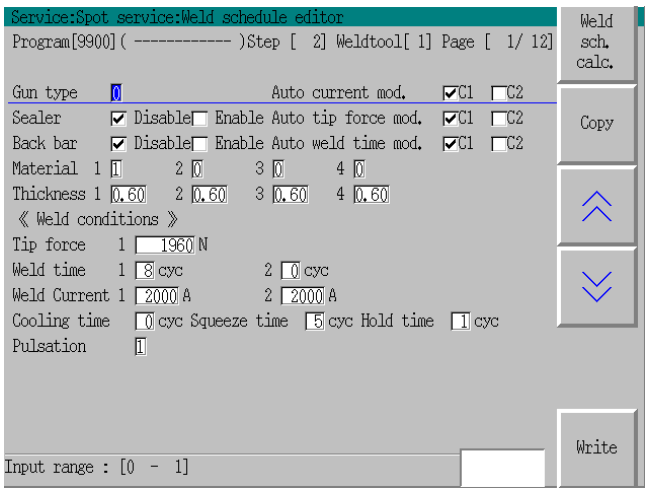
(10.1. Weld schedule editor <page 2>)



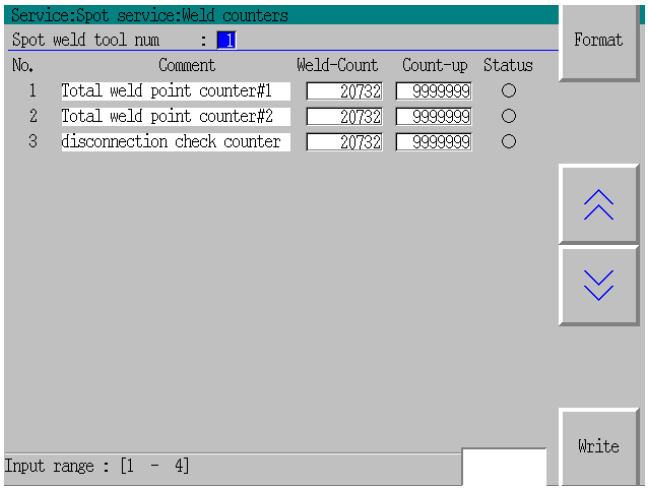
(10.1. Weld schedule editor <page 3>)



(10.1. Weld schedule editor <page 4>)

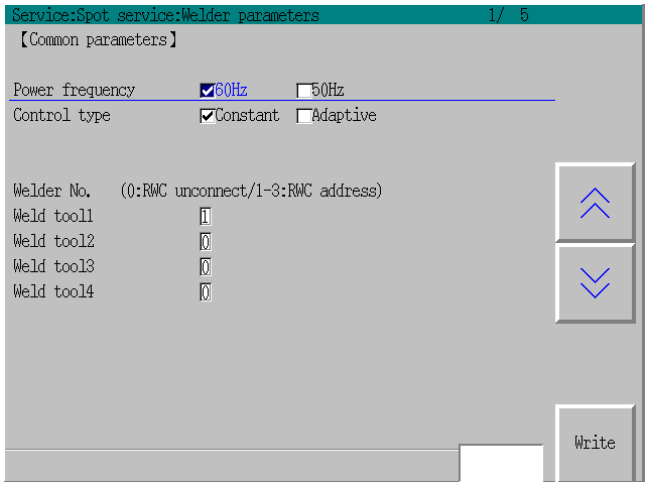


10.2. Weld counters



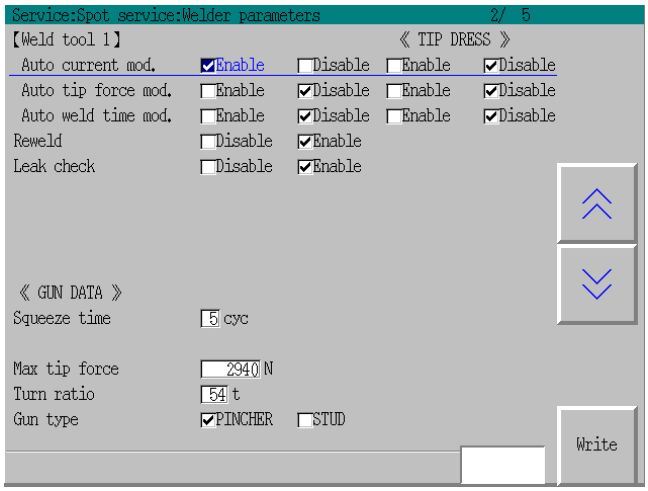
Displays/Sets [Weld-Count] and [Count-up] per weld gun.
[Weld-count] shows the number of welds completed.
When this number reaches the value set for [Count-up], warning is displayed.
Set the number of welds to be used as threshold for checking trouble, for cable inspection, replacement, etc.

10.3. Welder parameters

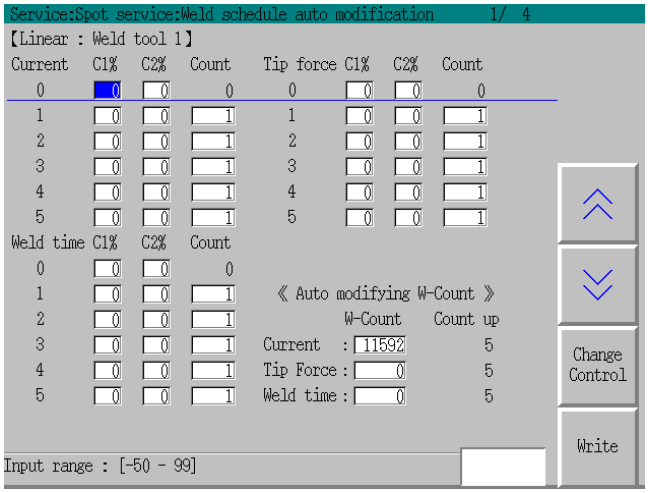


Sets welder, weld gun and weld specifications.

(10.3. Welder parameters <page 2>)

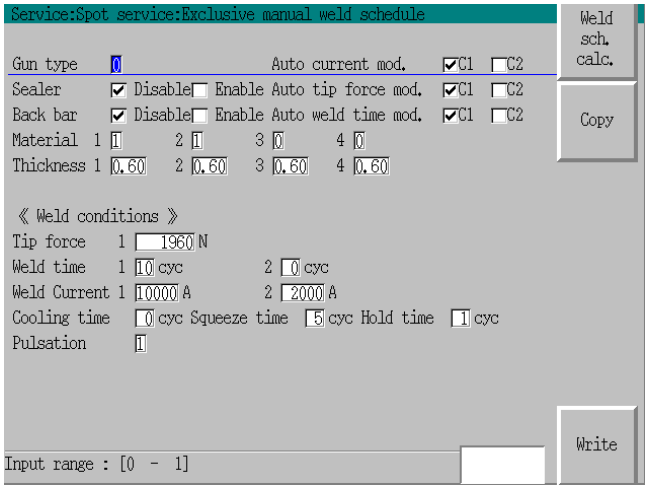


10.4. Weld schedule auto modification



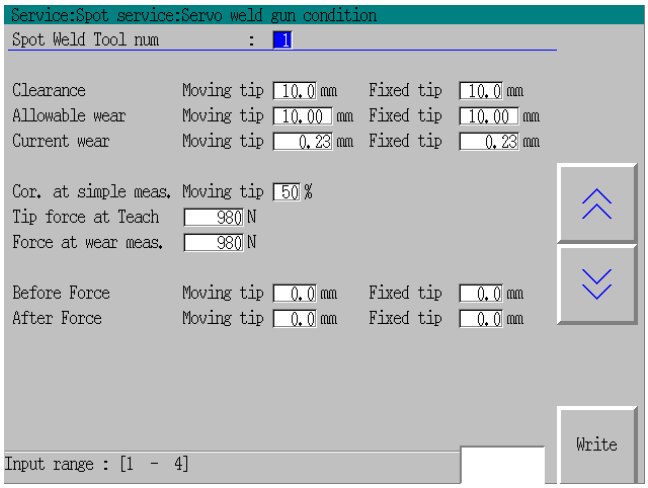
Displays/Sets linear up characteristics for each weld gun, including: weld current, tip force, and count (No. of welds) weld time.

10.5. Exclusive manual weld schedule



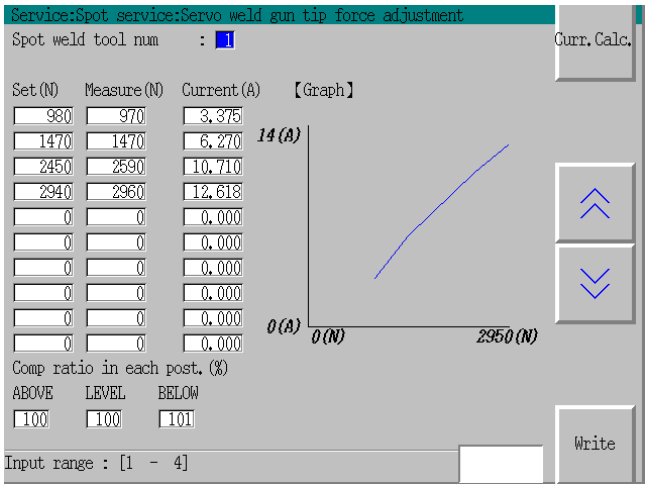
Sets conditions for manual welding in teach mode.
To weld manually based on conditions set here, select [USE] for [Exclusive manual schedule] in [11. Spot cond. record]. Set upper half of screen, then press <Weld sch. calc.> to automatically set values in <<Weld conditions>> area, based on welding database stored in controller.

10.20. Servo weld gun condition



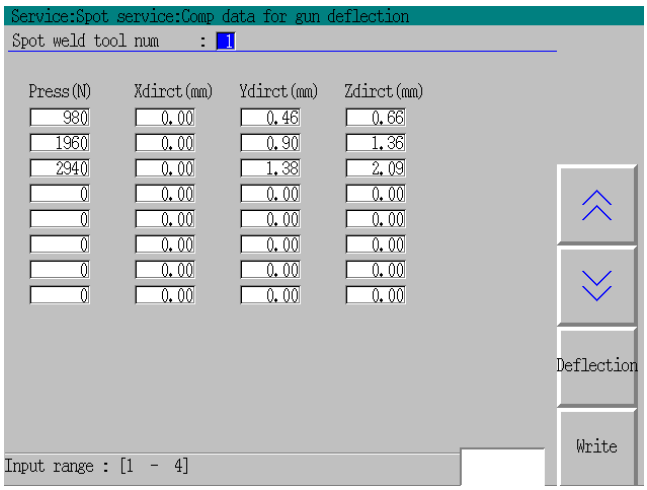
Displays/Sets conditions for each servo weld gun num., e.g. clearance width after weld, etc.
[Current wear] displays tip wear amount at moment screen is displayed. [Cor. at simple meas.] calculates moving tip wear as: pct. set here × total tip wear on both moving and fixed tips acquired from simple wear measurement (workless clamp). Fixed tip wear is: total wear – moving tip wear calculated above.

10.21. Servo weld gun tip force adjustment



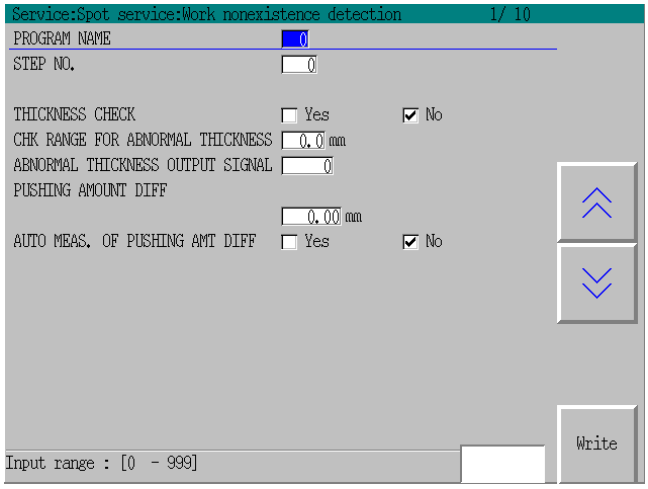
As desired below, calibrates so the set force matches the actual force that is output.
Press <Current Calc.> after inputting set value and actual measurement value.
In [Current], the gun axis motor current values necessary to attain the set force are displayed. The graph displays the relation between the set force and motor current value. Gravity affects the gun tip force depending on gun postures.
Set compensating % in [Comp ratio in each post.] for each posture. (Set to 100% in standard posture.)

10.22. Comp data for gun deflection



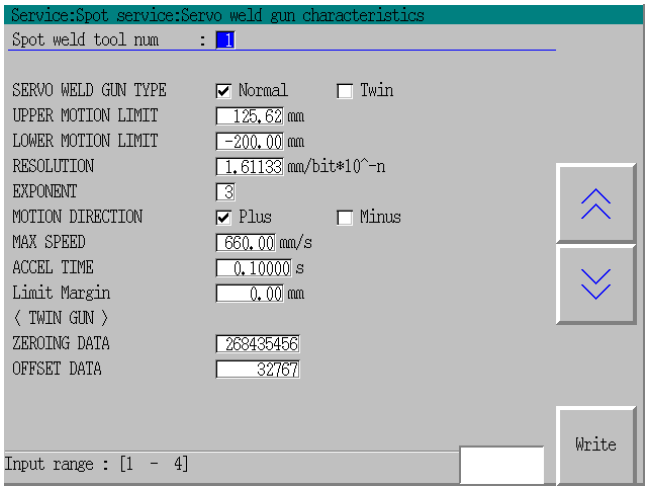
Compensates for gun deflection during pressurization motion in X, Y, and Z directions of the gun tool coordinates.

10.23. Workpiece nonexistence detection



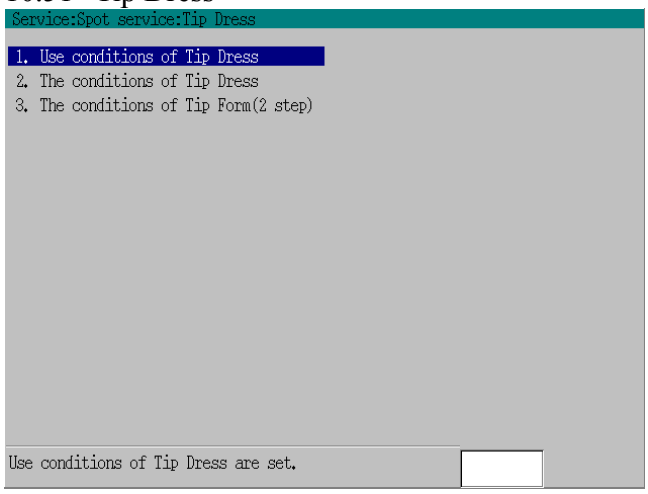
Detects missing workpiece when the difference thickness read at pressurizing and that in teaching is outside the allowable range. Workpiece thickness is checked when pressurizing weld points in normal or high-speed pressurization modes. When [Abnormal thickness output signal] is set to 0, abnormal signal is not output.

10.30. Servo weld gun characteristics



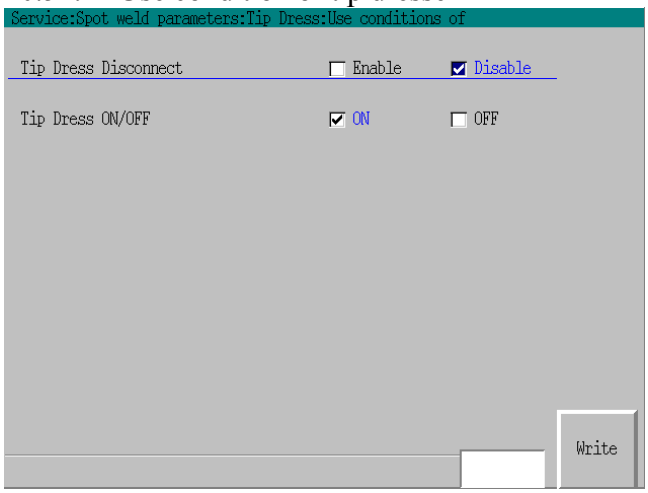
Registers the machine constants specific to each servo welding gun. Sets plus and minus of motion direction so that the gun closes when + axis key is pressed.

10.51 Tip Dress

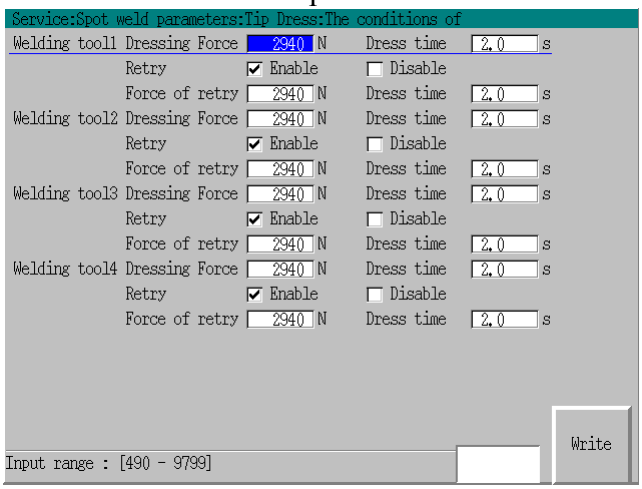


Registers the settings for the tip dresser. Sets whether tip dresser is used or not, dressing force, dressing time, dressing force at retry.

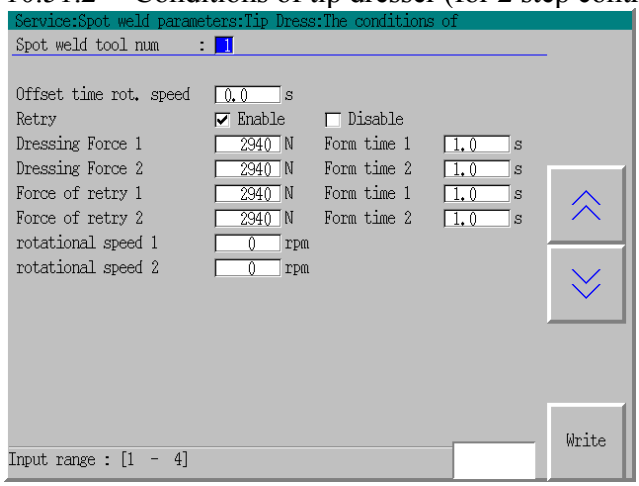
10.51.1 Use condition of tip dresser



10.51.2 Conditions of tip dresser

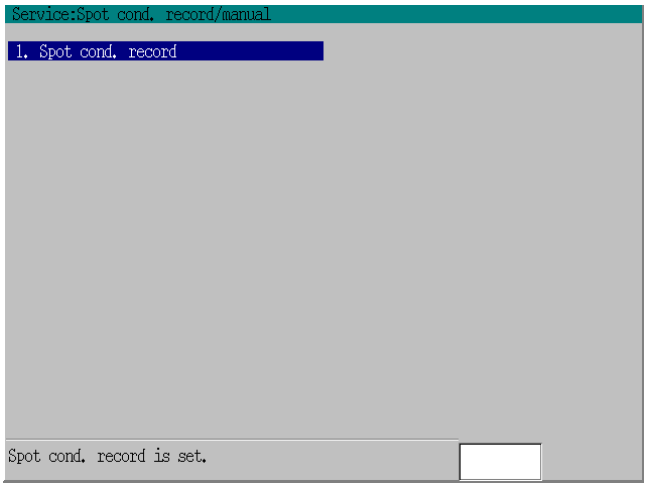


10.51.2 Conditions of tip dresser (for 2 step control)



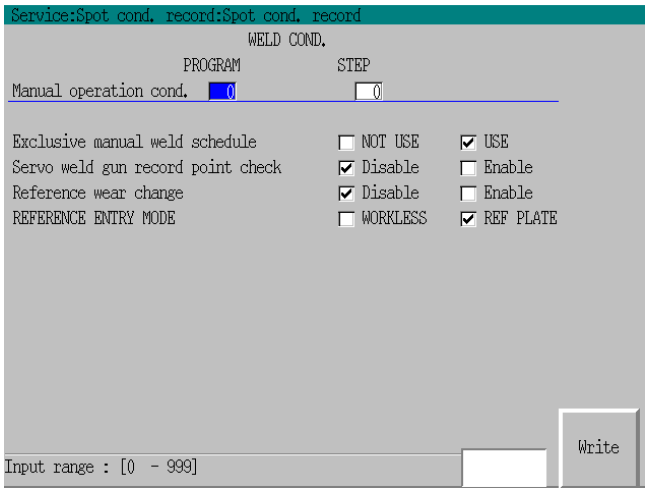
When using 2 step tip dressing, set rotation speed adjustment time, dressing force and dressing time for the first step and for second step.

11. Spot condition record

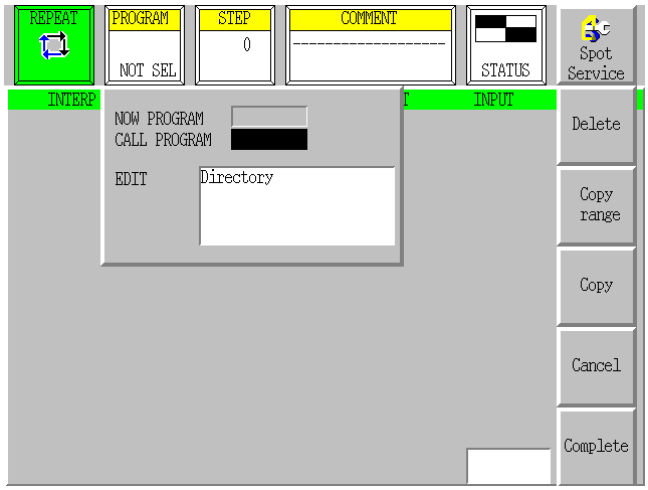


Specifies manual weld conditions and other conditions in teach mode.
To weld manually using conditions recorded in a paticular program, select [NOT USE] for [Exclusive manual schedule] on this screen, and specify the program and step numbers containing the desired conditions in [11. Spot cond. record] → [Exclusive manual schedule].

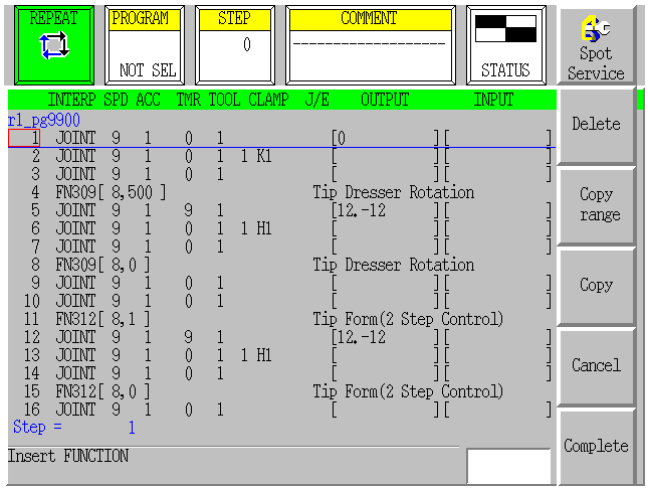
11.1. Spot cond. record



12. Hot edit

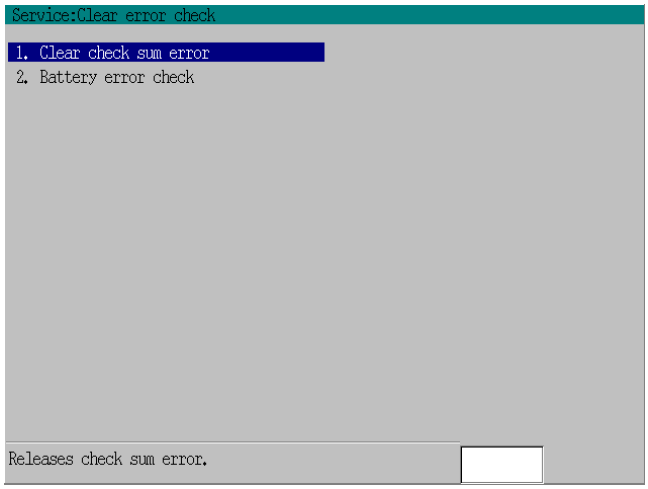


For the program currently not executed, modifies the auxiliary data of the program selected from the program list screen regardless of teach/repeat mode. Move cursor to the item to be modified, and edit via the input box displayed on the bottom of the screen or on the displayed setting screen. For the currently executed program, auxiliary/pose data cannot be modified from this screen.

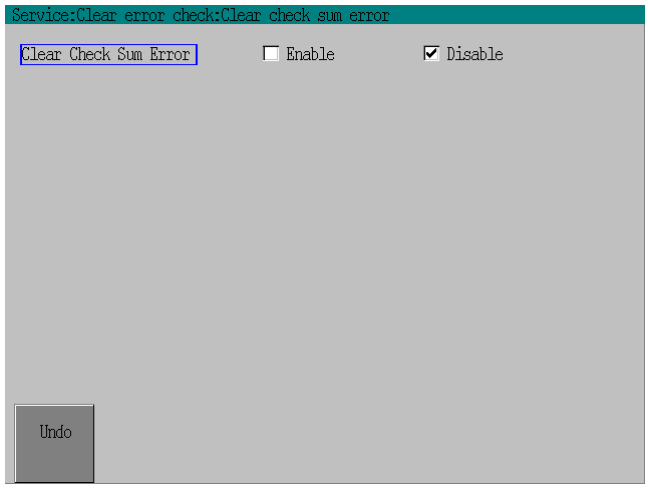


To edit I/O signals and comments, move the cursor to the desired item then press ↵ to access the relevant screen.

13. Clear error check



13.1. Clear check sum error

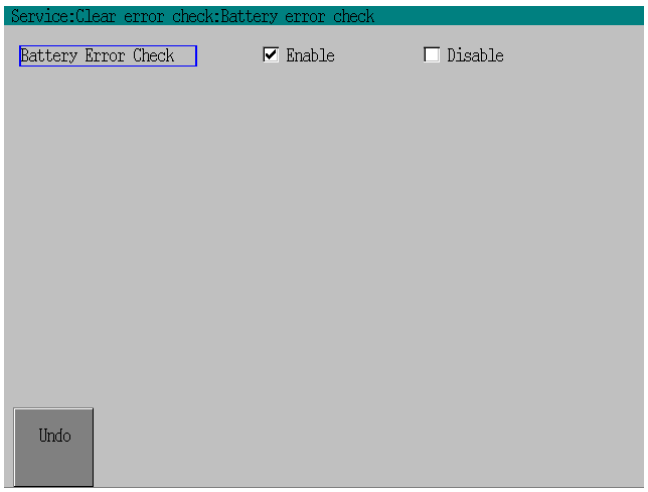


Checking [Enable] allows clearing sum check errors in the system data.
When executing this function, if any sum check errors remain in the data, the error cannot be cleared. In such case, instructions for resetting the data that includes the sum check error are displayed.

[NOTE]

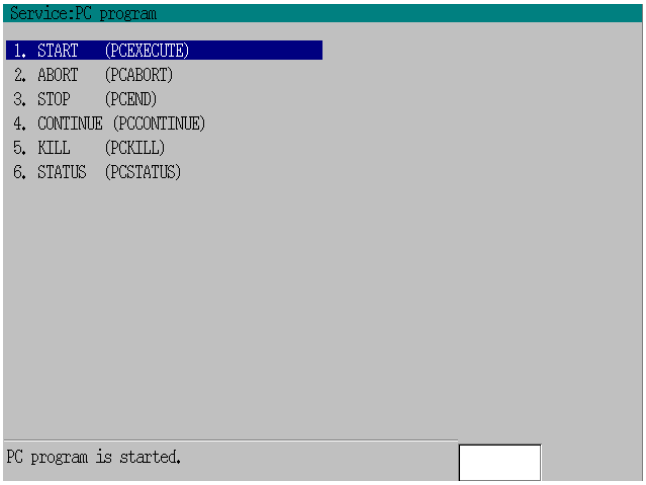
This setting automatically resets to Disable when turning controller power OFF → ON.

13.2. Battery error check



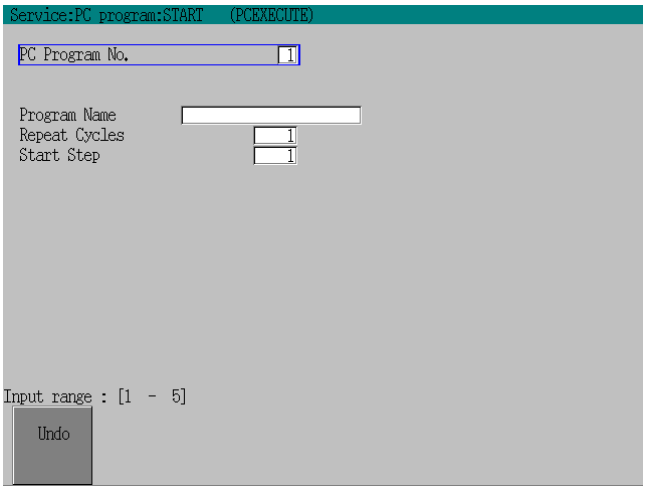
Sets whether or not to indicate an error message on the teach pendant when battery error occurs.

14. PC program



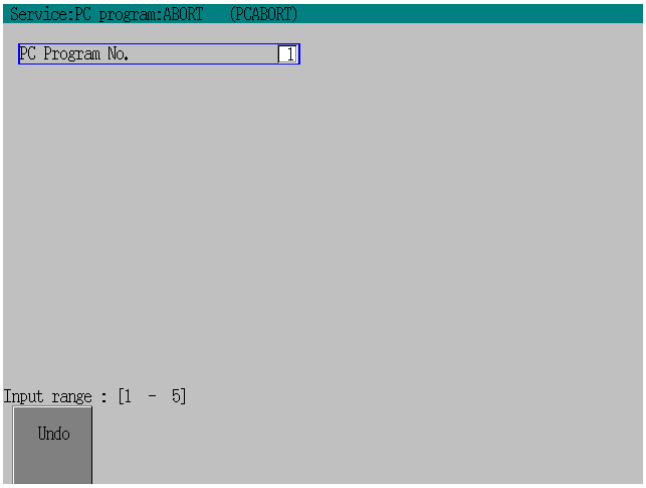
Initializes and controls prepared PC programs.

14.1. START (PCEXECUTE)



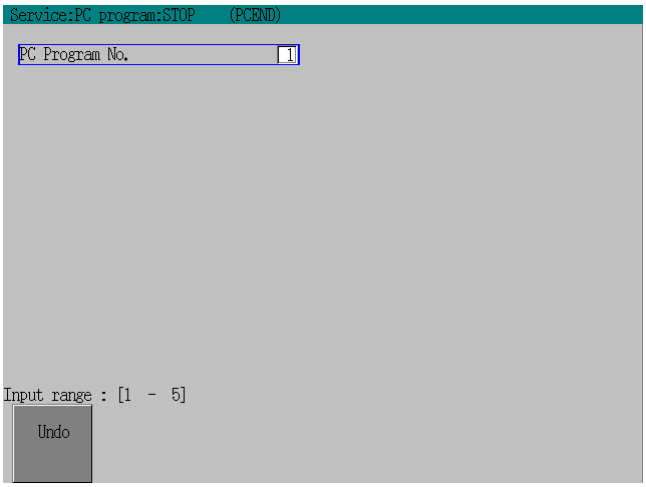
Executes the designated PC program.

14.2. ABORT (PCABORT)



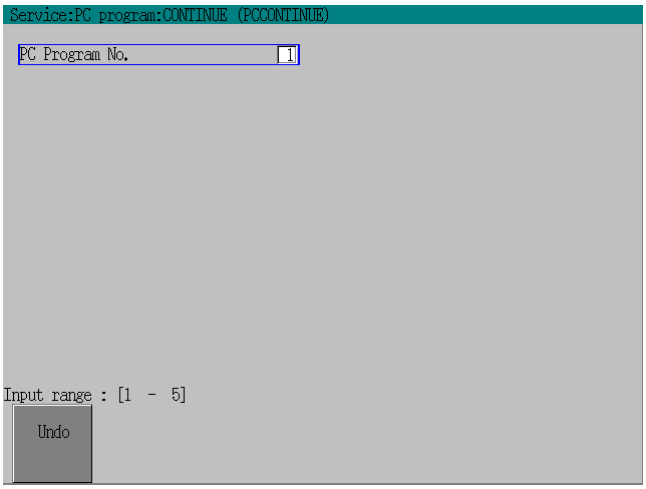
Interrupts the currently executing PC program.

14.3. STOP (PCEND)



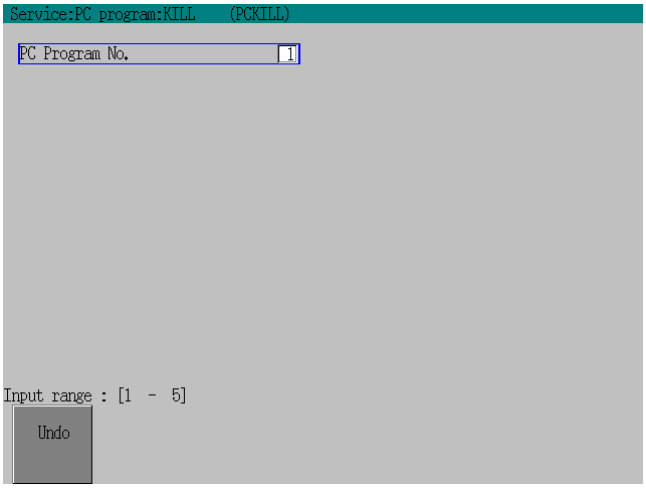
Stops the execution of the currently running PC program at the next STOP instruction, or when the final step of the program has been executed.

14.4. CONTINUE (PCCONTINUE)



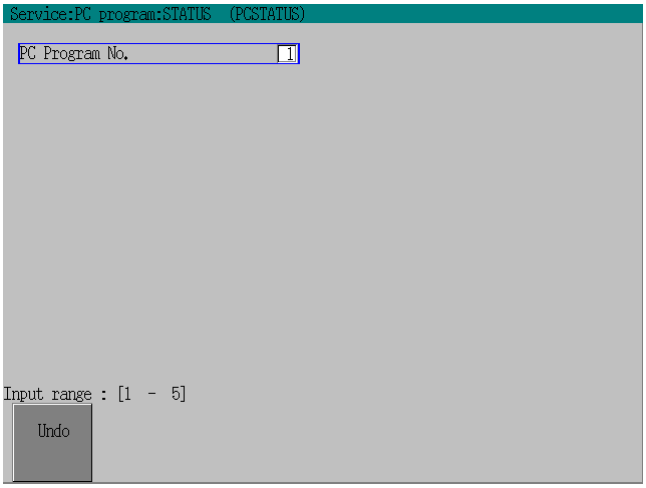
Restarts execution of the PC program that was interrupted.

14.5. KILL (PCKILL)



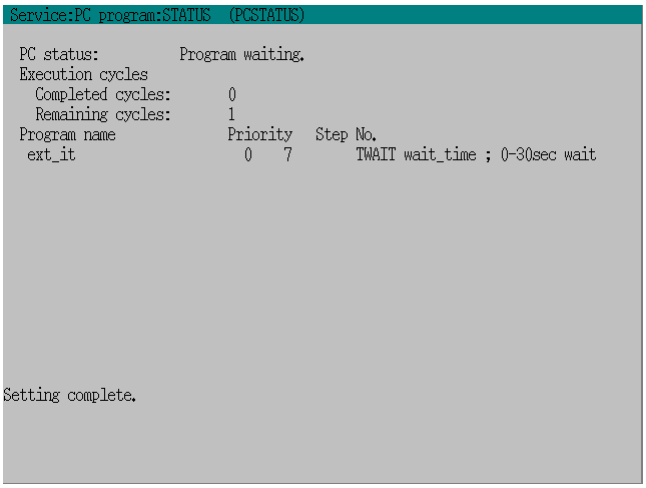
Cancels the currently selected PC program, and the stack becomes empty.

14.6. STATUS (PCSTATUS)

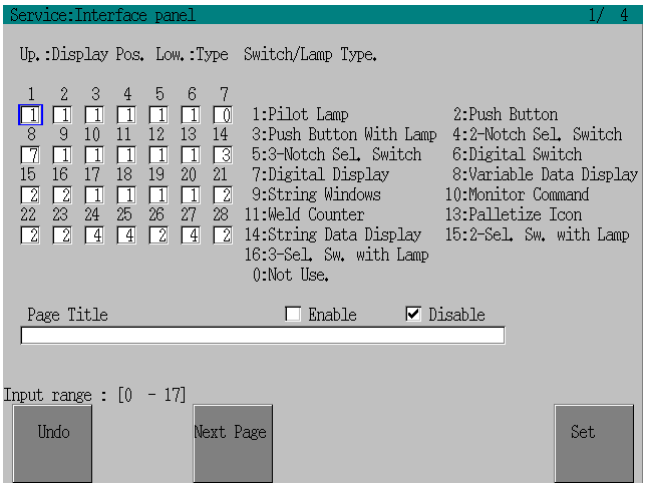


Displays status information for the currently executing PC program.

(14.6. STATUS (PCSTATUS) <page 2>)

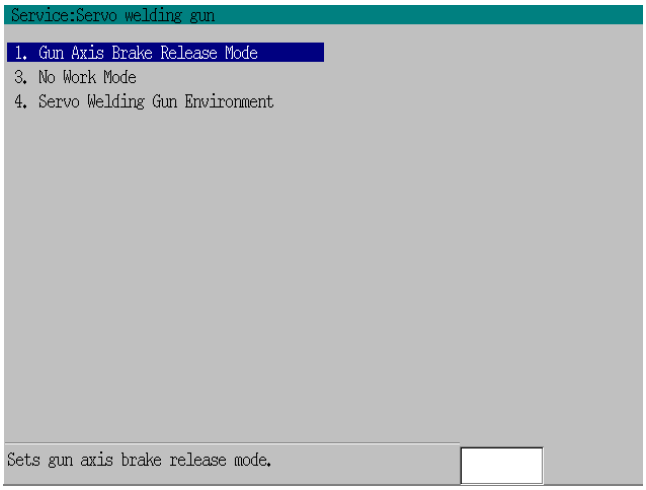


16. Interface panel

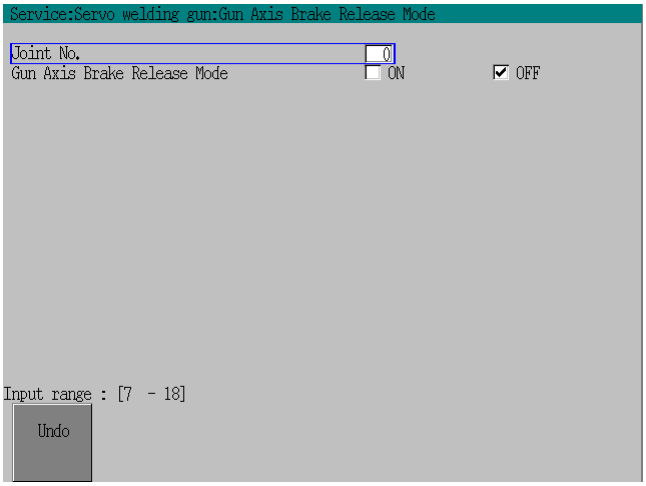


Allows setting 11 different kinds of elements such as switches and lamps on the interface panel of the teach pendant. The type and display position for each element can be set freely within the settable range.

17. Servo welding gun

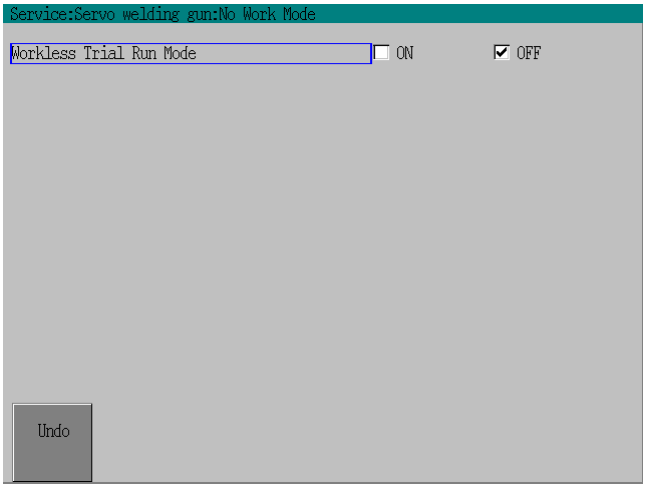


17.1. Gun Axis Brake Release Mode



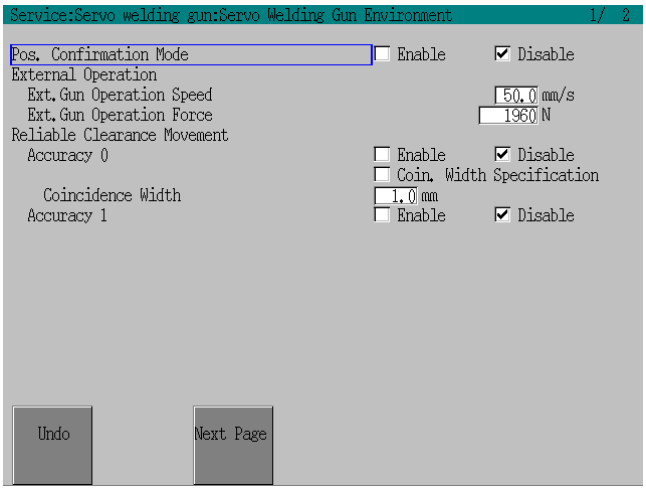
Gun axis brake cannot be released if gun axis is electrically disconnected, even if gun is mounted (chucked) to robot. However, gun axis brake can be released by setting [Gun Axis Brake Release] to ON and pressing the brake release switch. Once motor power is turned ON, [Gun Axis Brake Release] automatically resets to OFF.

17.3. No Workpiece Mode



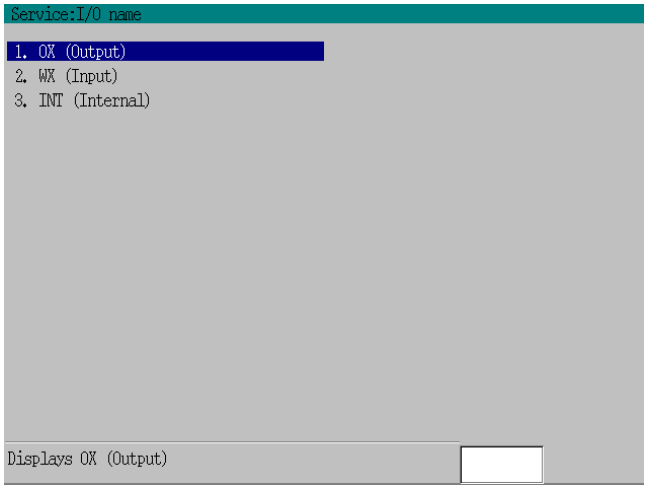
Selecting [ON] protects the tips from major impact when pressurizing the gun without workpiece (test operation, endurance run, etc.) or when welding a plate whose thickness is large.
Do not fail to select [OFF] when operating the robot with workpiece or when conducting gun motions without a plate.

17.4. Servo Welding Gun Environment



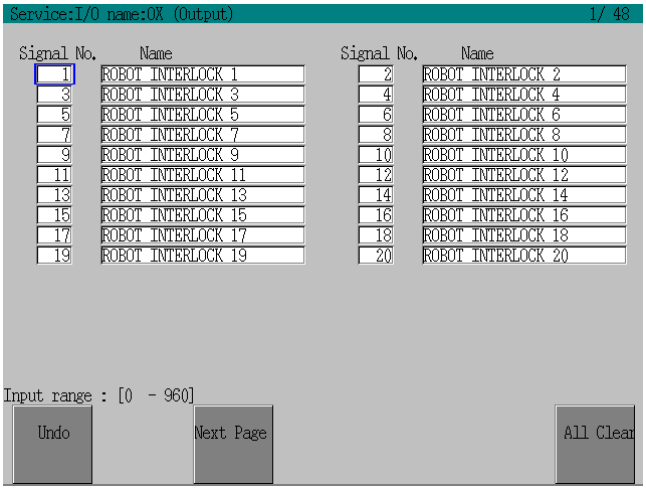
Sets operating parameters for the servo welding gun.
If [Enable] is selected for [Pos. Confirmation Mode], in check mode, the moving tip stops at the clearance position, and only the fixed tip moves to the taught point so that taught condition of the fixed tip can be checked.

18. I/O name



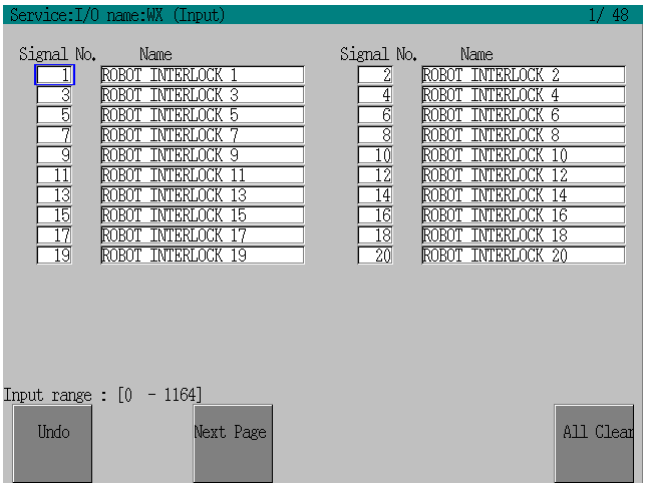
Names I/O signals so that each signal can be distinguished easily.

18.1. OX (Output)

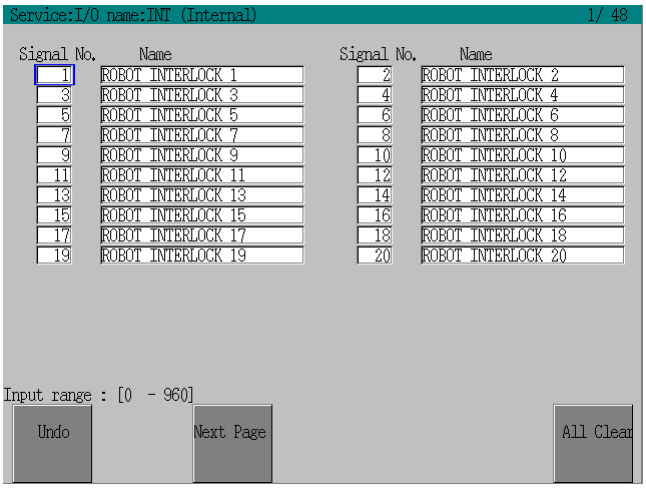


When moving cursor to the [Name] field of a desired Signal No., <Undo> changes to <Input>. Press <Input> and input a name on the displayed screen.

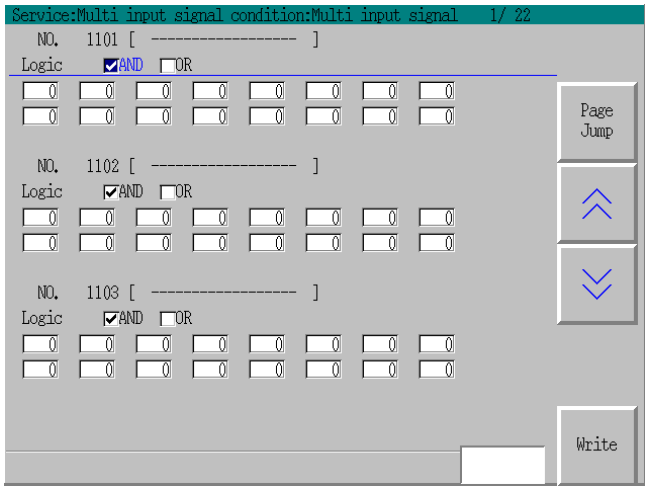
18.2. WX (Input)



18.3 INT (Internal)



20. Multi input signal conditions

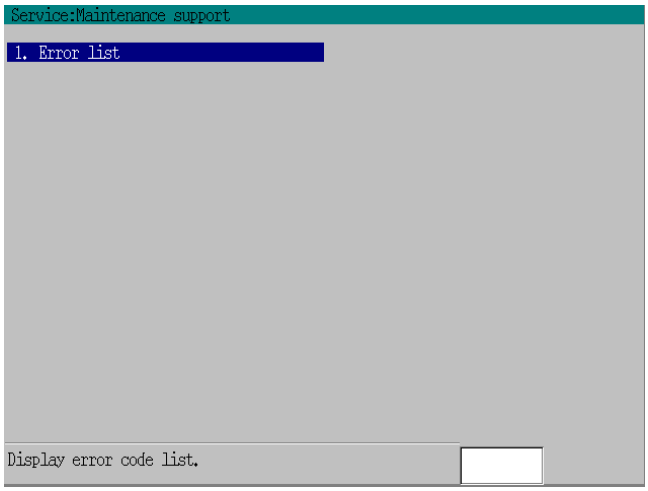


Combine multiple input signal conditions with AND or OR, reflect the result to one conditional signal (multi input signal: 1101-1164) reflects AND/OR logic operation result of several specified input signals.

Specify the input signals operated for each conditional signal and the logic condition AND/OR.

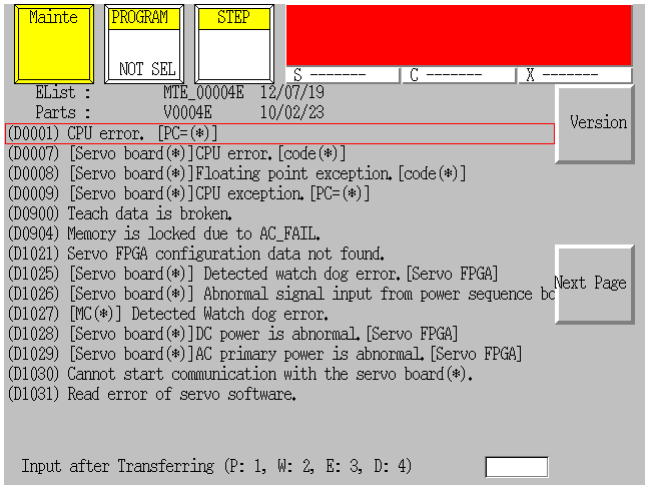
When using multi arm controllers, input signals operated and logic condition can be specified to each robot arm for the same conditional signals.

21. Maintenance support



Displays the error list on the maintenance support function.

21.1. Error list

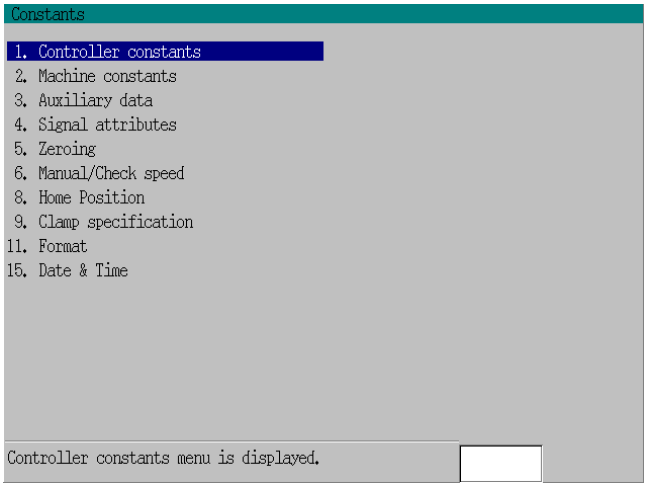


Select an error to display the detailed screen for that error.

8.0 CONSTANT FUNCTIONS

The main menu for the constant functions is shown below. Parameters are set in these functions for the robot arm, its physical dimensions, and auxiliary data, etc. To use each function, follow the guide message displayed at the bottom of the screen.

Pressing <Constants> displays the screen below. Move cursor to a desired item and press ↵ to display that function screen. Or, input the item number in the box on the bottom right of the screen and press ↵.



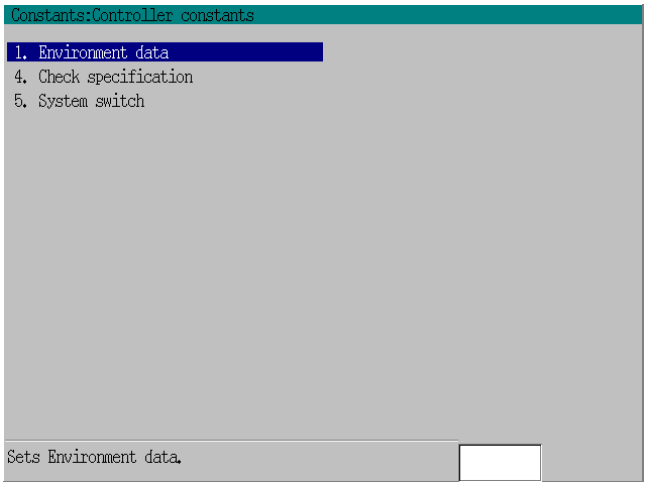
For multi-arm control, a step for inputting the robot number is added to the operations above.

The desired constant function screen can also be displayed by inputting its R code shown below. The R code input box is displayed by pressing R on the start-up screen.

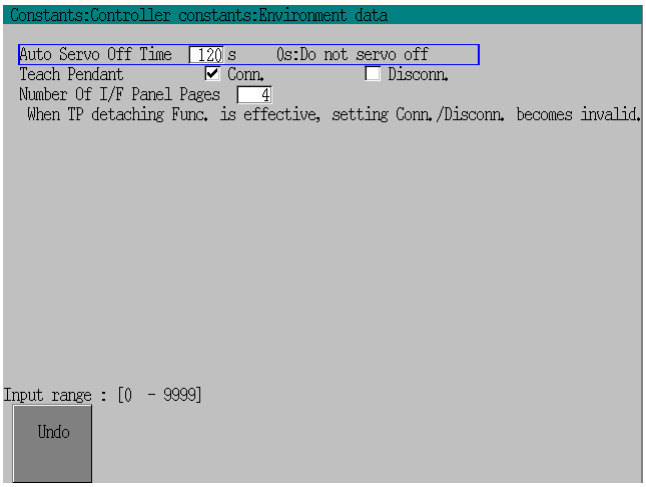
1. <Constants>

Main Menu Item No.	Service function	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
1	Controller constants	1	Environment data			R808
		4	Check Specification			R99
		5	System switch	1	System switch	R75
2	Machine constants	1	Software limit			R51
		2	Base coordinates			R47
		3	Pos. error range at E-stop			R42
		4	Encoder error range			R43
		5	Auto Software Limit Setting			
		24	Interference check function			R710
3	Auxiliary data	1	Speed			R54
		2	Accuracy			R53
		3	Tool dimensions			R48
		5	Timer			R58
4	Signal attributes	1	Dedicated signals display			R113
5	Zeroing	1	Encoder rot. counter reset			R140
		2	Zeroing			R41
		3	Zeroing data set/display			R44
6	Manual/Check speed	1	Teach speed			R56
		2	Check speed			R56
8	Home Position	1	Home Position			
9	Clamp specification	1	Spot weld gun			
11	Format					R100
15	Time/Date					R96
17	Static torque check function	1	Torq. cond. for load presence detect			
		2	Torq. cond. for load absence detect			
		3	Environmental setting	1	Reducing speed rate and effectiveness	
				2	Detection delay time	
				3	No. of torque detections	
				4	Set Enable/Disable function	

1. Controller constants



1.1. Environment data (R91)

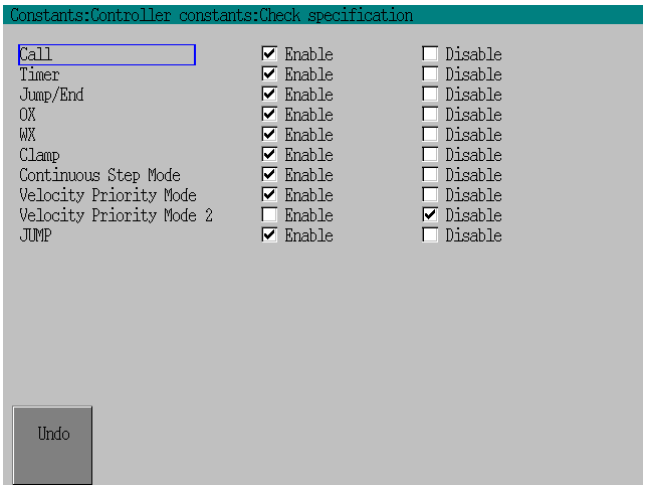


Turns OFF servoing during automatic operation after the time set in [Auto Servo OFF Time] has elapsed when robot is waiting for a WX signal.

[Teach pendant] specifies the teach pendant connection conditions used to control automatic operation.

[Number of I/F Panel Pages] specifies the number of I/F panels to be displayed.

1.4. Check specification (R99)



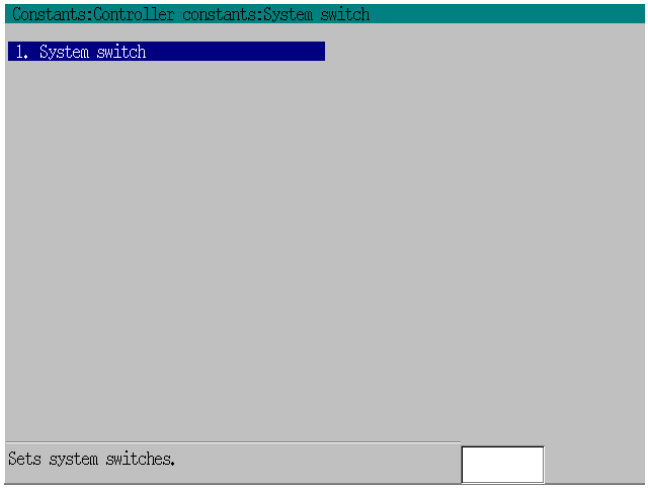
Sets whether or not to execute CALL, timer, jump/end, OX, WX, clamp, etc. when executing the taught program in check mode.

CALL Function	Enable	Executes CALL instruction in check mode.
	Disable	Ignores CALL instruction in check mode.
Timer	Enable	Waits by timer setting in taught step.
	Disable	Does not wait by timer setting in taught step.
Jump/ End	Enable	Executes Jump/ End.
	Disable	Does not execute Jump/ End.
OX	Enable	Outputs signal from the robot to external devices.
	Disable	Does not output signal from the robot to external devices.
WX	Enable	Receives input signals from external devices.
	Disable	Ignores input signals from external devices.
Clamp	Enable	Executes the processing of clamp signal.
	Disable	Does not execute the processing of clamp signal.
GO/ BACK continuous mode	Enable	When in Check Once mode, pressing CHECK GO or CHECK BACK after axes coincidence one step.
	Disable	When in Check Once mode, pressing ENABLE + CHECK GO or CHECK BACK after axes coincidence one step.
Speed priority mode	Enable	Moves in the maximum speed of 250 mm/s regardless of the taught speed. Effective only in Check Once.
	Disable	The slower the taught speed, the greater becomes the acceleration/ deceleration speed.
Speed priority mode 2	Enable	When Speed priority mode is enabled gives priority to the speed regardless of Check Once or Check Continue setting.
	Disable	Operates by the speed priority modes setting.
Jump instruction	Enable	Executes JUMP instruction in check mode.
	Disable	Ignores JUMP instruction in check mode.

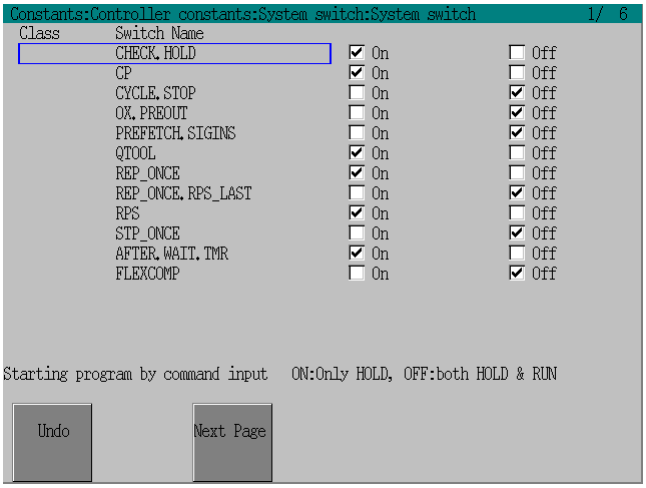
The difference in robot motion between CHECK GO and CHECK BACK is as shown in the list below. Some are unavailable depending on the software version.

	CHECK GO	CHECK BACK
CALLFunction	Moves according to setting	Invalid regardless of setting
Timer	Moves according to setting	Invalid regardless of setting
Jump/ End	Moves according to setting	Invalid regardless of setting
OX	Moves according to setting	Moves according to setting
WX	Moves according to setting	Invalid regardless of setting
Clamp	Moves according to setting	Moves according to setting

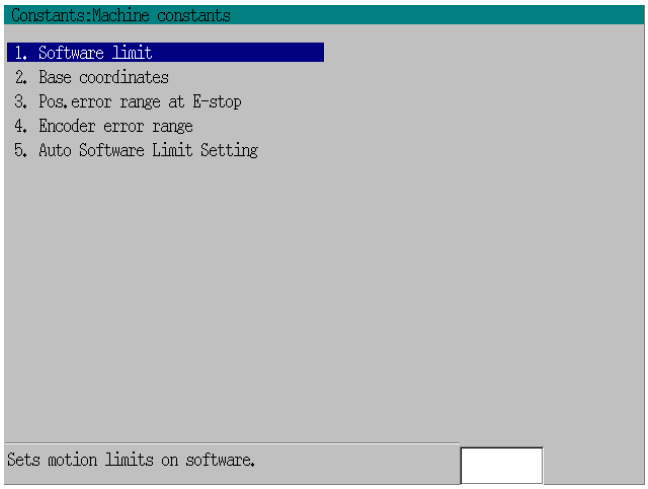
1.5. System switch



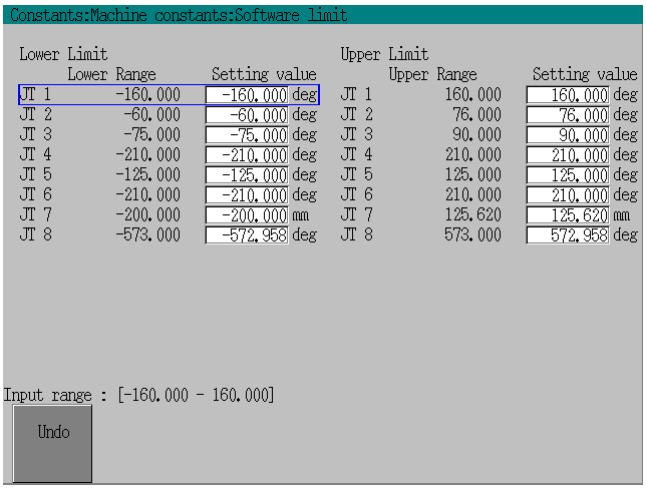
Sets ON/OFF or effective/ineffective for system switches which set fundamental system specifications.



2. Machine constants

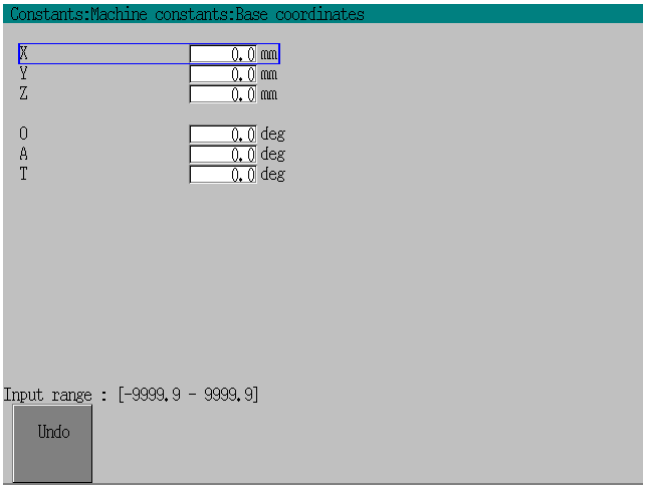


2.1. Software limit



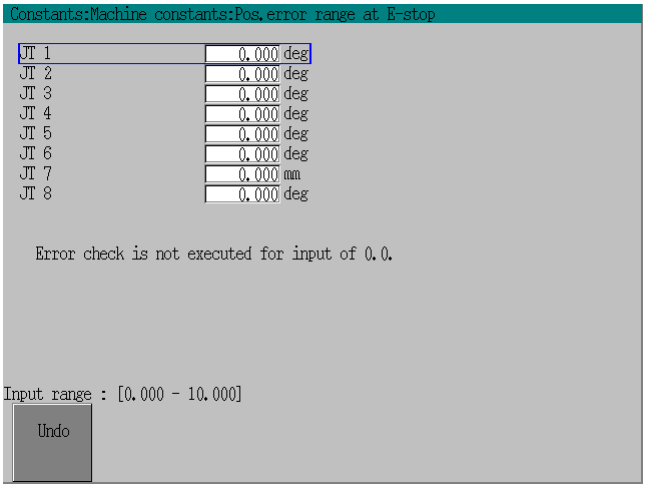
Sets upper and lower limits of the robot motion range for all joints on the software.

2.2. Base coordinates



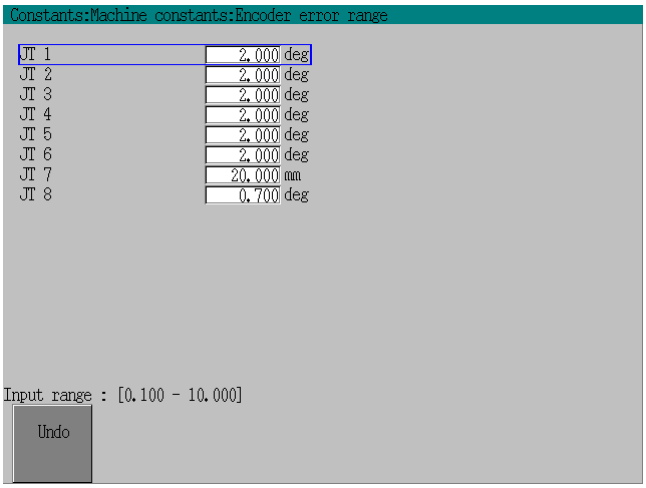
Sets the base coordinates of the robot. Decides position and posture of the base coordinates as viewed from the null base coordinates by inputting coordinate XYZ values, and Euler angles, OAT.

2.3. Pos. error range at E-stop



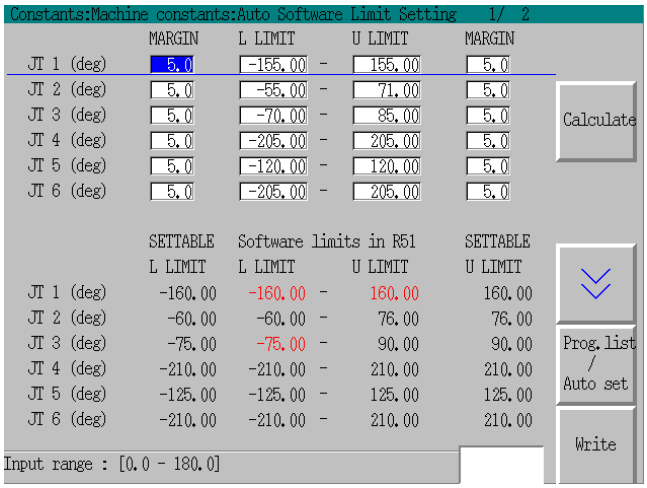
Outputs error if encoder value when restarting robot after emergency stop deviates from the value at previous emergency stop by more than the value set here as error range.

2.4. Encoder error range



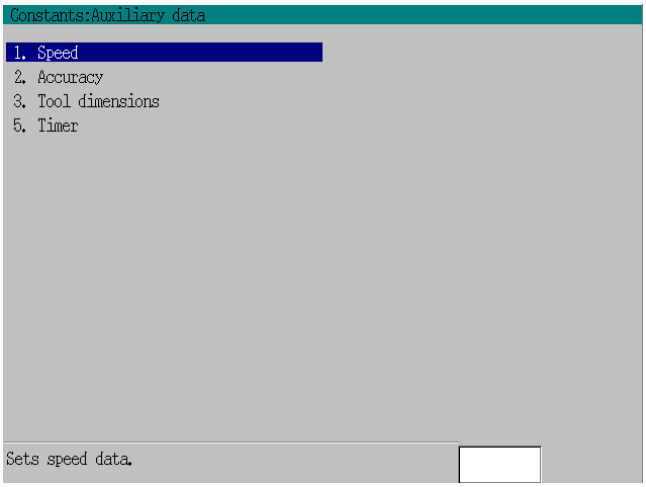
Outputs error if encoder value at controller power ON deviates from the value at controller power OFF by more than the value set here as error range.

2.5. Auto Software Limit Setting



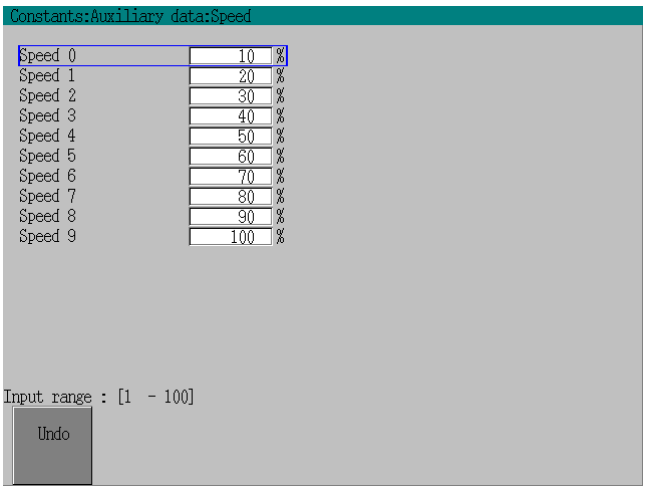
Automatically sets upper and lower motion limits on software for R51.
Select a program from the program list displayed by pressing <Prog. list/Auto set>, then press <Calculate> to set the upper and lower limits automatically.
[U LIMIT] is registered as “calculated upper limit + margin”
[L LIMIT] is registered as “calculated lower limit – margin”
Margins are input directly on this screen. (range: 0.0 – 180.0)

3. Auxiliary data



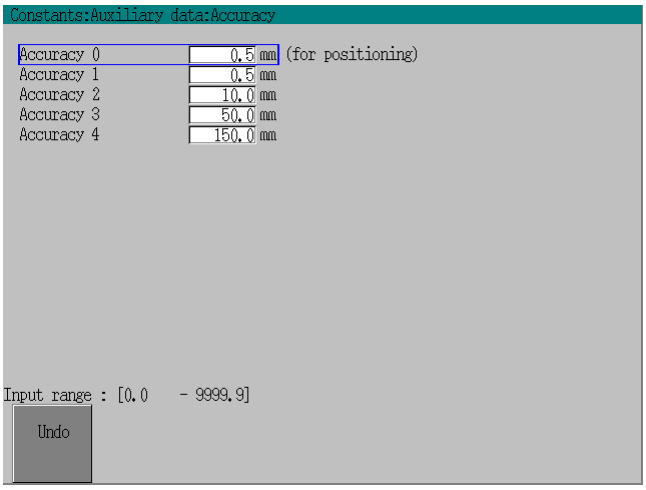
Sets the actual data corresponding to auxiliary data of each command displayed as a number on the screen.

3.1. Speed



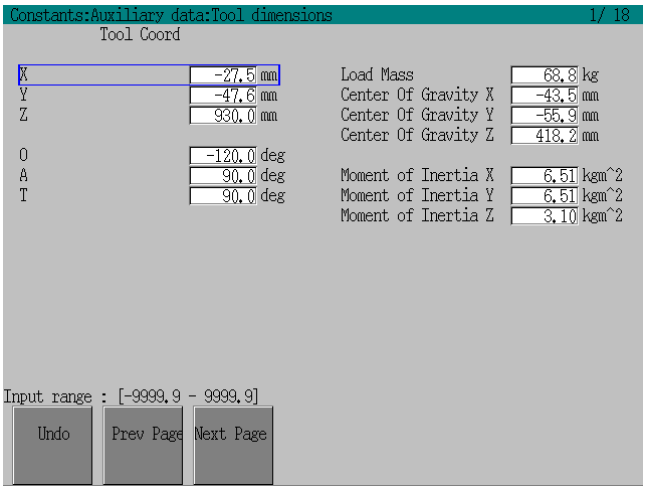
Sets the speed data to auxiliary data 0-9. All speed data are set as a percentage (%) of the maximum speed. (Setting range: 1-100)

3.2. Accuracy



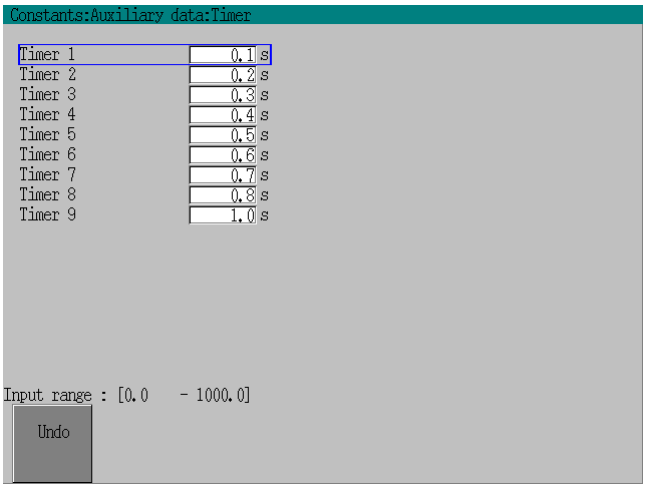
Sets the range of accuracy for auxiliary data [Accuracy 0]- [Accuracy 4] in block teaching. Accuracy 0 verifies axis coincidence by the current values. Accuracy 1 – 4verifies axis coincidence by the command values.

3.3. Tool dimensions



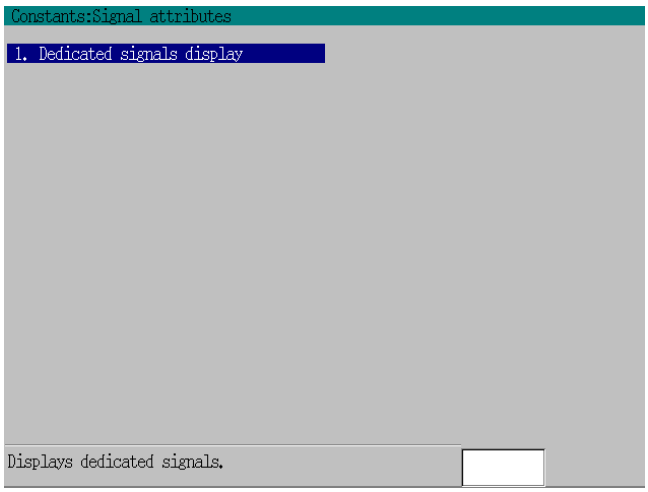
Sets the tool data to tools 1-9.
Data to be set here are: XYZ origin of tool coordinates seen from wrist flange coordinates, rotational angle which decides posture of the tool coordinates, load mass, center of gravity, and moment of inertia. Robot can move in direction of tool +Z coordinates axis based on the tool coordinates.

3.5. Timer

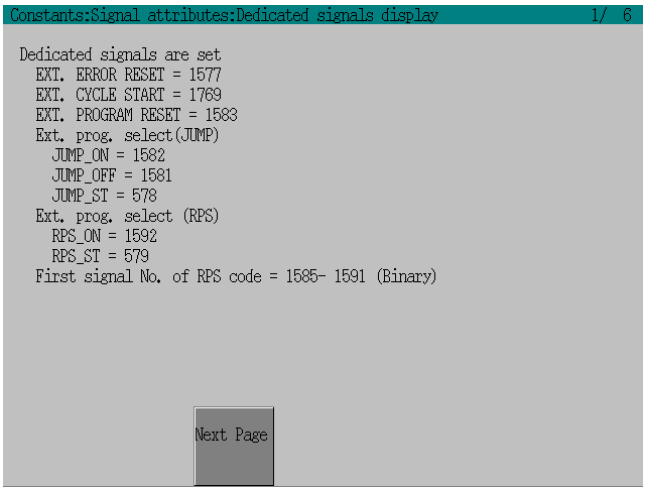


Sets the waiting time to auxiliary data 1-9.

4. Signal attributes



4.1. Dedicated signals display



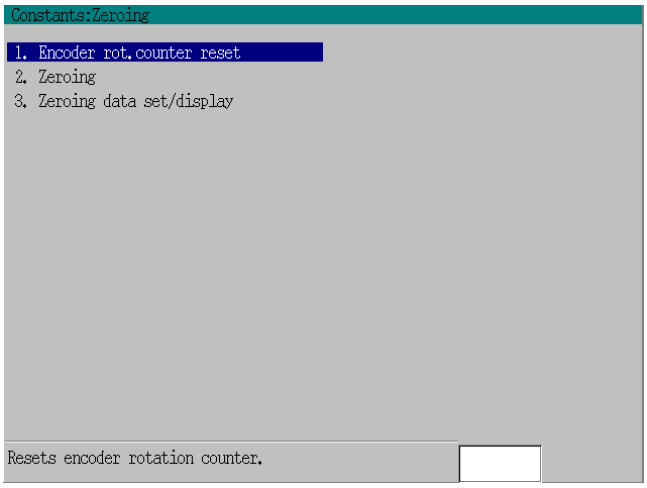
Displays currently set dedicated I/O signals. Settings are made at factory shipment according to specifications.

5. Zeroing

Zeroing registers the current encoder value as the zero displacement position (reference zero position, typically when axis scribe marks align = 0°/0mm). Joints can also be zeroed if unaligned with their scribe marks by specifying [JT angle set]. However, the [SETTING] encoder value stored in the controller will be used as the value that corresponds to the zero displacement position. To zero, it is necessary to consider the encoder rotation counter (offset) and the current displacement value (angle/mm value for that axis). First, in 5.1 reset the encoder rotation counter, and then in 5.2 set the current encoder value as the encoder value when robot is at zero displacement position.

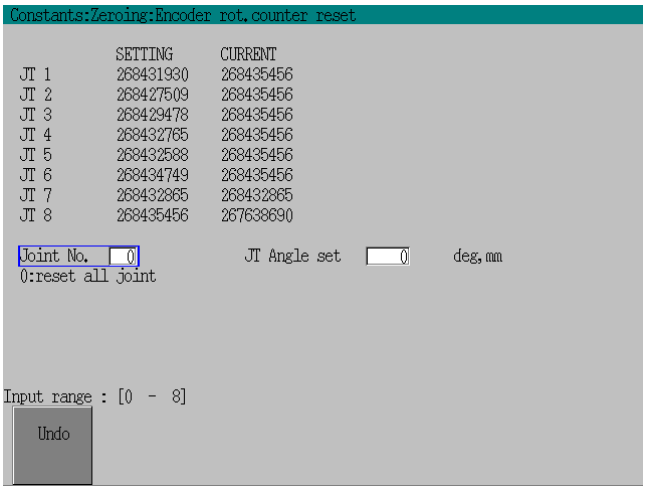
[NOTE]

For servo weld gun, zeroing is done automatically when the gun is connected so do not perform zeroing via this function.

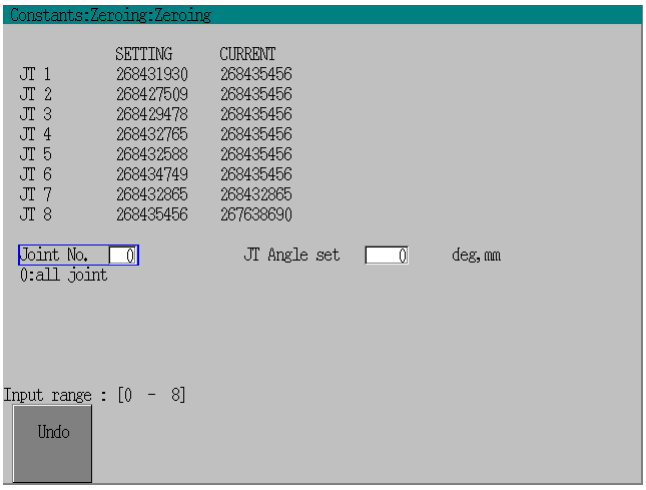


To reset the encoder rotation counter for all joints, input 0 to [Joint No.] and the zeroing degree to [JT Angle set], then press ↵. OFFSET at reset is displayed on screen of [3. Zeroing data set/ display - 2/2] (offset). To reset encoder rotation counter for a specific joint, input the joint number in [Joint No.] and follow the above procedure. When replacing encoder (motor), do not fail to reset this rotation counter before zeroing each joint in 5.2.

5.1. Encoder rot. counter reset

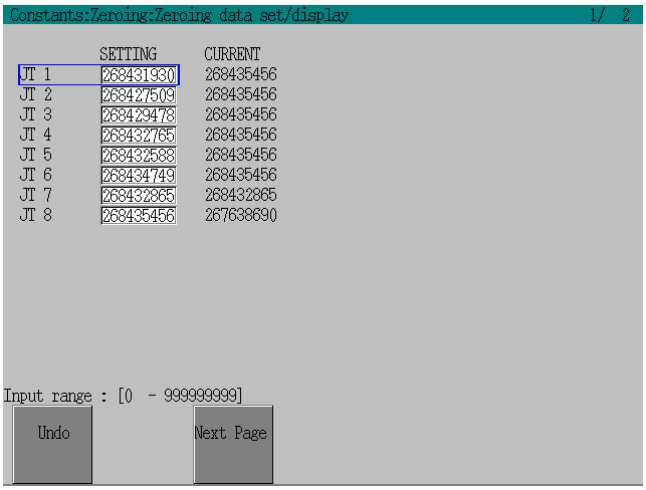


5.2. Zeroing



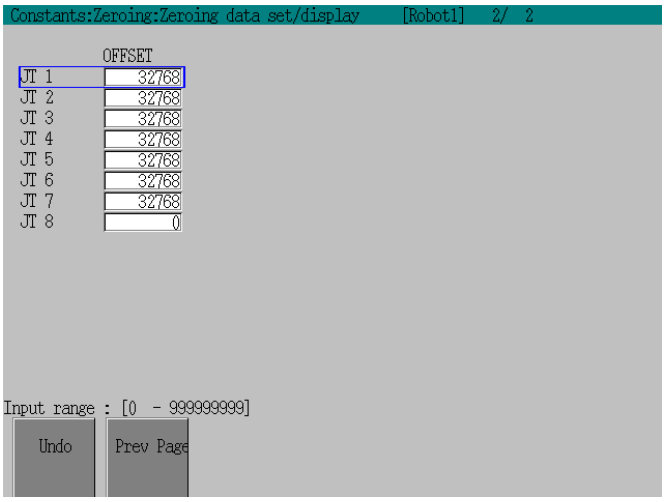
To set all joints to zero, input 0 to [Joint No.] and press ↵ to register the current encoder value as the set value. To zero a specified joint, move the joint to the set posture first, and then input the joint number to [Joint No.] and the degree for zeroing to [JT Angle set] to register the set value.

5.3. Zeroing data set/display

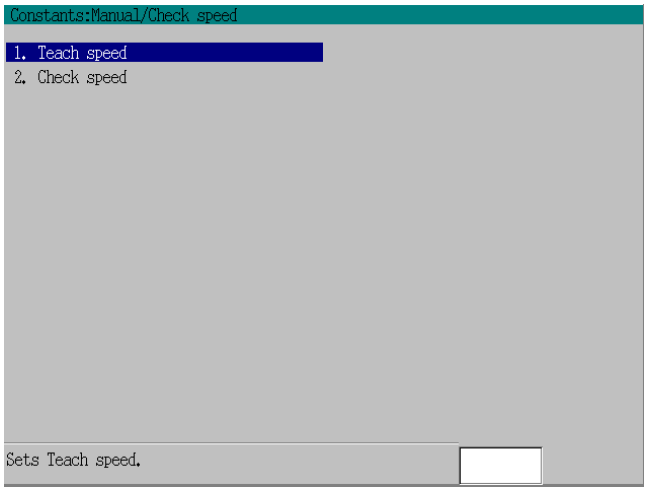


Displays current setting values. Inputting setting values for each joint directly is also possible on this screen. Move cursor to [SETTING] of each JT and input data by NUMBER (0-9). Avoid using this function in normal operation as this function is for maintenance purposes, such as restoring data settings lost due to dead encoder battery.

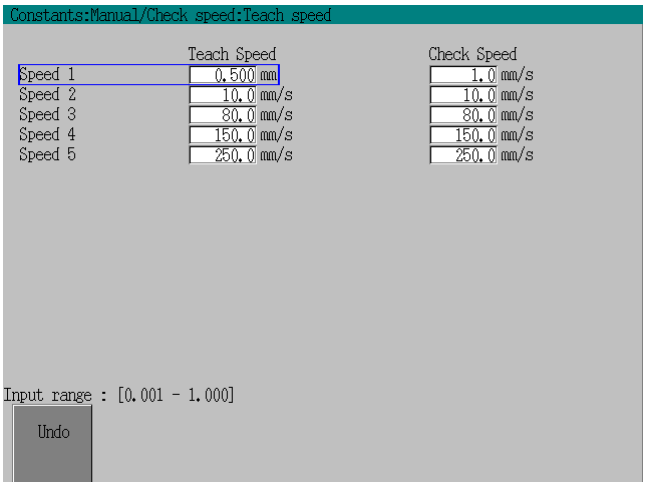
(5.3. Zeroing data set/display <page 2>)



6. Manual/Check speed

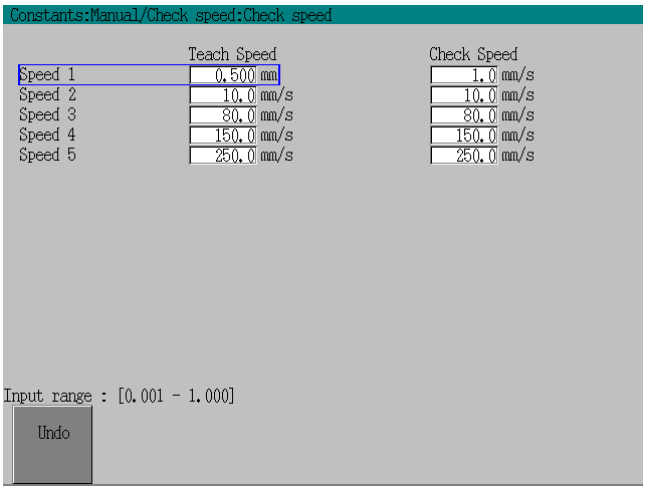


6.1. Teach speed



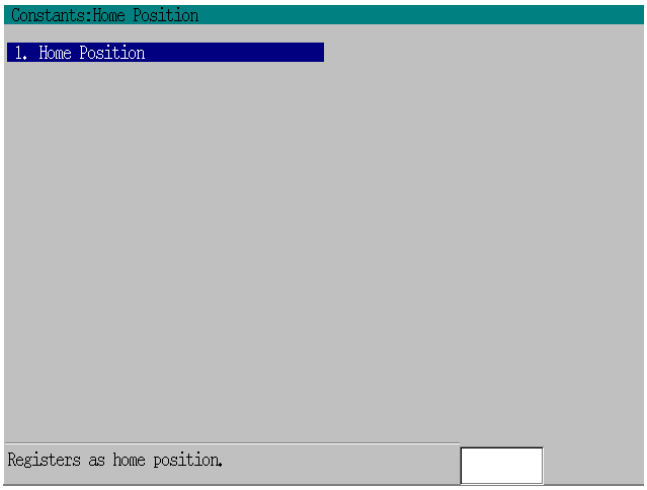
Sets low, middle, and high manual operation speeds for teach/check motion in [Speed 2] to [Speed 5]. Inching increment is set in [Speed 1].

6.2. Check speed



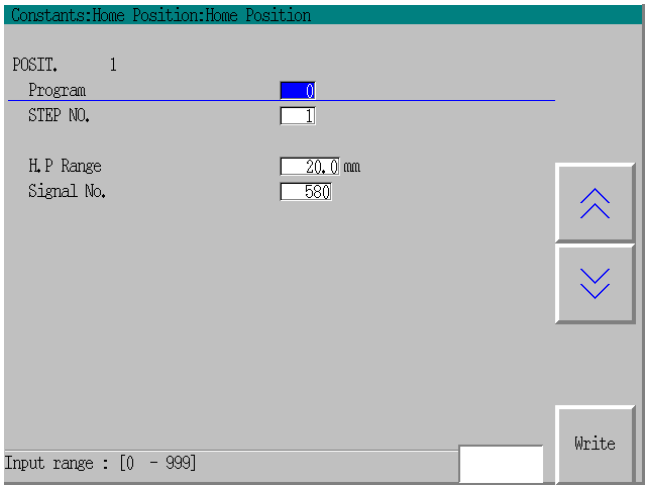
Sets low, middle, and high check motion speeds for teach/check motion in [Speed 2] to [Speed 5]. Inching increment is set in [Speed 1].

8. Home Position

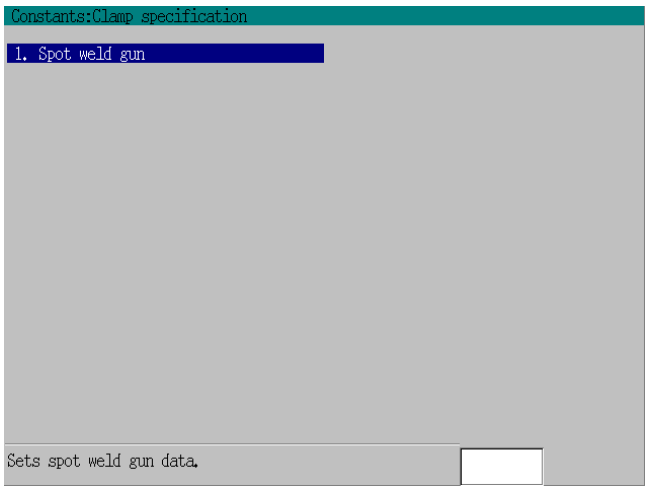


Registers pose recorded in step of specified program as the home position. The signal set in [Signal No.] is output when robot reaches the set pose.
If the pose of the specified step is changed, the home position data automatically reflects the new pose.
When the specified step is deleted, the recorded home position for the step is also deleted after a warning message is displayed.
In [H.P Range], set the distance where robot is considered within the radius of the circle whose center is the home position.

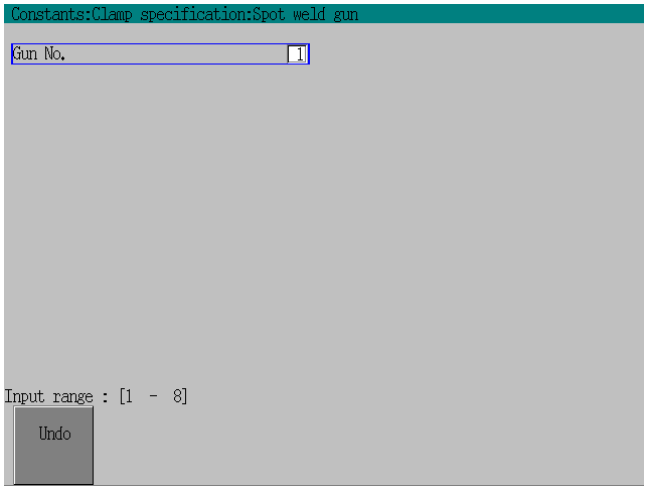
8.1. Home Position



9. Clamp specification

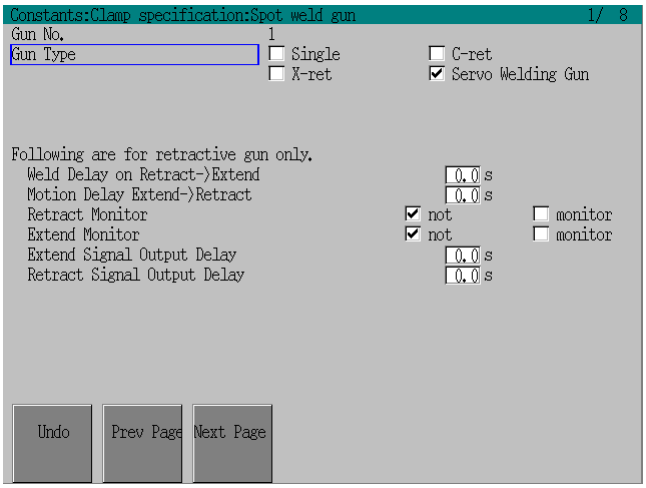


9.1. Spot weld gun

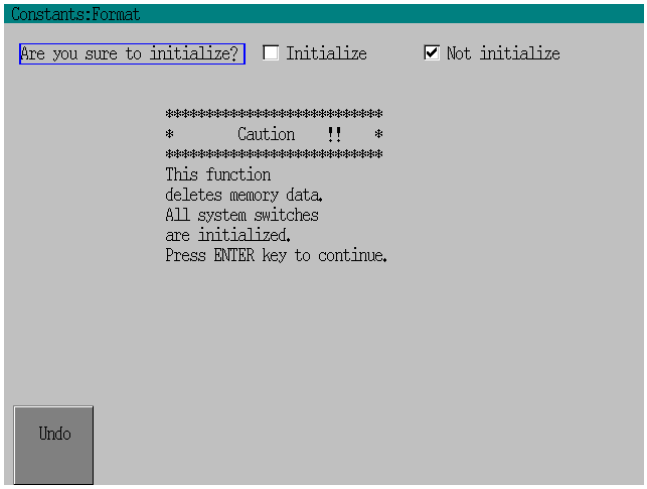


Specifies the number of the spot weld gun to be used with that robot.

(9.1. Spot weld gun <page 2>)



11. Format

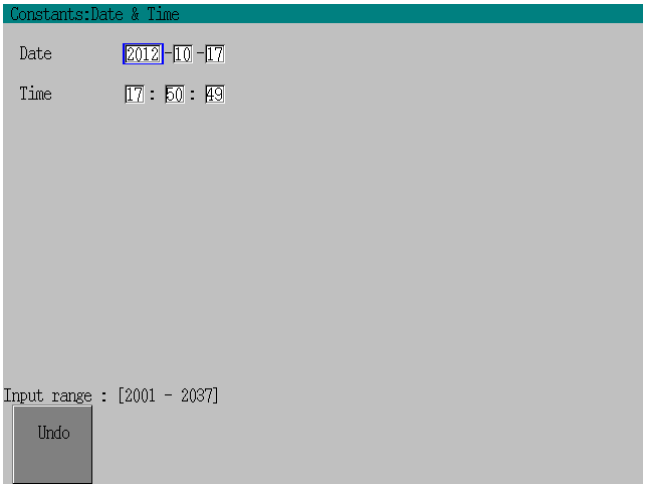


Initializes memory in controller.

CAUTION

Initializing this system erases all programs and variable data from memory.

15. Date & Time

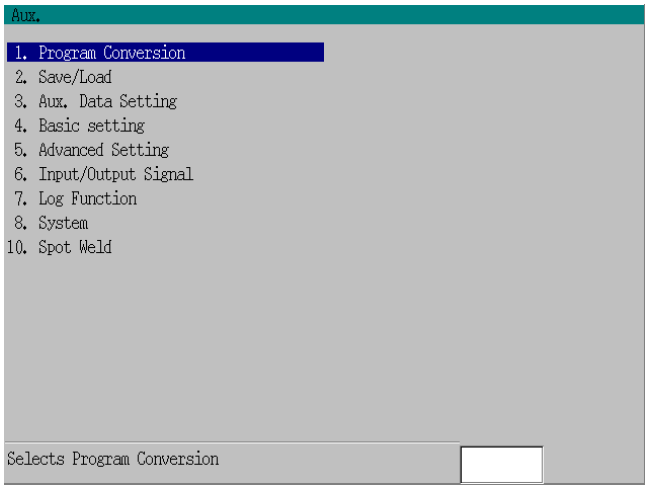


Sets the current year, month, day and time for the clock built into the controller. This time setting is used for the current time shown on the teach pendant and in the error log.

9.0 AUXILIARY FUNCTIONS

The main menu of auxiliary functions is shown below. A table of all available auxiliary function screens is shown on the following pages. Service functions, constant functions, and other function systems are accessed from this menu. To use each function, follow the guide message displayed at the bottom of the screen.

To display the screen below, press <STATUS> then select [FUNCTIONS] from the pull-down menu. Move cursor to a desired item and press ↵ to display the submenu for that item. Or, input the 4-digit number for the function in the box on bottom right of the screen and press ↵. For instance, input 0603 to display the screen for 3. Dedicated signals display in 6. Input/ output signal.



In the event of conflict of specifications between auxiliary functions and service/constant functions, the latter has priority.

Main Menu Item No.	Service func.	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
1	Program conversion	1	Transfer data			R3
		2	Mirror image			R6
		3	Transform data	1	Start data transformation	R9
				2	Register tool coordinates	
				3	Measure tool coordinates	
				4	Compensate for gravity	
		4	XYZ shift			R80
		5	Joint shift			R81
		6	Tool shift			R82
		8	Inverse program copy			R89
2	Save/ Load	1	Save			R10
		2	Load			R11
		3	File/ Folder operate			
		10	Autosave configuration	1	Save data1	R210
				2	Save data2	
				3	Save data3	
				4	Display of autosave log	
		14	Other settings			R211
3	Aux. data setting	1	Speed			R54
		2	Accuracy			R53
		3	Timer			R58
		4	Tool coordinates			R48
		5	Fixed tool coordinates			
		7	AS Language Mode Setting			
		99	Block instruction change			
4	Basic setting	1	Teach/Check speed			R56
		3	Working space			R77
		4	Load on arm			R404
		5	Auto tool coordinates register			R40
		6	Auto load measurement			
5	Advanced setting	1	Zeroing (R501)	1	Zeroing	R41
				2	Zeroing data set/display	R44
				3	Encoder rotation counter reset	R140
		2	System switch			R75

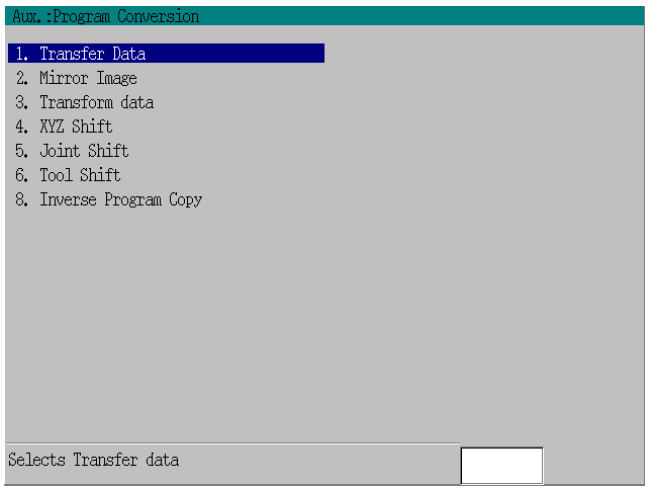
Main Menu Item No.	Service func.	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
5		3	Pos. deviation error range at E-stop			R42
		4	Enc. value error range at power-ON			R43
		5	Robot installation posture			R46
		6	Base coordinates			R47
		7	Motion limits			R51
		8	Slow repeat			R55
		9	Interface panel			R131
		12	Deviation Limit for Continuing			
		18	Moving Area XYZ Limits			
6	Input/Output signal	3	Dedicated signals display			R113
		4	OX specification setting	1	OX specification setting	R117
		5	Clamp specifications (R605)	12	Spot weld gun definition	
		6	Signal name (R138)	1	OX (Output)	
				2	WX (Input)	
				3	INT (Internal)	
		10	Input/ Output Signals in Robot Arm			
		11	Number of I/O Signals			
		16	Signal Environment			
		17	Workpiece program			R617
		19	Input/ Output through Setting			
		21	Analog Output Offset			
7	Monitor	2	Error logging display (R120)	1	All	
				2	Operation error (P)	
				3	Mechanical/Control warning (W)	
				6	Property of logging	
		3	Operation logging display (R122)	1	All	
				2	Operation logging	
				3	Command logging	
				5	Property of logging	
		6	Operating data display	1	Operating data display	R147
		7	Maintenance support (R707)	1	Maintenance support aux.	
				2	Error list	

Main Menu Item No.	Service func.	Sub Menu Item No.	Service Functions-Sub menu					R Code No.
7		8	Data Storage	1	Setting	01	JT Angle	
						02	XYZOAT	
						03	JT Command	
						04	JT Deviation	
						05	JT Speed	
						06	Motor Cur. Value	
						07	Motor Speed	
						08	Motor Cur. Command	
						09	Tool Speed	
						10	I/O Signal	
						11	Combination	
		9	Motor torque information (R124)	2	Duty			
				3	Failure prediction setting			
				4	Base Data			
		10	Program edit logging					R713
		11	Weld condition log					R714
		19	DIAG Function	1	Lifetime alarm setting			
		23	Teach Assist Correct Logging					
8	System	1	Memory available					R70
		2	Inhibit record					R71
		3	Reset check sum error					R78
		4	Software version					R90
		5	Initialize system					R100
		6	Battery error check					R806
		7	Check specification					R99
		8	Environment data					R808
		9	Time/Date					R96
		10	PC program run/ stop	1	Select start (PCEXECUTE)			R130
				2	Select abort (PCABORT)			R130
				3	Select stop (PCEND)			R130
				4	Select continue (PCCONTINUE)			R130
				5	Kill PC prog. (PCKILL)			R130
				6	Selects status (PCSTATUS)			R130
		11	Choose language	1	Choose language			R91

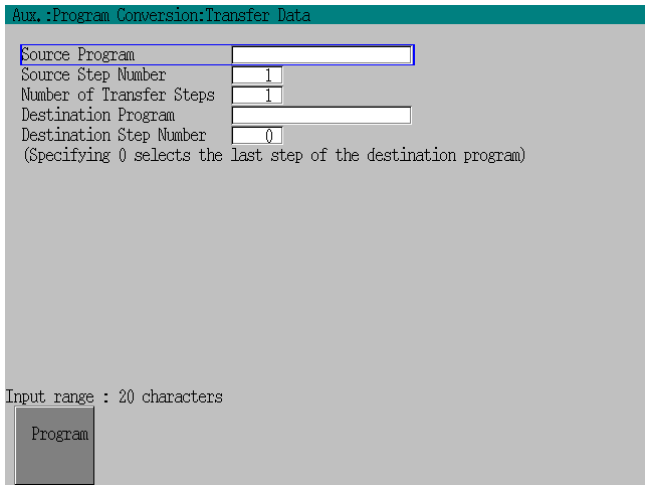
Main Menu Item No.	Service func.	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
8		11	Choose language	2	Language Allocation Function	R91
		12	Network setting			R189
		15	FTP server setting			R815
		18	USB Keyboard			
		97	Select auxiliary function			R198
		98	Change operation level			R197
10	Spot weld	1	Servo weld gun clamp definition			R1001
		11	Servo weld gun mechanical parameter			R1011
		12	Data for gun zeroing			R1012
		14	Auto Gun ACC Measurement			
		21	Servo weld gun			R1021
		22	Servo weld gun parameter			R97
		23	Force calibration			R1023
		24	Force compensation			R161
		25	Clamp force setting			R1025
		26	Deflection measurement			R1026
		27	Deflection compensation			R1027
		28	Deflection compensation at Teach			R1028
		29	Wear measurement parameters			R1029
		30	Tip base data change for wear disp.			R59
		31	Tip base data setting for wear disp.			R1031
		32	Workpiece thickness check			R164
		33	Gun axis brake release mode			R162
		34	Workless trial run			R60
12	Paint, Sealing	3	Spray enable/disable			
		4	Output ref flowrate	1	Flowrate calibration table	
				2	Pressure/Voltage table	
				3	Flowrate magnification table	
				4	Applying pressure table	
				5	Set primary line pressure	
				6	Set press. and temp. limits	
				7	Set primary line pressure command	
				8	Environment data set	

Main Menu Item No.	Service func.	Sub Menu Item No.	Service Functions-Sub menu			R Code No.
12		4		9	Set gun/pump compatibility	
				10	Set material circulation data	
				11	A/D D/A monitor	
				12	Data monitor	
				13	Clogging pressure	
		5	3D-sensor compensation	1	Reference points registration	
				2	Master/Slave	
				3	Allowable deviation range	
				4	XYZ display	
				5	Offline conversion	
		6	Painting dedicated signal delay/preout time setting			

1. Program conversion

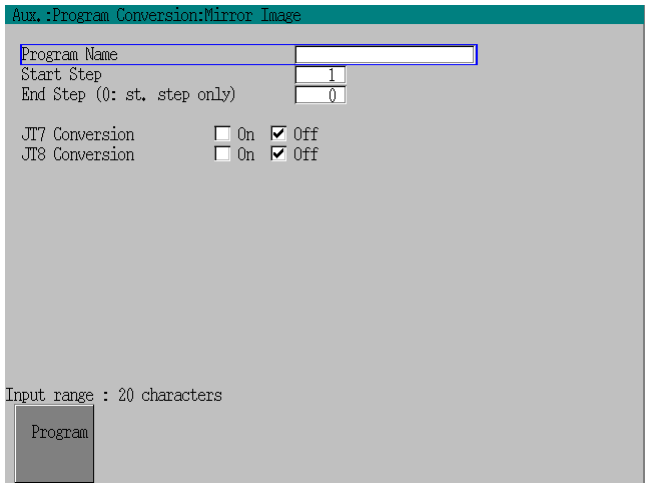


1.1. Program conversion: Transfer data



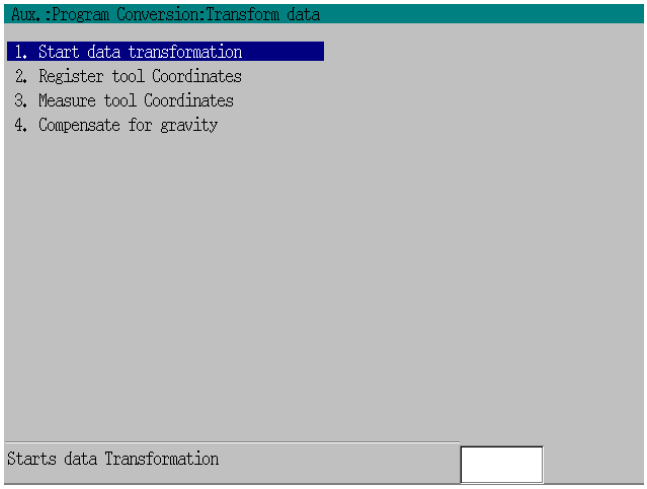
Allows transferring program step(s) between programs or to a different step within the same program.

1.2. Program conversion: Mirror image



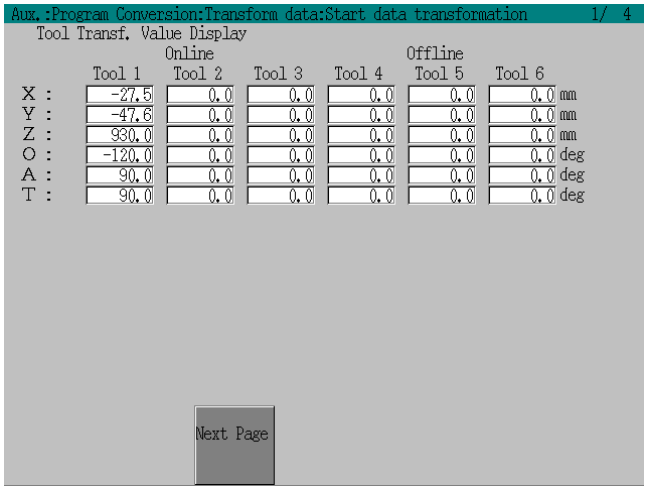
See 6.7 in 7.0 Service Functions.

1.3. Program conversion: Transform data

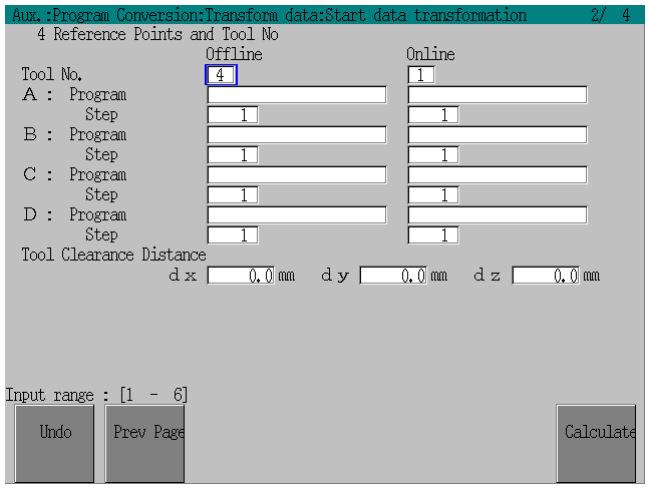


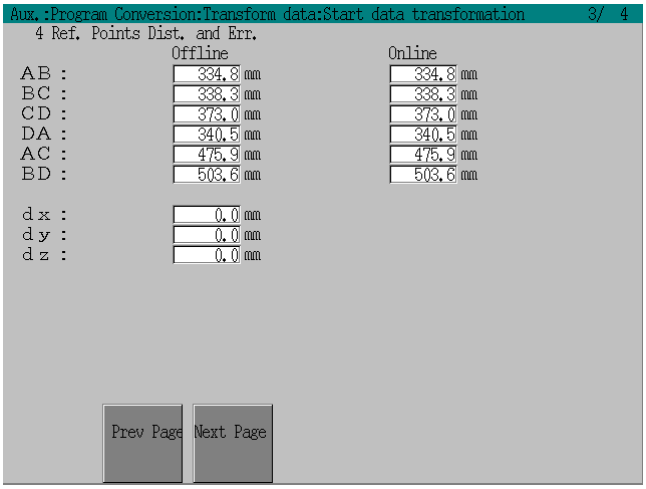
See 6.8 in 7.0 Service Functions.

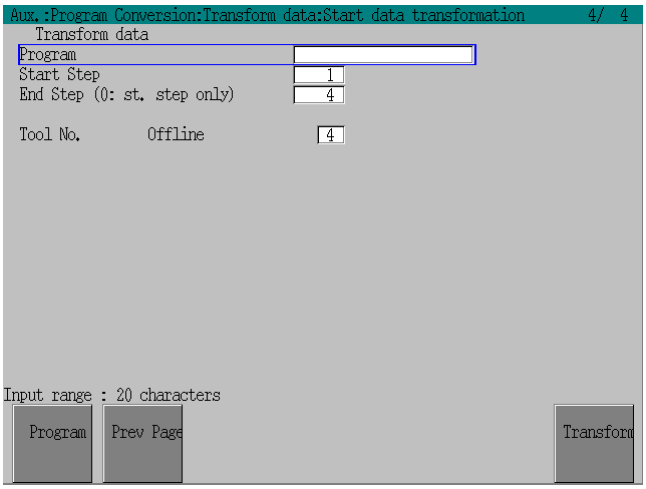
1.3.1. Program conversion: Transform data: Start data transformation



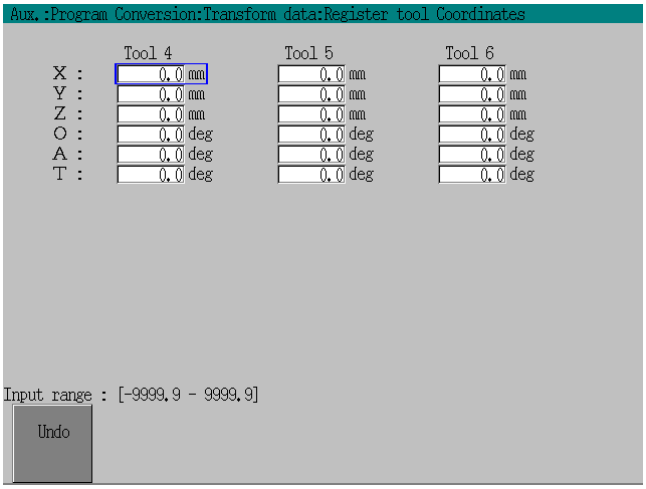
See 6.8.1 in 7.0 Service Functions.





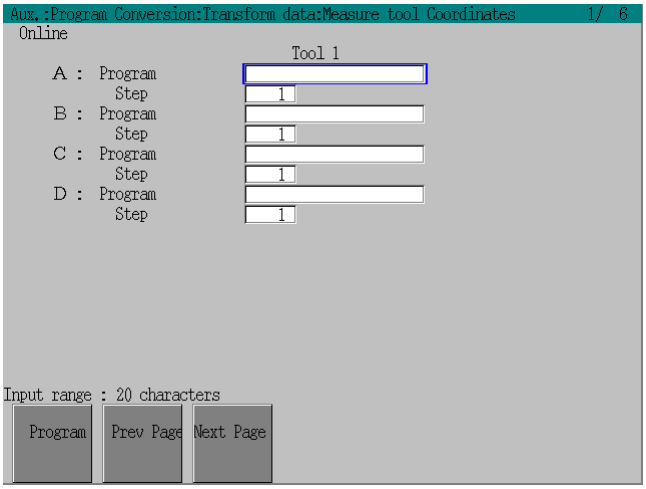


1.3.2. Program conversion: Transform data: Register tool coordinates



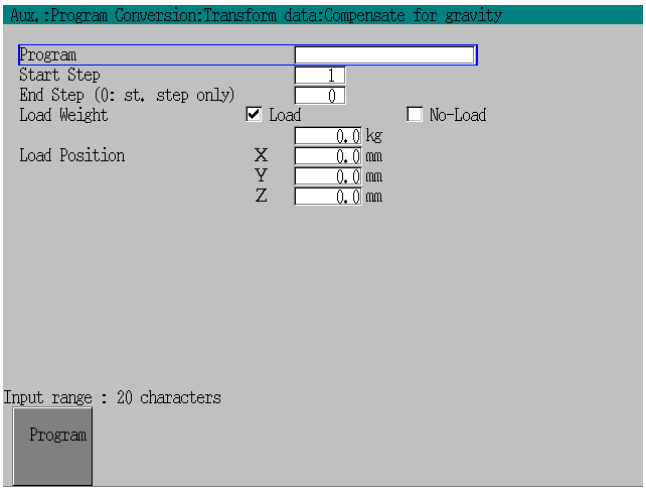
See 6.8.2 in 7.0 Service Functions.

1.3.3. Program conversion: Transform data: Measure tool coordinates



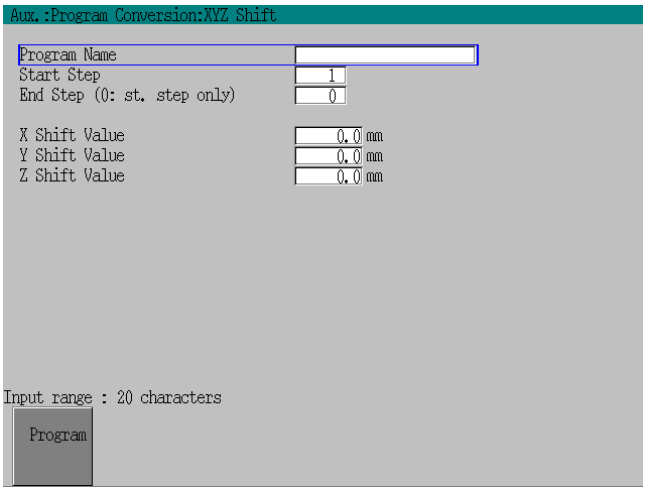
See 6.8.3 in 7.0 Service Functions.

1.3.4. Program conversion: Transform data: Compensate for gravity



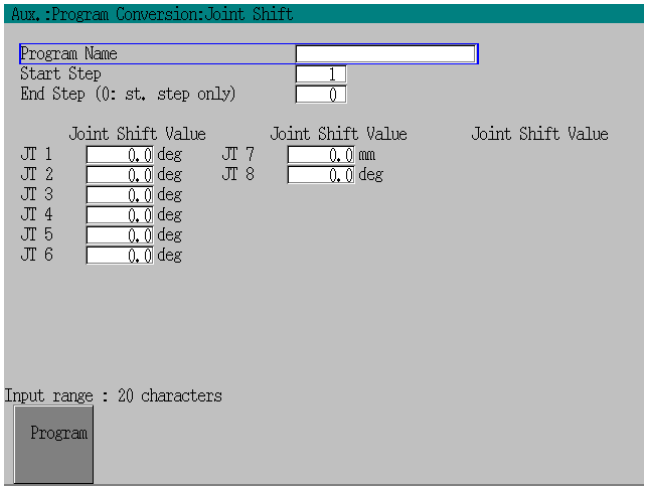
See 6.8.4 in 7.0 Service Functions.

1.4. Program conversion: XYZ shift



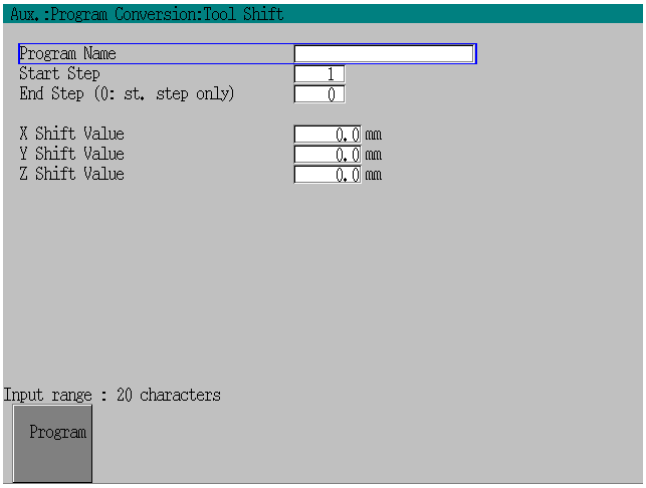
See 6.4 in 7.0 Service Functions.

1.5. Program conversion: Joint shift



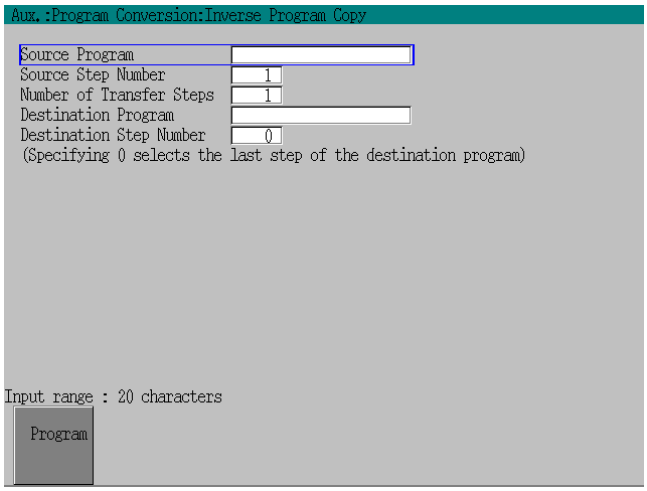
See 6.3 in 7.0 Service Functions.

1.6. Program conversion: Tool shift



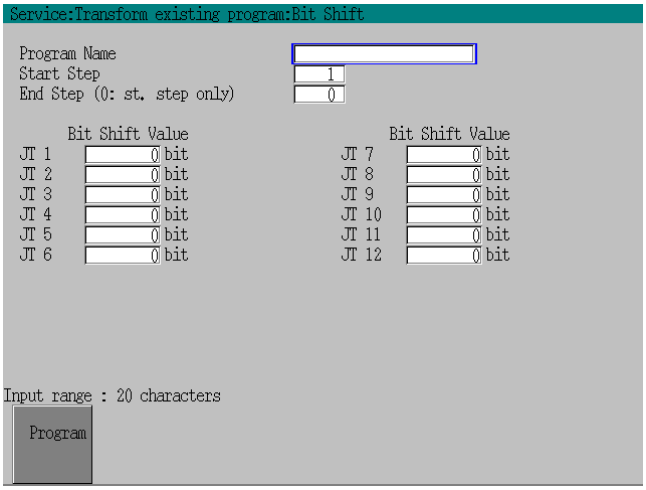
See 6.5 in 7.0 Service Functions.

1.8. Program conversion: Inverse program copy



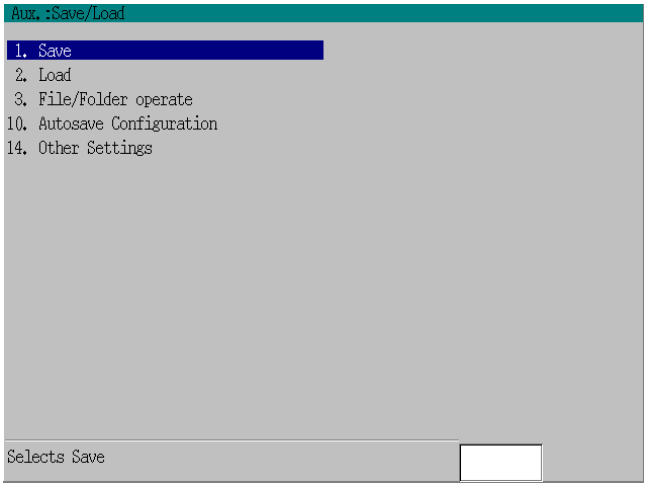
See 6.2 in 7.0 Service Functions.

1.9. Program conversion: Bit shift

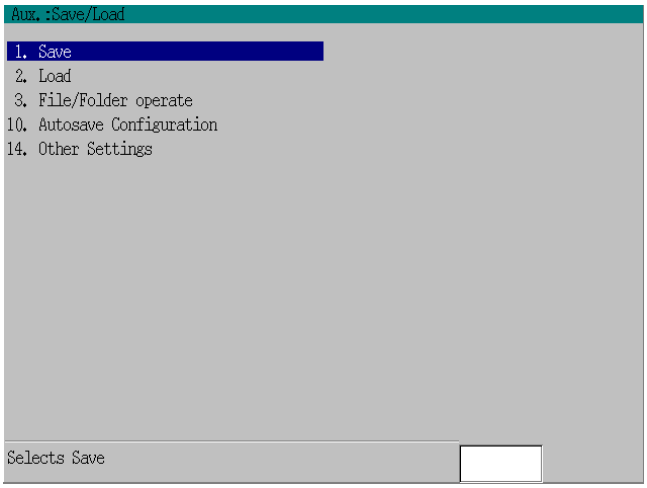


See 6.9 in 7.0 Service Functions.

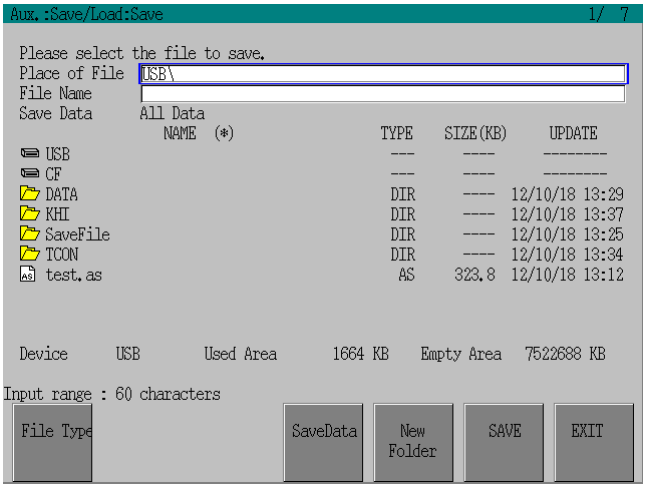
2. Save/Load



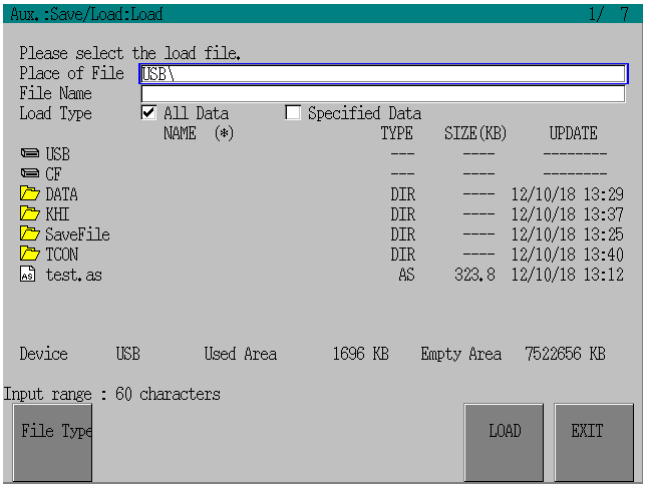
2.1. Save/Load: Save



See 4.1 in 7.0 Service Functions.

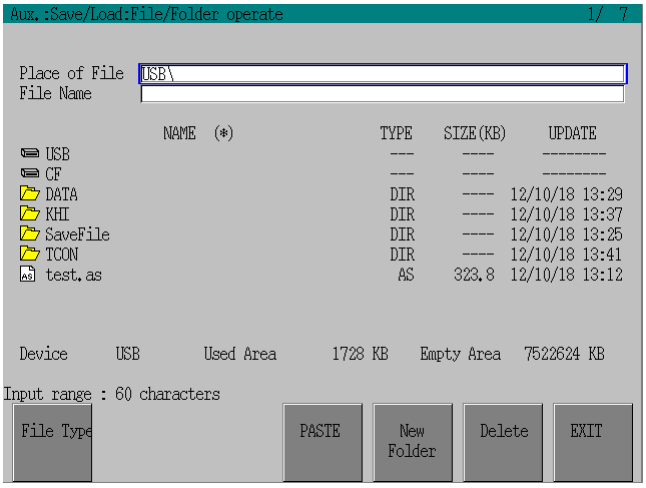


2.2. Save/Load: Load



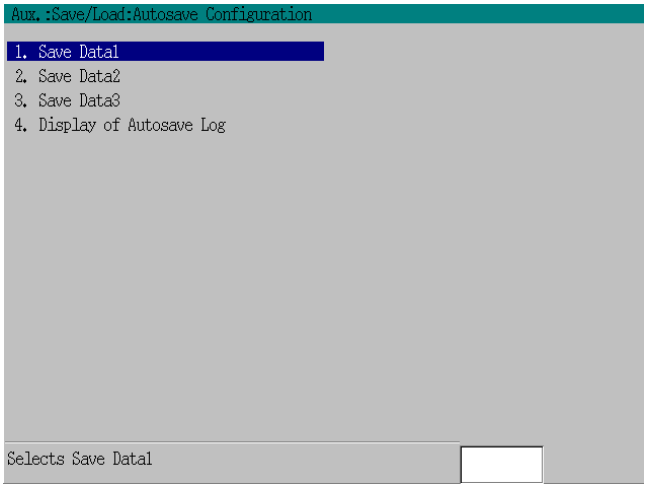
See 4.2 in 7.0 Service Functions.

2.3 Save/Load: File Folder operate



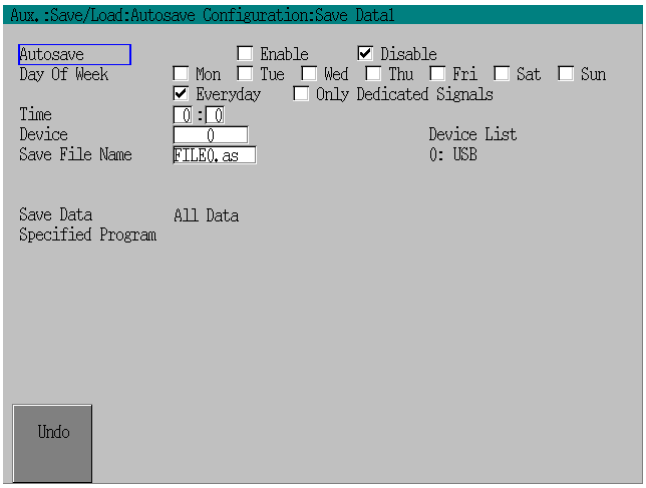
See 4.3 in 7.0 Service Functions.

2.10. Save/Load: Autosave configuration



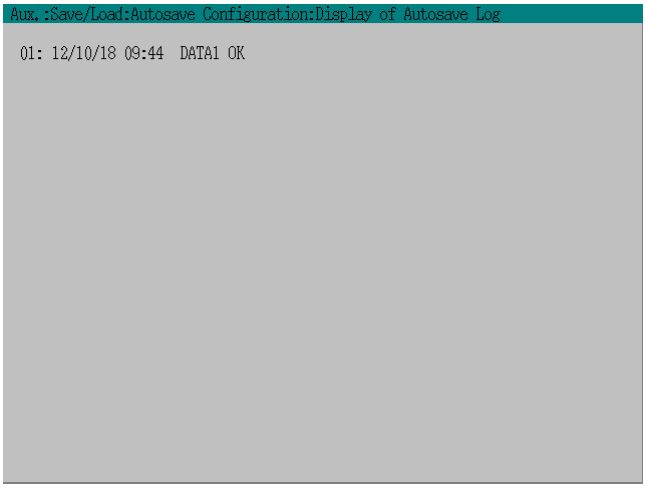
See 4.10 in 7.0 Service Functions.

2.10.1/2/3. Save/Load: Autosave configuration: Save data1/2/3



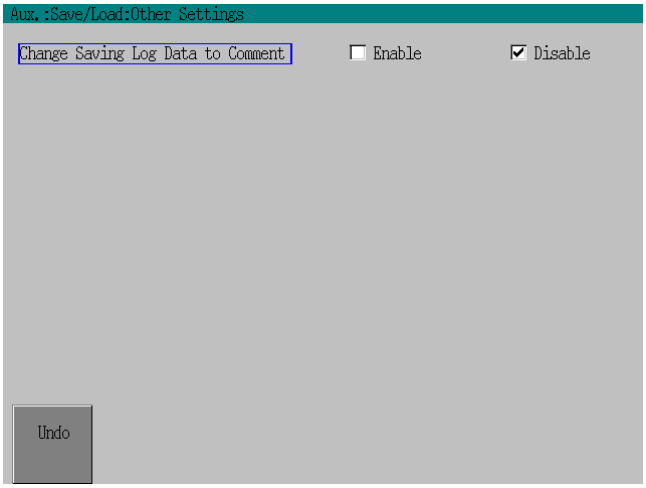
See 4.10.1 in 7.0 Service Functions.

2.10.4. Save/Load: Autosave configuration: Display of autosave log



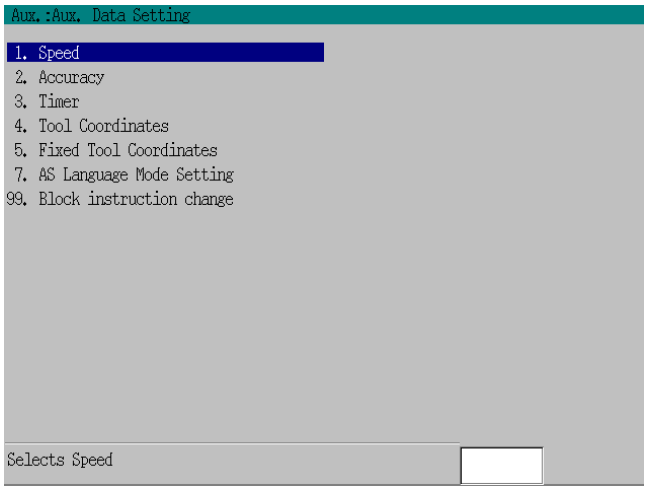
See 4.10.4 in 7.0 Service Functions.

2.11. Save/Load: Other settings



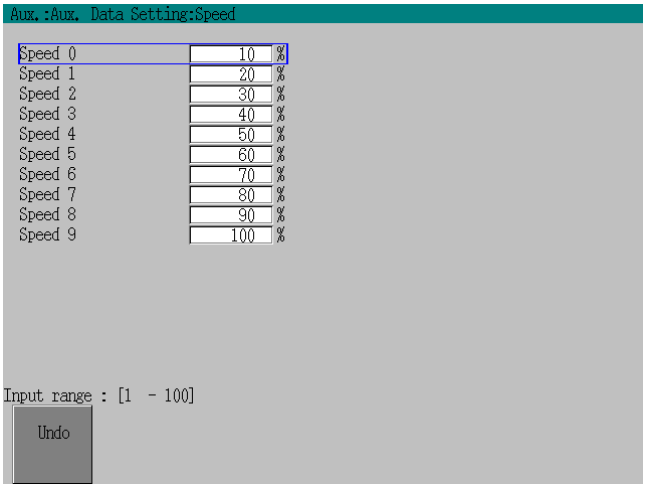
See 4.11 in 7.0 Service Functions.

3. Aux. data setting



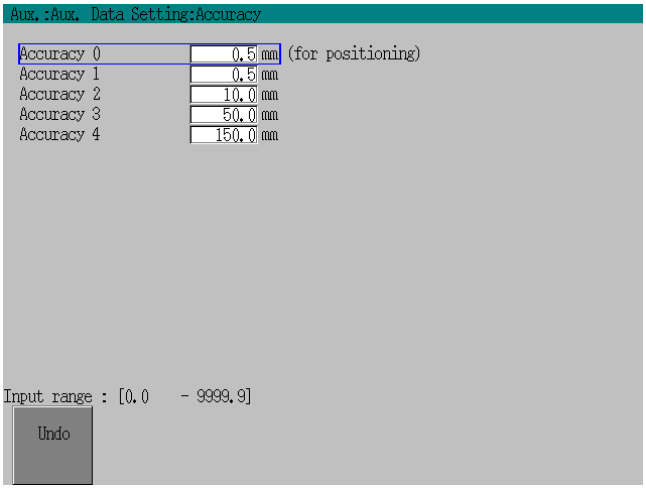
See 3 in 8.0 Constant Functions.

3.1. Aux. data setting: Speed



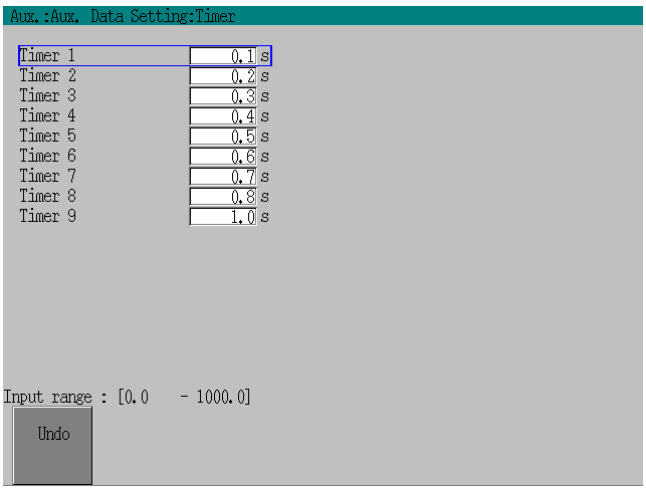
See 3.1 in 8.0 Constant Functions.

3.2. Aux. data setting: Accuracy



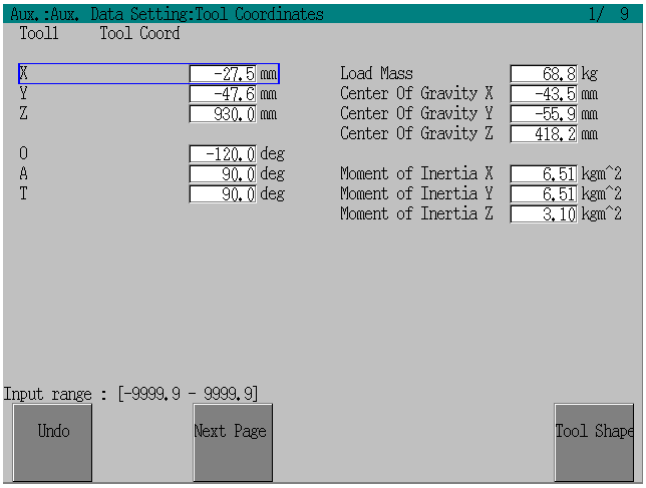
See 3.2 in 8.0 Constant Functions.

3.3. Aux. data setting: Timer



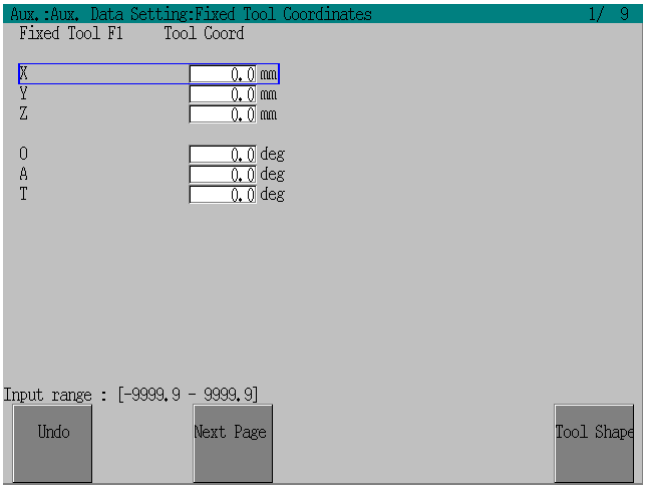
See 3.5 in 8.0 Constant Functions.

3.4. Aux. data setting: Tool coordinates



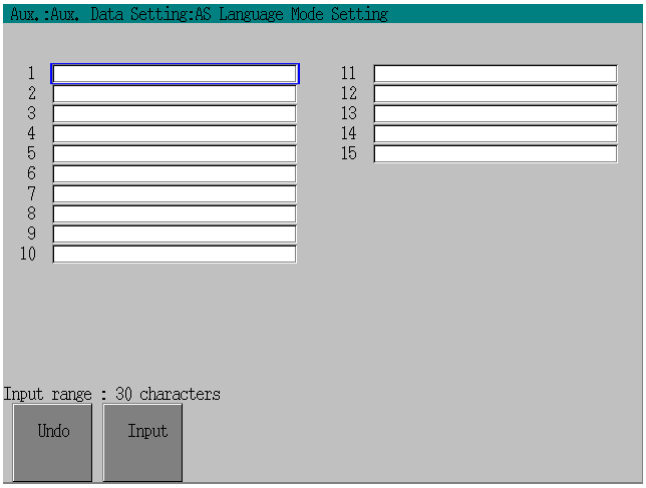
See 3.3 in 8.0 Constant Functions.

3.5. Aux. data setting: Fixed tool coordinates



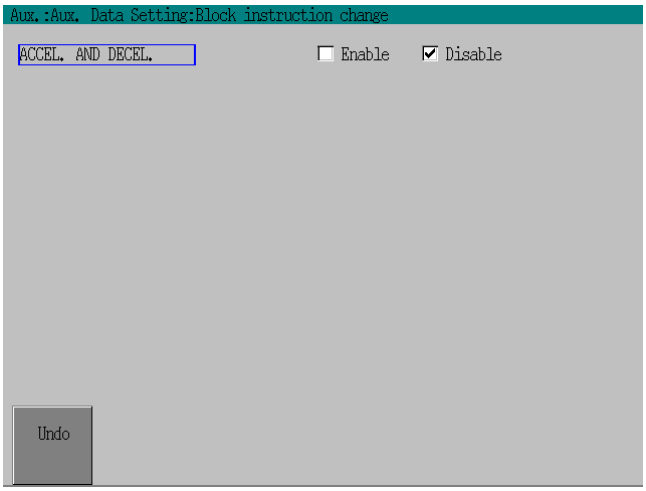
Input the transformation values of the fixed tool coordinates based on the robot base coordinates.

3.7. AS Language Mode Setting



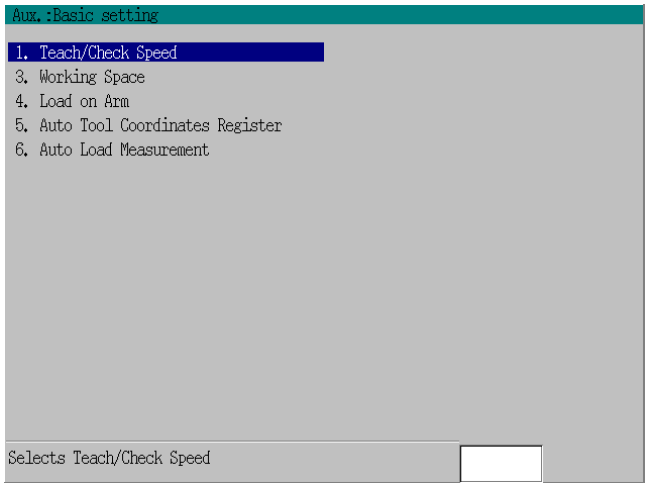
Registers frequently used AS language instructions so it will be convenient in teaching programs. Up to 15 instructions can be registered here.

3.99 Block instruction change

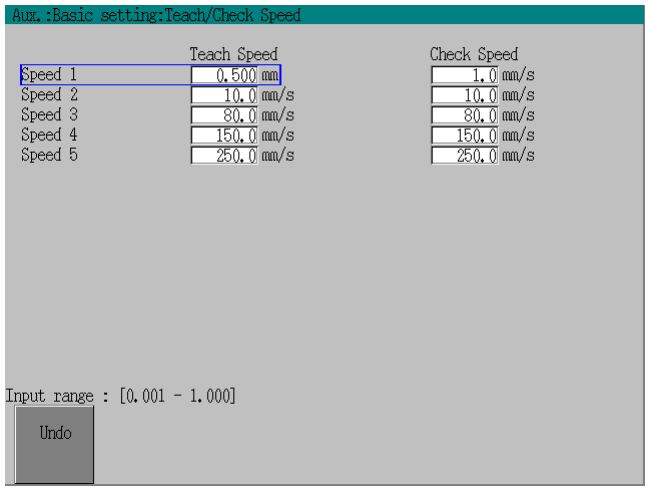


Sets whether Acceleration and Deceleration instructions are included (Enable) or not (Disable) in block instruction teaching. When set to Enable, the acceleration/ deceleration speed set inAux. 0301 Speed will be enabled and specifying Speed 0 – Speed 9 in block teaching will make the robot move at the assigned acceleration/ deceleration speed. Select Disable for this function to use ACCEL and DECEL instructions. Also, when specifying the speed by direct input, this function is invalid.

4. Basic setting

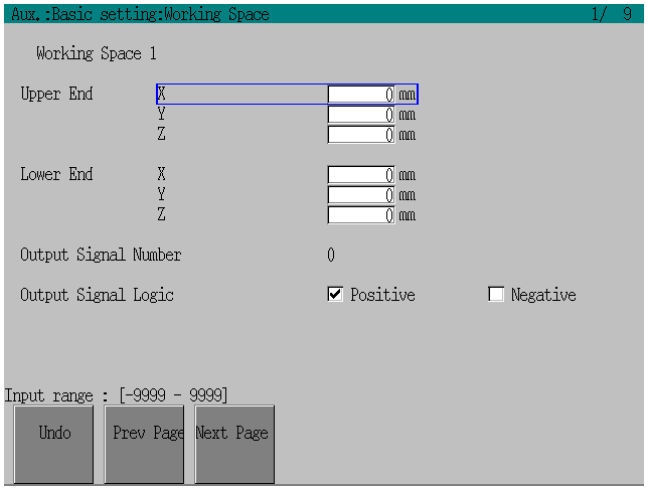


4.1. Basic setting: Teach/Check speed

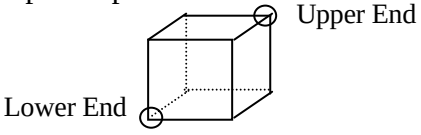


See 6.1/6.2 in 8.0 Constant Functions.

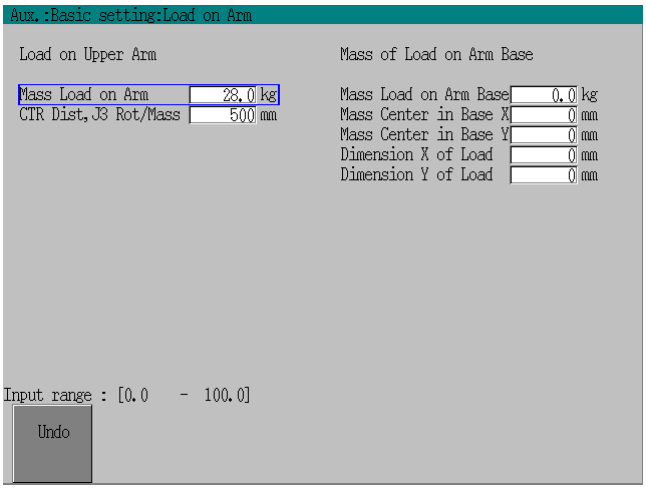
4.3. Basic setting: Working space



Defines a rectangular 3D workpiece space parallel to the base coordinate by specifying the 3-dimensional position of upper and lower corner positions which are located diagonally from each other. (See picture below.) The specified signal is output if the tool coordinate origin (TCP) is within the workpiece space.

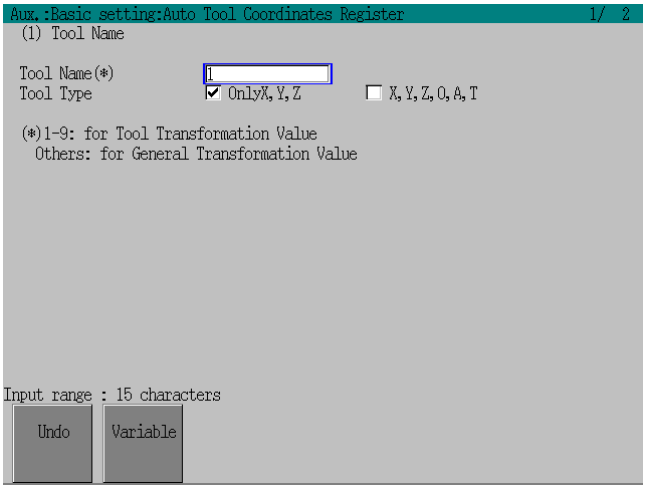


4.4. Basic setting: Load on arm

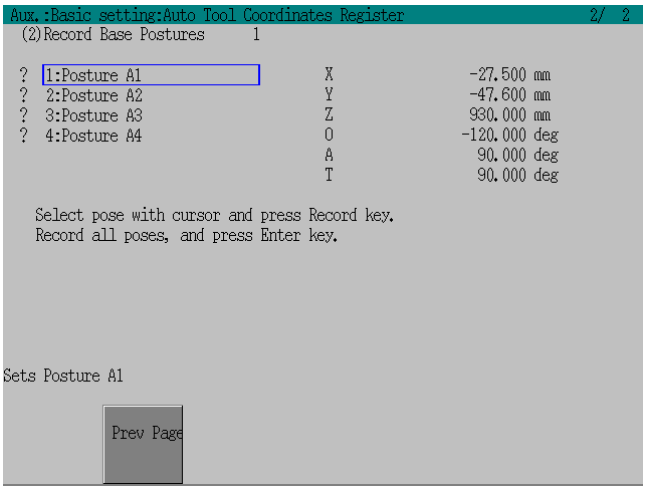


Specify the load applied to the upper arm and arm base of the robot to optimally adjust acceleration/ deceleration, vibration, etc.

4.5. Basic setting: Auto tool coordinates register

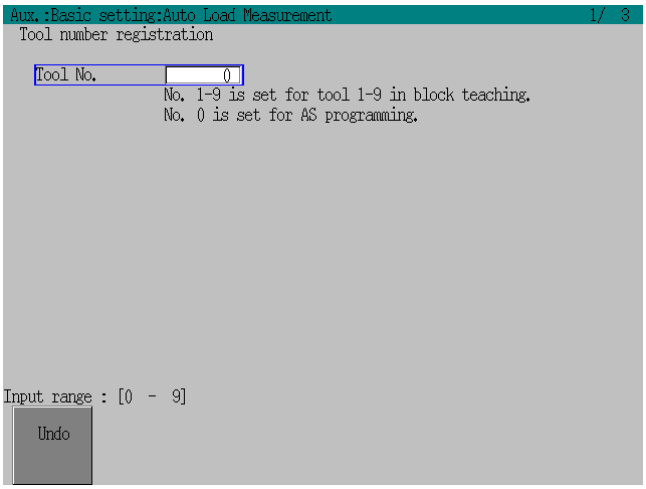


Calculates the tool data and automatically registers its data based on 4 taught poses that point the same fixed point. Tool must be attached to the robot arm before registration.
Set tool number and how to calculate tool data in this screen.

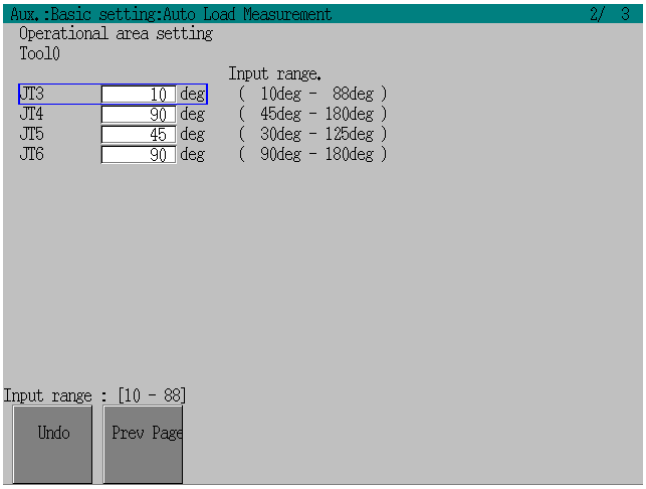


Register the tool pose data by teaching 4 different poses that point the same fixed point.

4.6. Basic setting: Auto load measurement

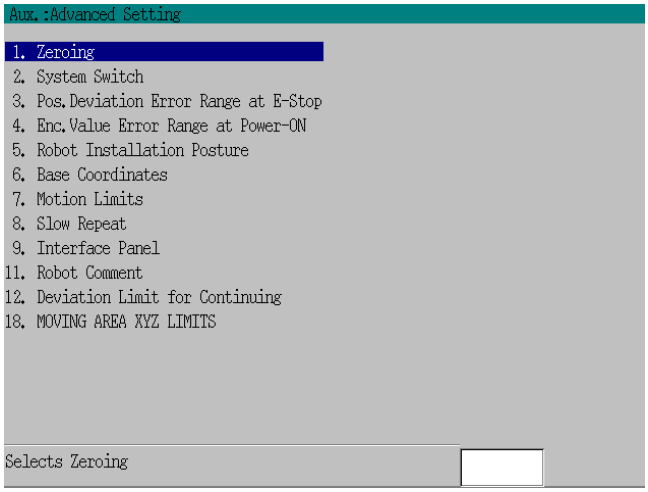


Automatically calculates load mass and center of gravity of tool. Calculation is based on results of the control program for load measurement executed with the tool mounted on the robot.

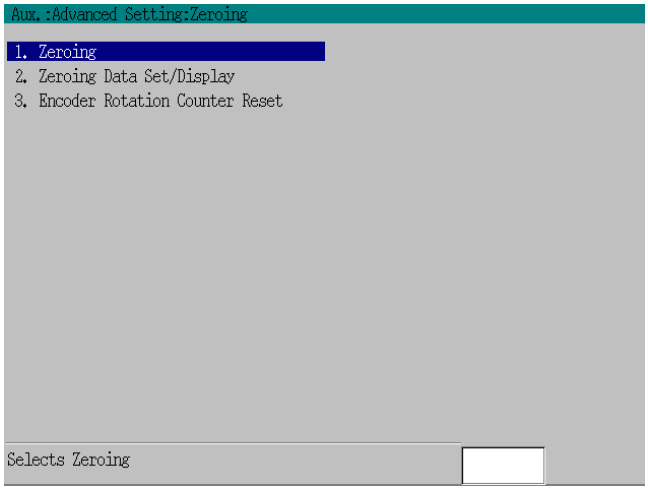


Sets the motion range for each axis. Confirm the axis does not interfere with peripheral objects within its motion range.

5. Advanced setting

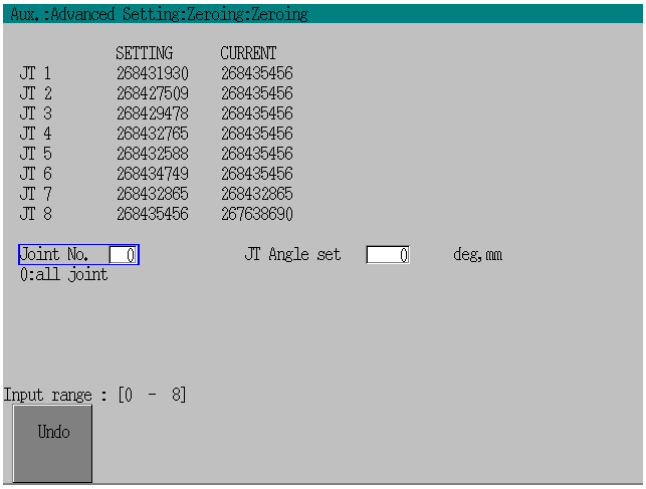


5.1. Advanced setting: Zeroing



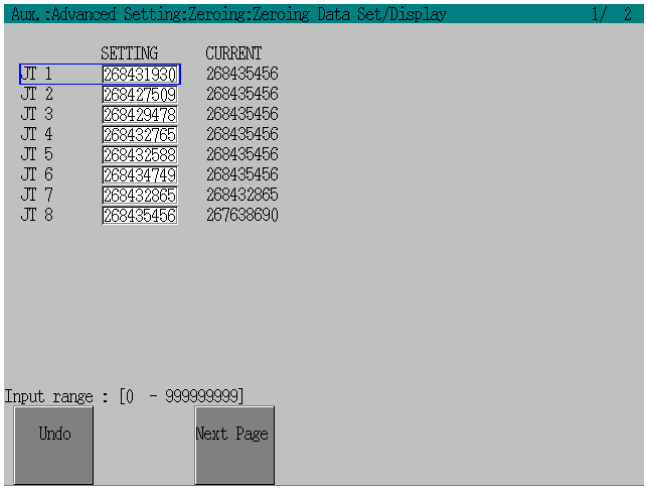
See 5 in 8.0 Constant Functions.

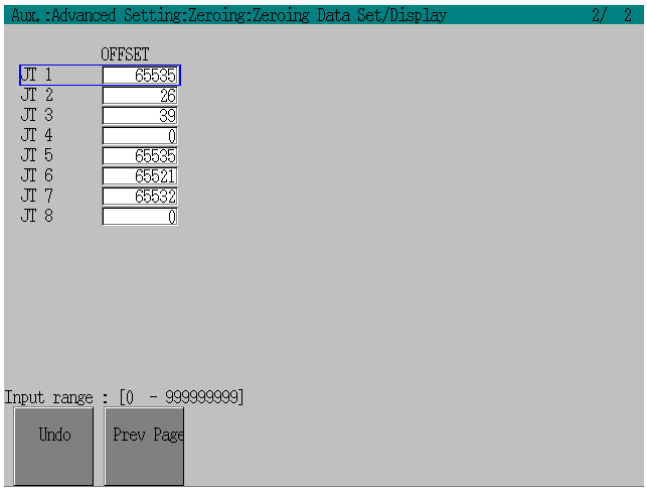
5.1.1. Advanced setting: Zeroing: Zeroing



See 5.2 in 8.0 Constant Functions.

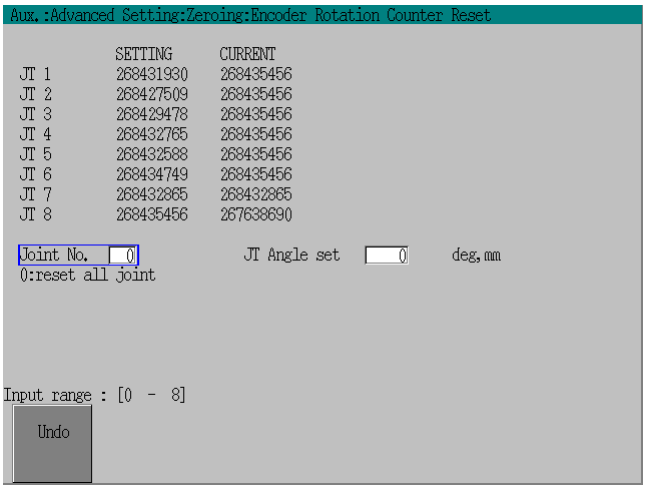
5.1.2. Advanced setting: Zeroing: Zeroing data set/display





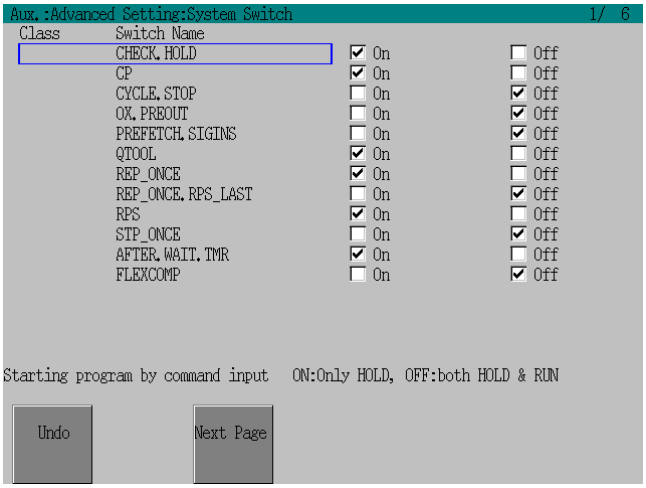
See 5.3 in 8.0 Constant Functions.

5.1.3. Advanced setting: Zeroing: Encoder rotation counter reset



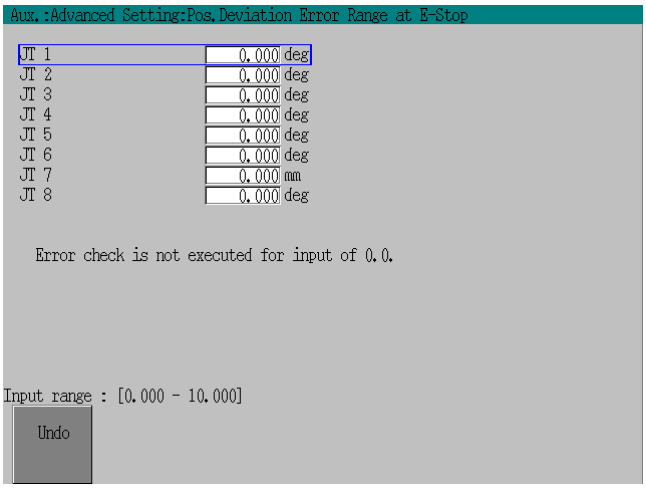
See 5.1 in 8.0 Constant Functions.

5.2. Advanced setting: System switch



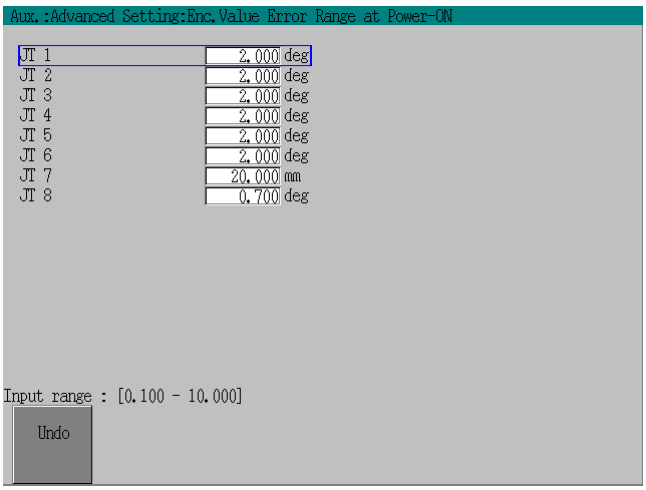
See 1.5 in 8.0 Constant Functions.

5.3. Advanced setting: Pos. deviation error range at E-stop



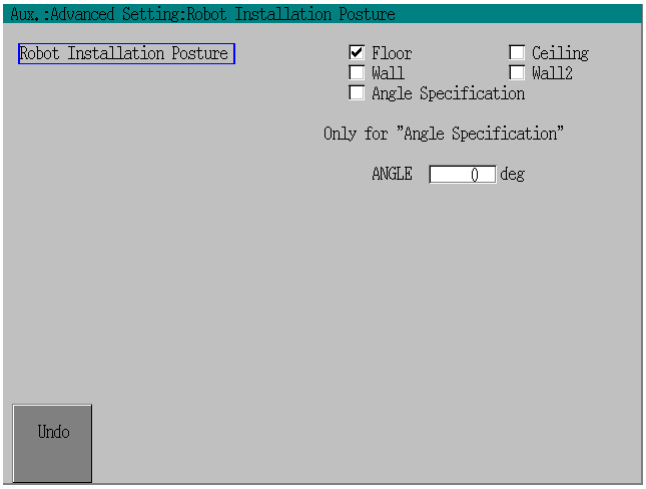
See 2.3 in 8.0 Constant Functions.

5.4. Advanced setting: Encoder value error range at power ON



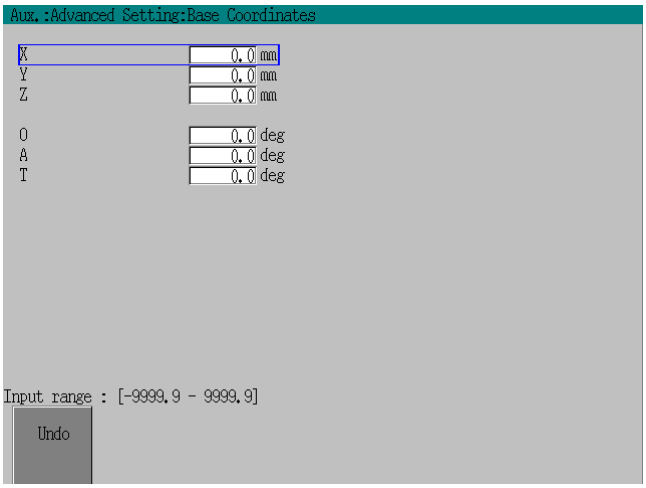
See 2.4 in 8.0 Constant Functions.

5.5. Advanced setting: Robot installation posture



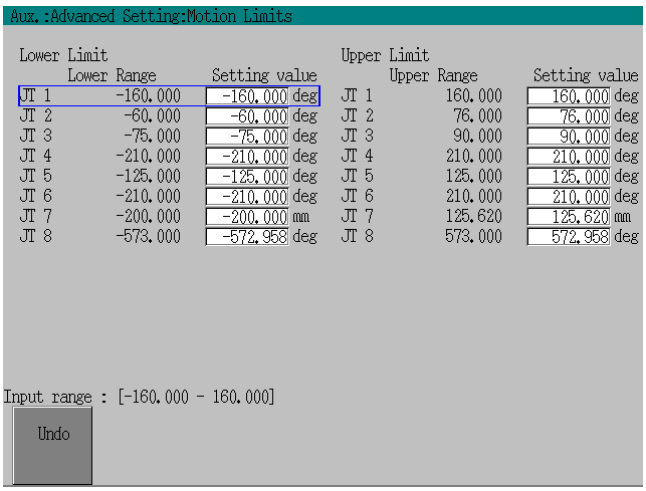
Select the installation type from the menu displayed which represents the actual installation posture of the robot. This sets the +Z axis of base coordinates vertically upward and opposite gravity, for any installation posture that the robot may take.

5.6. Advanced setting: Base coordinates



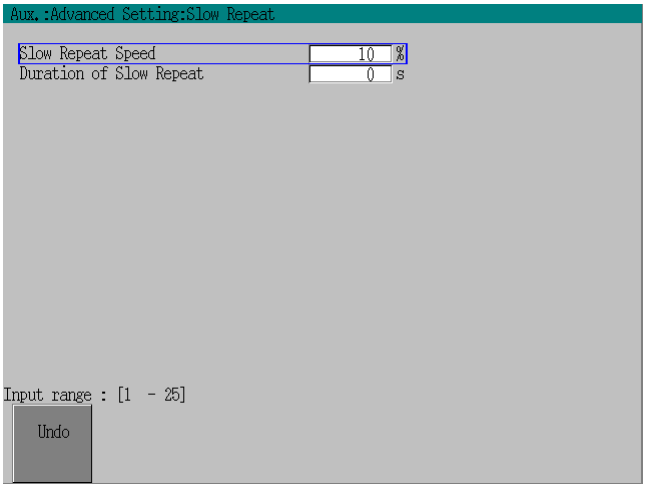
See 2.2 in 8.0 Constant Functions.

5.7. Advanced setting: Motion limits



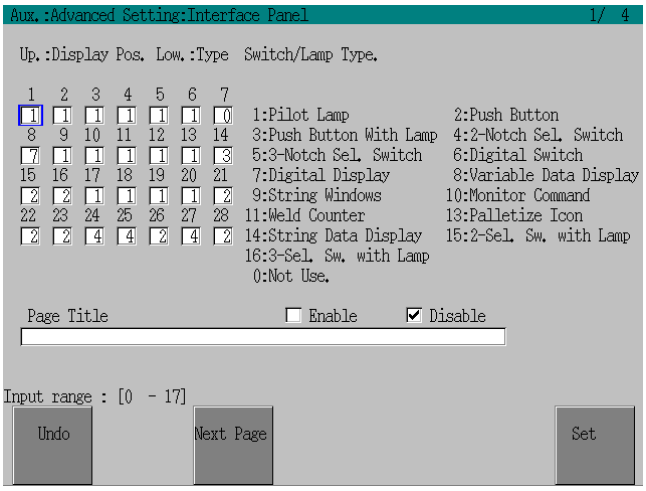
See 2.1 in 8.0 Constant Functions.

5.8. Advanced setting: Slow repeat



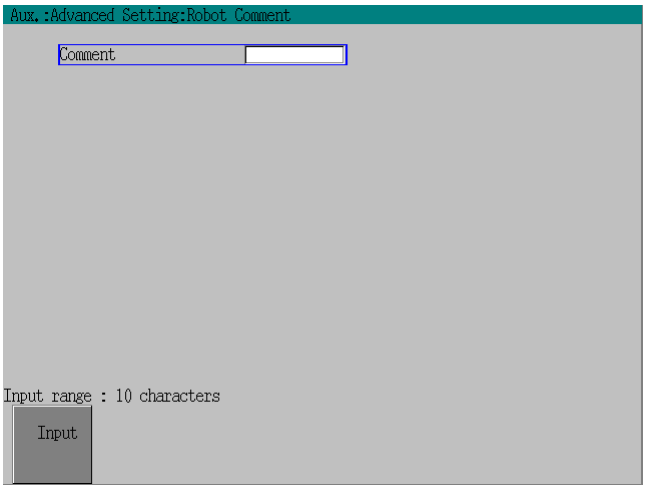
Sets slow repeat speed as a percentage of the maximum repeat speed of the robot.

5.9. Advanced setting: Interface panel



See 16 in 7.0 Service Functions.

5.11. Advanced setting: Robot comment



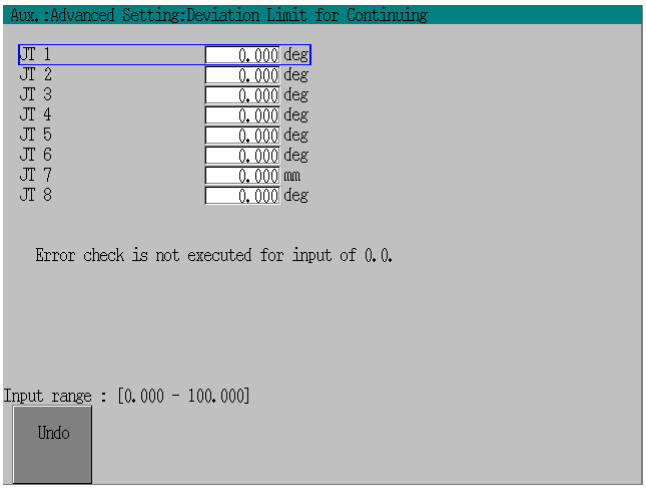
Sets comment to identify each robot. The comment is displayed on the robot selection key when that robot is currently selected on screen.

5.12 Advanced Setting: Deviation Limit for Continuing

This function sets the deviation limit from restart position for each axis when continuing programmed operation.

Axis deviation at restart position = |(Current axis value at restart) – (Axis value at the last stop by cycle-start OFF)|

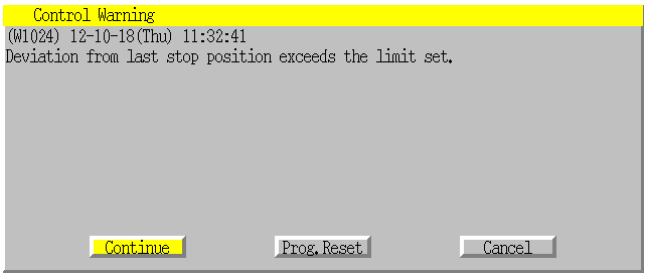
The purpose of this warning detection is to prevent a robot from interfering with peripheral objects such as jigs and workpiece when returning the robot to the last stop pose.



Input allowable deviation range for each axis, and press ↵. When setting the limit value to “0.000”, no error check is executed at the time of restart. Values are stored when “Setting

[NOTE]

Setting values too small may cause an error at restart even under normal operating conditions.



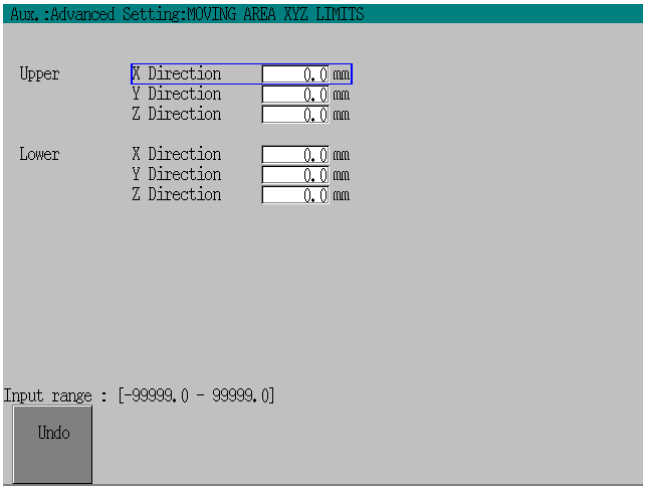
The screen on the left appears when deviation exceeds the set limit at the time of restart. Press <Continue> to continue operation after returning to the last stopped pose at slow repeat speed in joint

[NOTE]

The deviation from the last stop position is not checked when restarting a robot by external signals.

5.18 Advanced Setting: Moving Area XYZ Limits

This function sets the upper and lower limits within the XYZ area of world coordinates, including traverse axis, to control the robot motion based on the TCP. This function is valid only for motion in repeat, check and teach modes. (The check is not executed when teaching and changing/ registering pose data.) Moving from out of range to within the range is allowed.

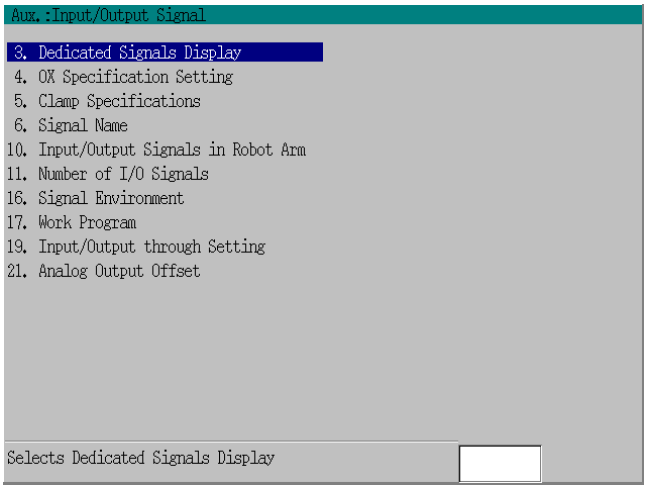


Move cursor to each item and input the upper/lower limits. If the setting is correct, press ↵. Values are stored when “Setting complete.” is displayed.

[NOTE]

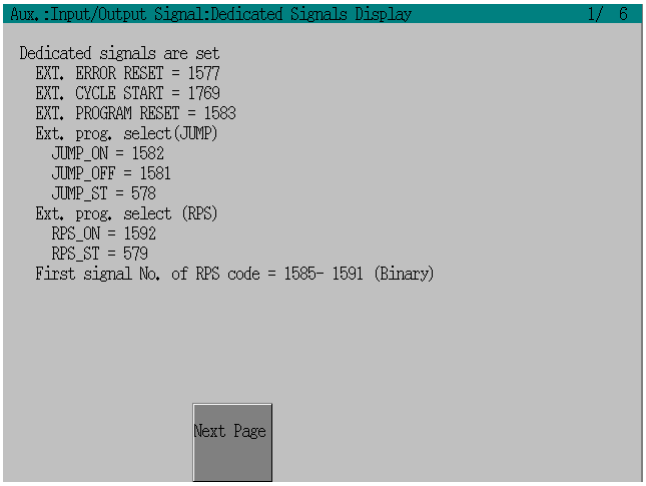
1. If the same values are set for the upper and lower limits, the motion range check is not executed.
2. The area of XYZ including traverse axis is checked.
   (Only in systems where robot cooperates with traverse axis.)
3. If the lower limit exceeds the upper limit, error occurs.

6. Input/Output signal



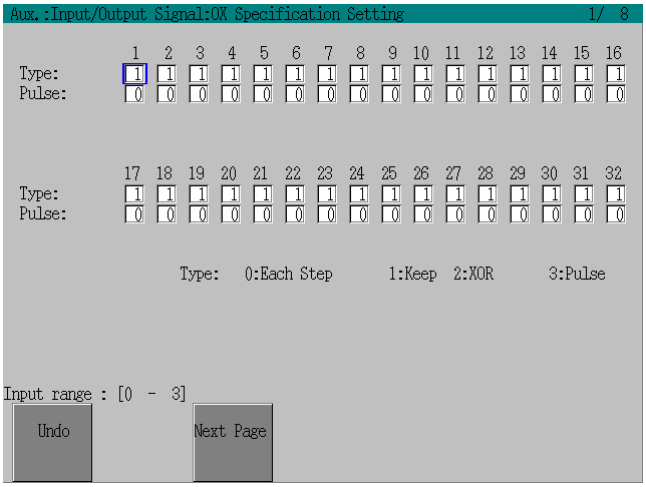
Displays currently set input/output signals and sets their specifications.

6.3. Input/Output signal: Dedicated signals display



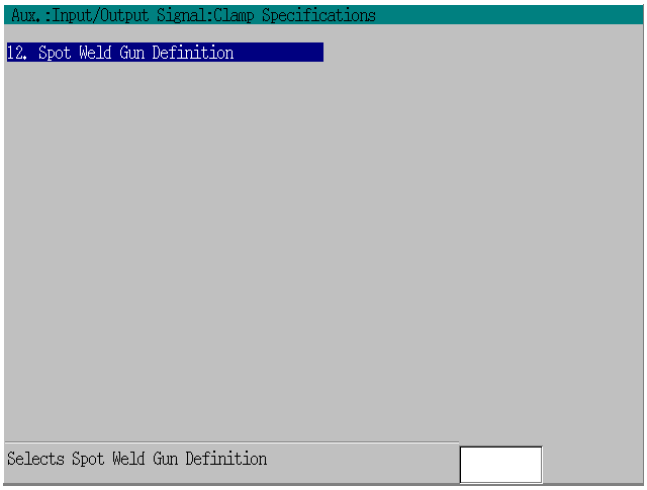
See 2.13/14 in 7.0 Service Functions.

6.4. Input/Output signal: OX specification setting



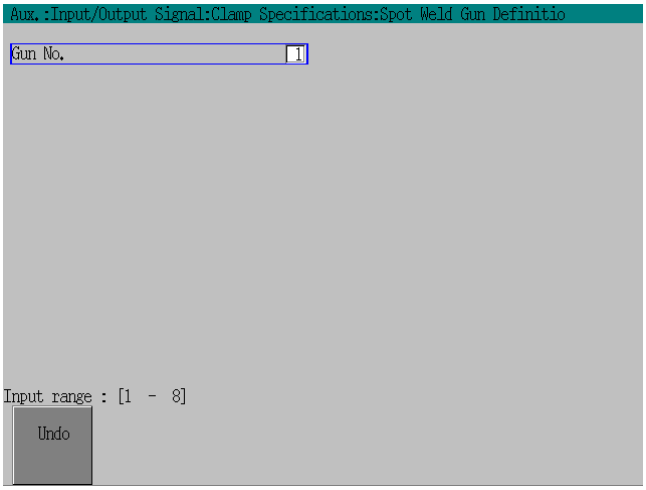
Assigns signal types. [0: Each step] outputs at step execution/axes coincidence. [1: Keep] outputs ON continuously until turned OFF. [2: XOR] sets adjacent numbered signals as a pair, one signal turns ON when other turns OFF. [3: Pulse] turns ON only for pulse duration, the 0 default value sets 0.4 sec. Press <Next Page> for signals numbers OX33+.

6.5. Input/Output Signal: Clamp specifications



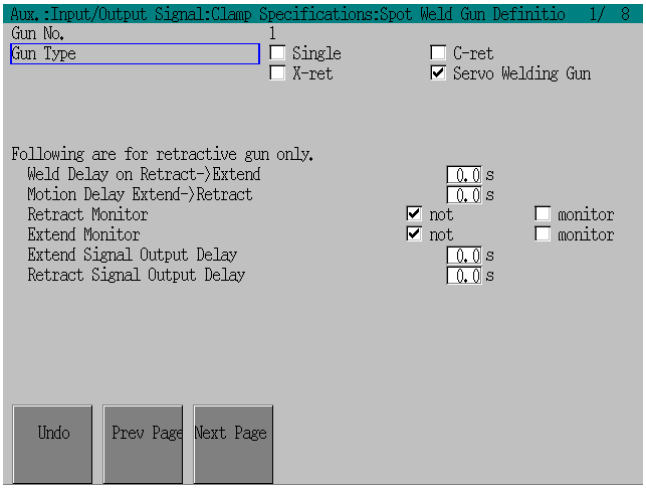
Sets the specifications of the gun to be used on each robot.

6.5.1. Input/Output signal: Clamp specifications: Spot weld gun definition



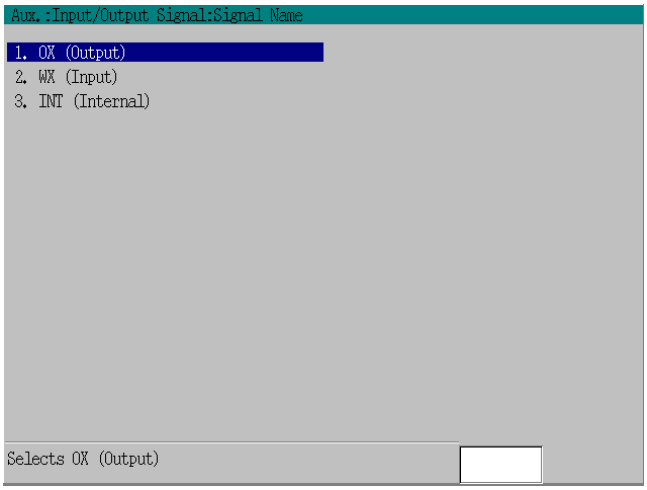
Sets the gun number to be used with each robot.

6.5.2. Input/Output signal: Clamp specifications: Spot weld gun definition <page 2>



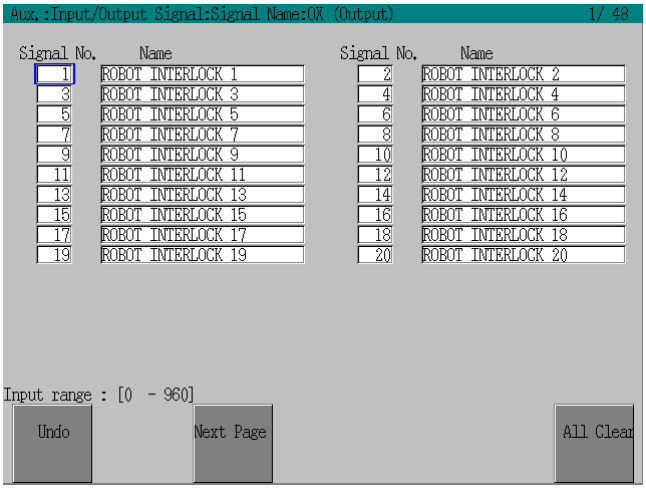
Specifies the type of spot weld gun to be used and sets gun characteristics if using retractive spec. gun, X-ret or C-ret. For other gun numbers, press <Next Page>.

6.6. Input/Output Signal: Signal name



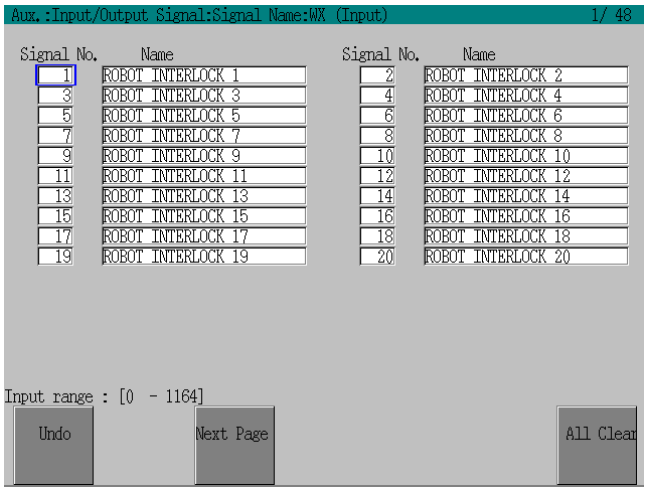
See 18 in 7.0 Service Functions.

6.6.1. Input/Output signal: Signal name: OX (Output)



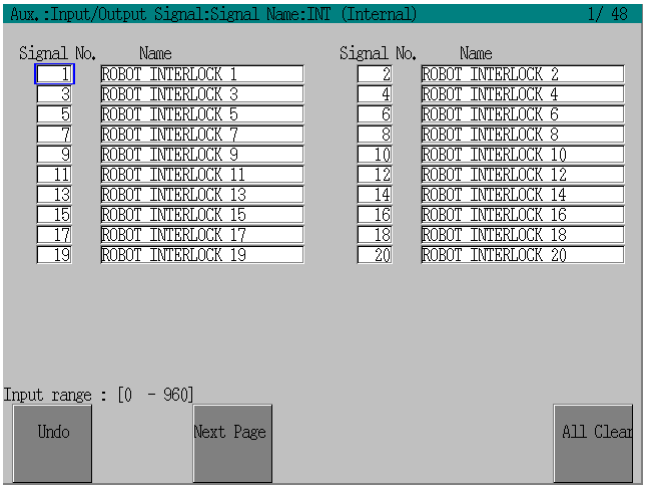
See 18.1 in 7.0 Service Functions.
For other signal numbers, press <Next Page>.

6.6.2. Input/ Output signal: Signal name: WX (Input)



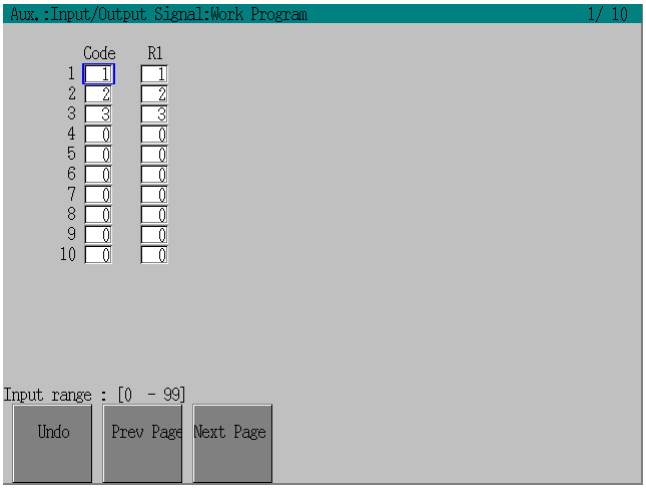
See 18.2 in 7.0 Service Functions.
For other signal numbers, press <Next Page>.

6.6.3 Input/ Output signal: Signal name: INT (Internal)



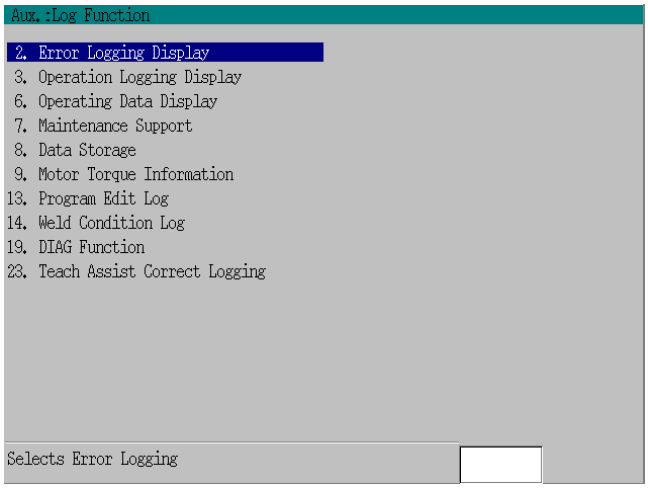
See 18.3 in 7.0 Service Functions.
For other signal numbers, press <Next Page>.

6.17. Input/Output signal: Workpiece program

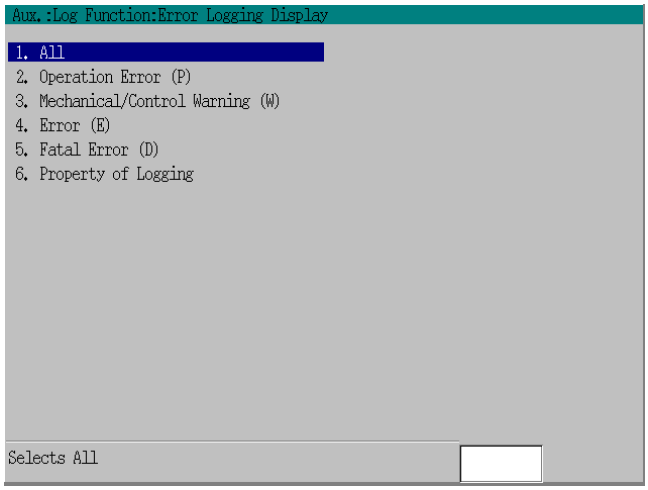


Sets a program number to be called when a specified RPS ON signal and RPS code are input. Setting range: RPS code number 0-99, and program number 0-999. Code indicates RPS code number. R1 indicate Robot Numbers 1, and the programs to be called are input in the columns below R1.

7. Monitor

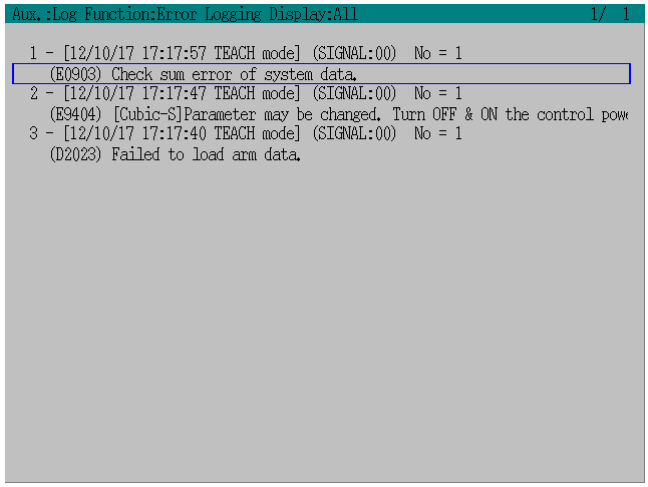


7.2. Monitor: Error Logging Display



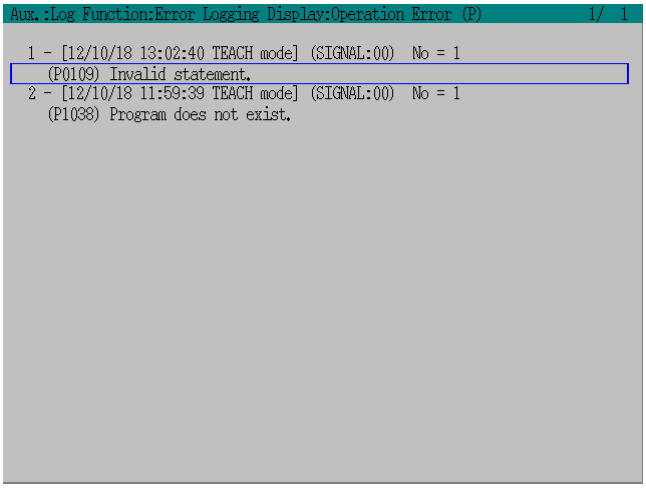
Displays the error history with the most recent entry listed first, categorized in error types P, W, E and D. Error log entries include the data and time of occurrence, error code and message. Selecting [1.All] displays all errors logged thus far regardless of type.

7.2.1. Monitor: Error Logging Display: All



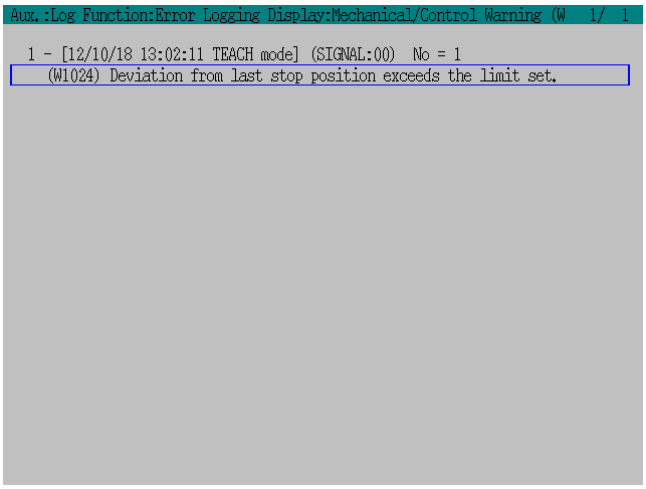
Displays all of the log items.

7.2.2. Monitor: Error Logging Display: Operation Error (P)



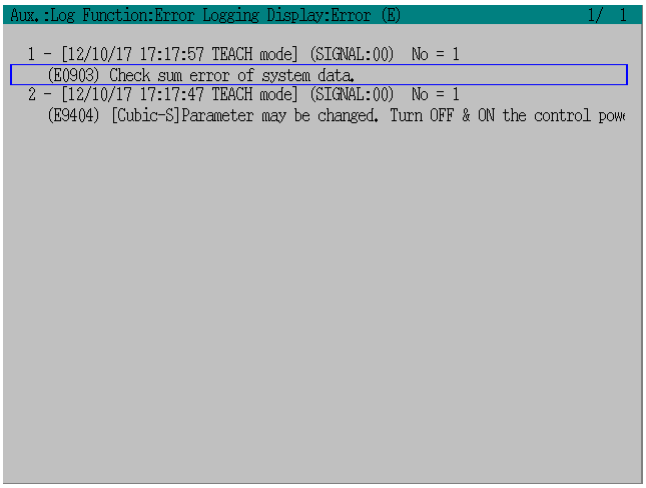
Displays a history of the operation errors. To display this log, select [Enable] for Logging operation errors and warnings in 7.2.6.

7.2.3. Monitor: Error Logging Display: Mechanical/Control Warning (W)



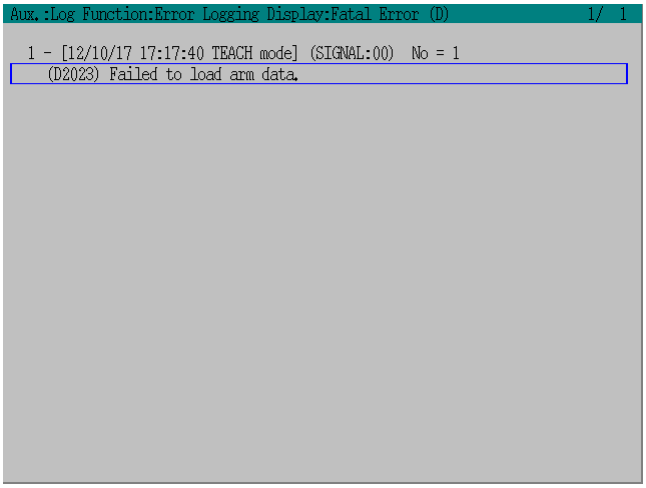
Displays a history of warnings output by the controller. To display this log, select [Enable] for logging operation errors and warnings in 7.2.6.

7.2.4. Monitor: Error Logging Display: Error (E)



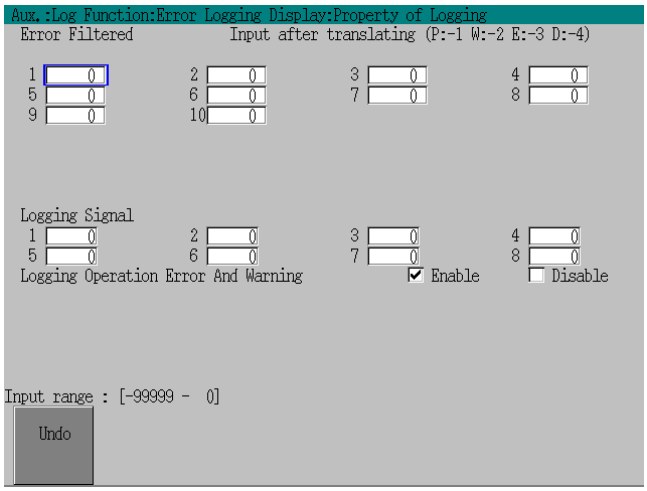
Displays the error log contents.

7.2.5. Monitor: Error Logging Display: Fatal Error (D)



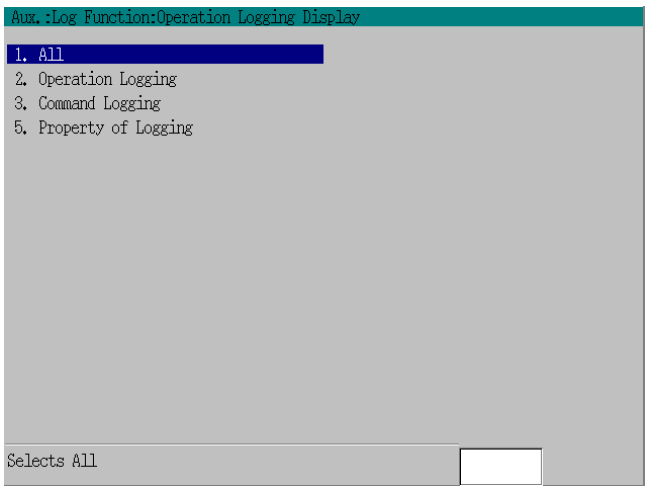
Displays a history of fatal errors (D) output by the controller.

7.2.6. Monitor: Error Logging Display: Property of Logging



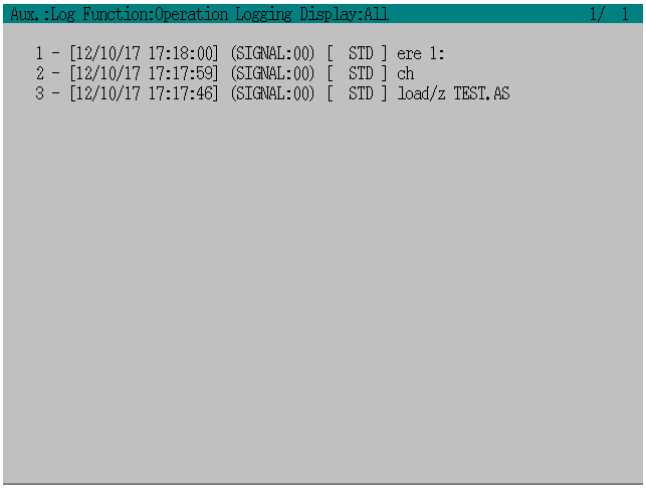
Sets how the error log is displayed. [Error Filtered] can set specific error codes not to be displayed in error log.

7.3. Monitor: Operation Logging Display



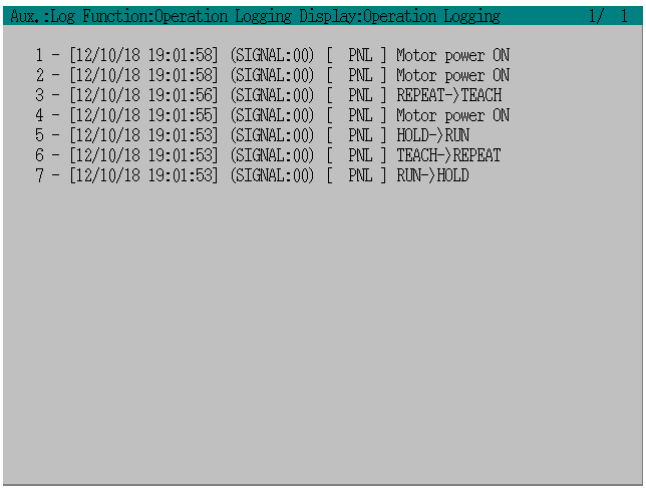
Select which type of log to display among 4 types of logs.

7.3.1. Monitor: Operation Logging Display: All



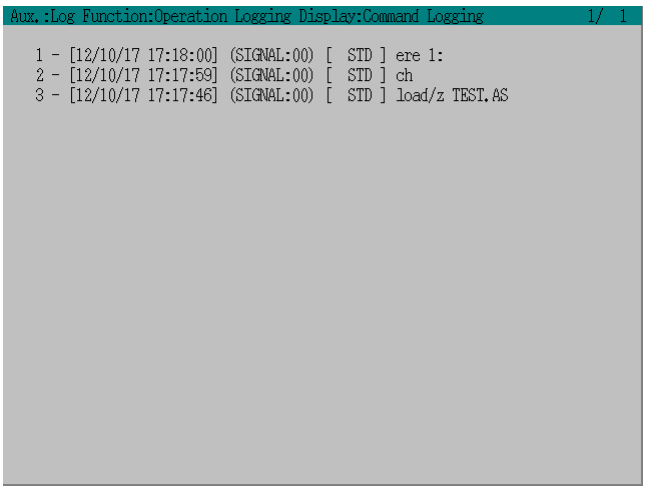
Displays all operations stored in the log. This is an unfiltered display of items recorded in the operation log.

7.3.2. Monitor: Operation Logging Display: Operation Logging



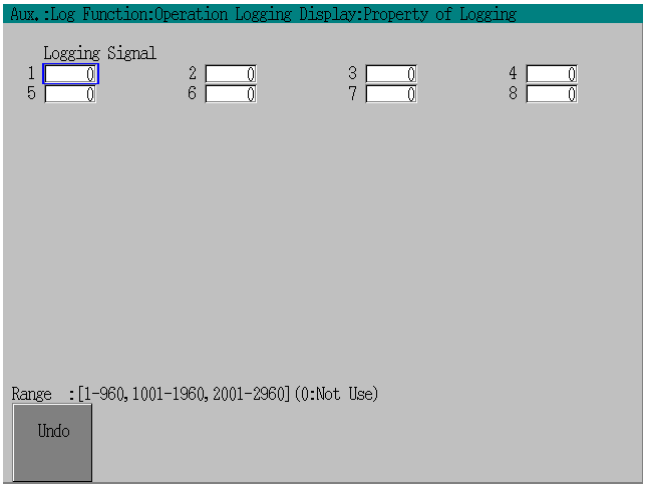
Displays only operations, commands and signals are not displayed.

7.3.3. Monitor: Operation Logging Display: Command Logging



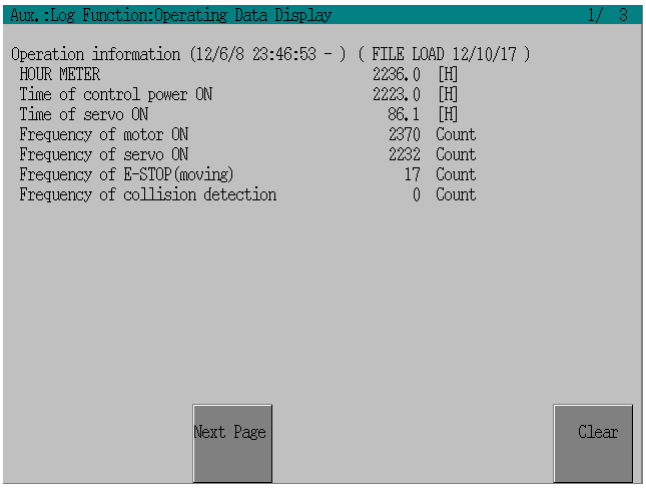
Displays only commands stored in the operation log.

7.3.5. Monitor: Operation Logging Display: Property of Logging

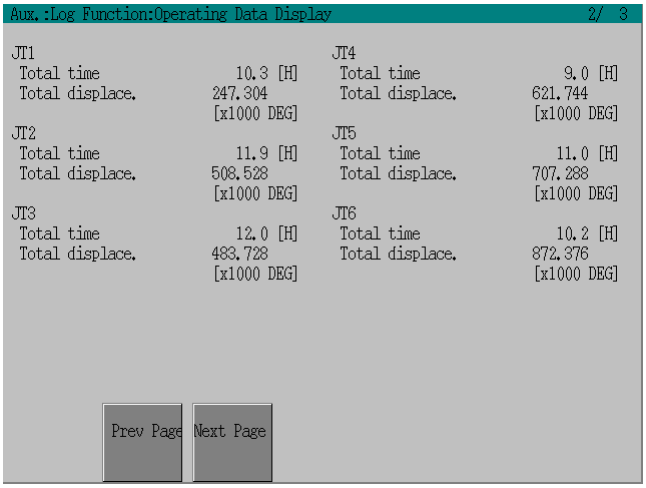


Specifies signal numbers whose signal condition is to be displayed in the operation log.

7.6. Monitor: Operating Data Display

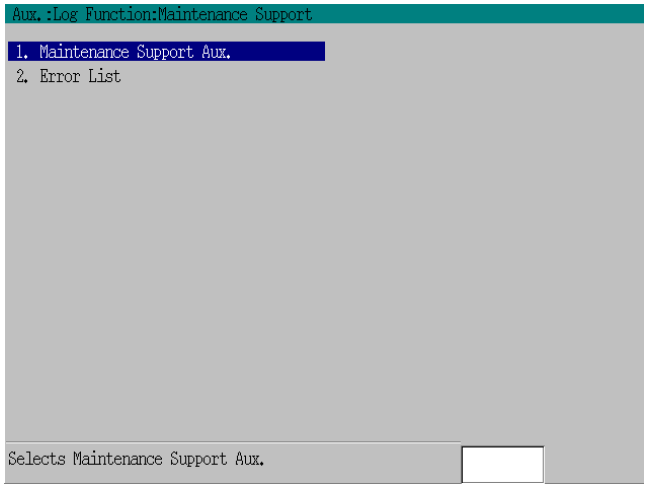


Displays robot operation information: hour meter (motor power ON time), time of controller power ON and servo ON, and the number of times motor power, servoing and E-Stop were engaged.



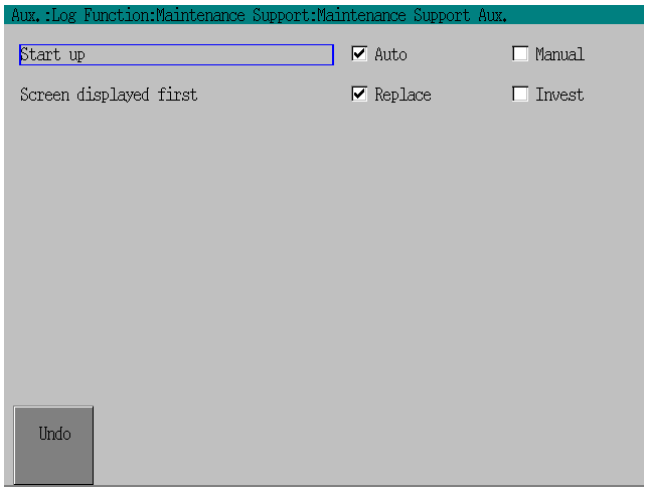
Displays the total accumulated operation time and displacement for each axis. Pressing <Next Page> displays the operation times and displacements for axes after JT6.

7.7. Monitor: Maintenance Support



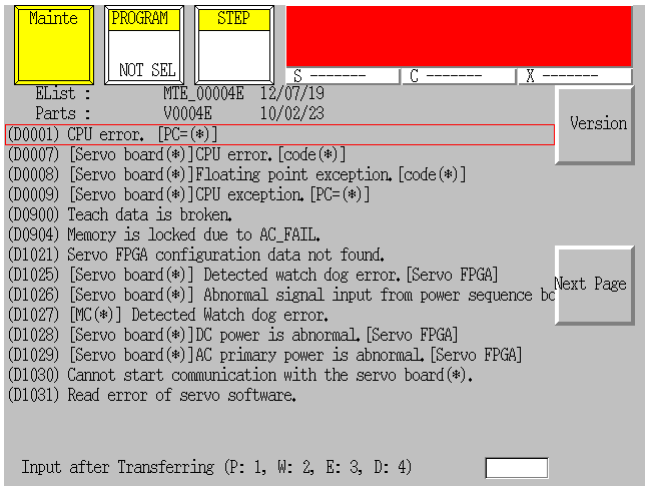
Select [1. Maintenance Support aux.] to set the method for starting up the maintenance support function, and [2. Error List] to display a listing of errors that are recognized by that function.

7.7.1. Monitor: Maintenance Support: Maintenance Support Aux.



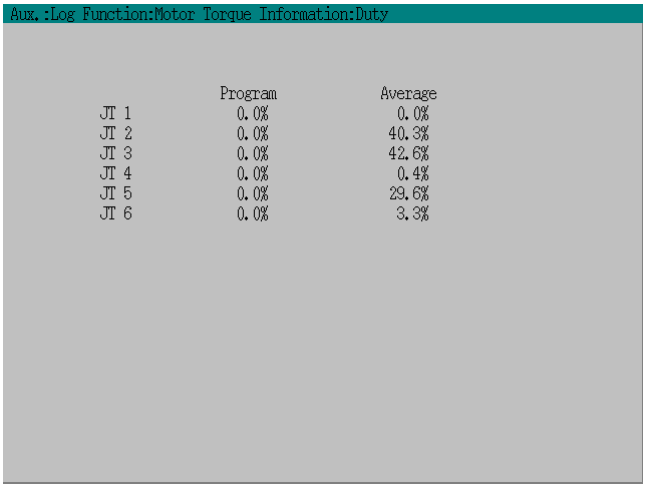
Select the desired display method(s) for the maintenance support screen.
The settings shown here specify maintenance support to display automatically at time of error, and to display the replacement method screen first as the default when error occurs.

7.7.2. Monitor: Maintenance Support: Error List



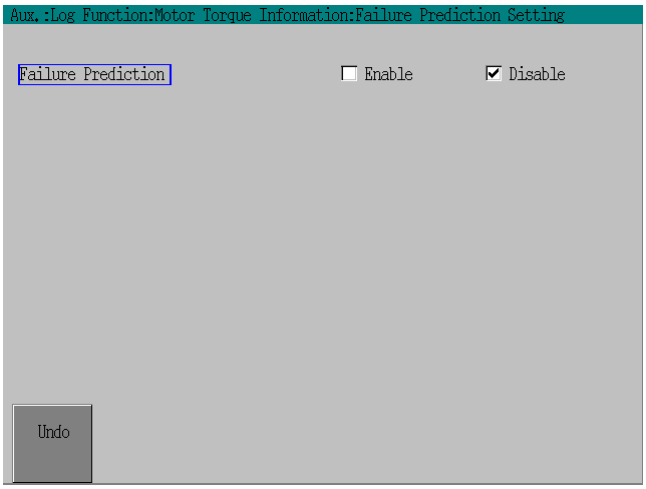
See 21.1 in 7.0 Service Functions.

7.9.2. Monitor: Motor Torque Information (R124): Duty

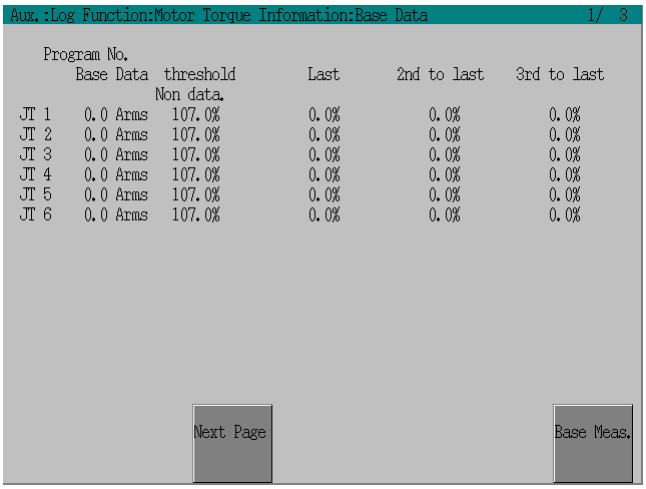


[Program] displays percentage of peak motor current to rated motor current for each axis calculated the last time the monitoring program was executed. [Average] displays percentage of the average motor current to the rated motor current calculated during the last operation that was monitored, the time period for monitoring/reading current values in an operation is set in 7.9.7.

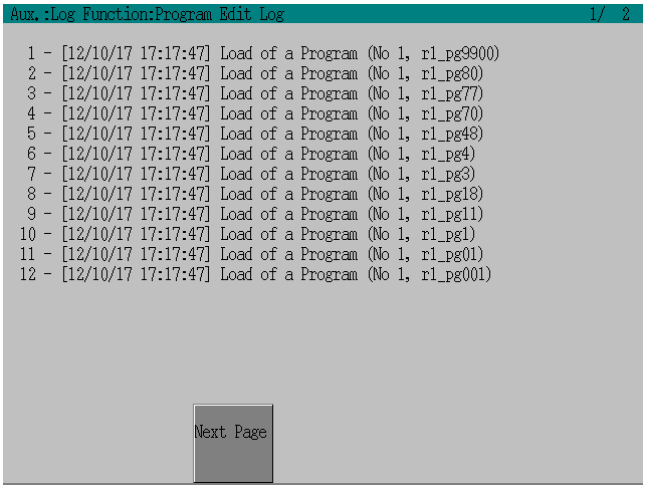
7.9.3. Monitor: Motor Torque Information (R124): Failure prediction axis setting



Warns of reducer failure by continuous monitoring of the load applied to drive system. As reducer approaches failure load on arm increases. Axis load is monitored via I2 calculation (current rms), and warning outputs if load exceeds set threshold. Set [Enable] to start monitoring, and then specify axes to be monitored in 7.9.5.

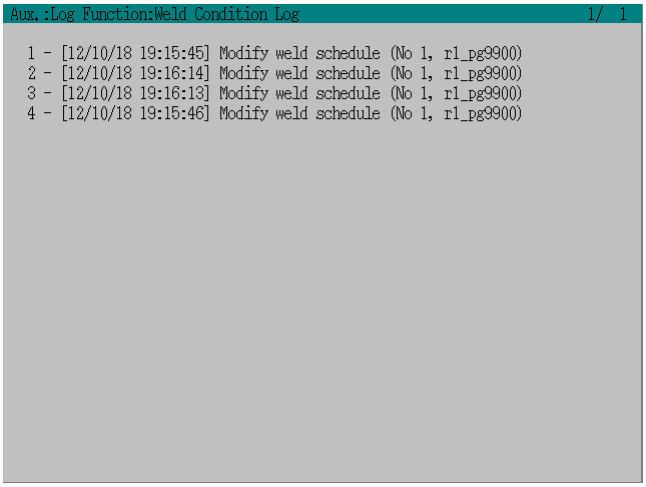


7.13. Monitor: Program Edit Logging



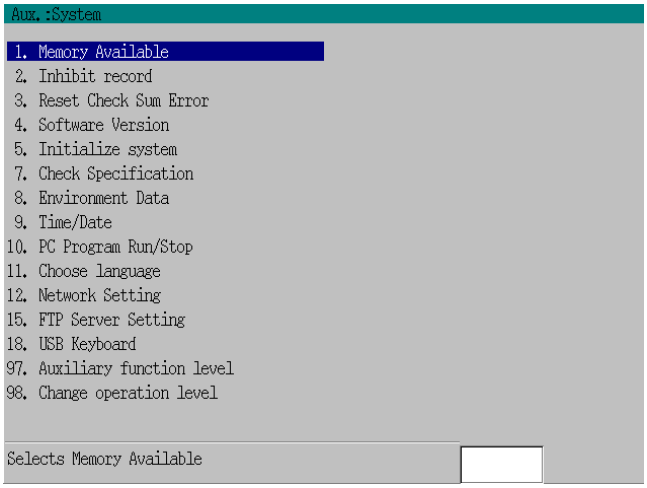
Displays the program edit log of each robot.

7.14. Monitor: Weld Condition Log

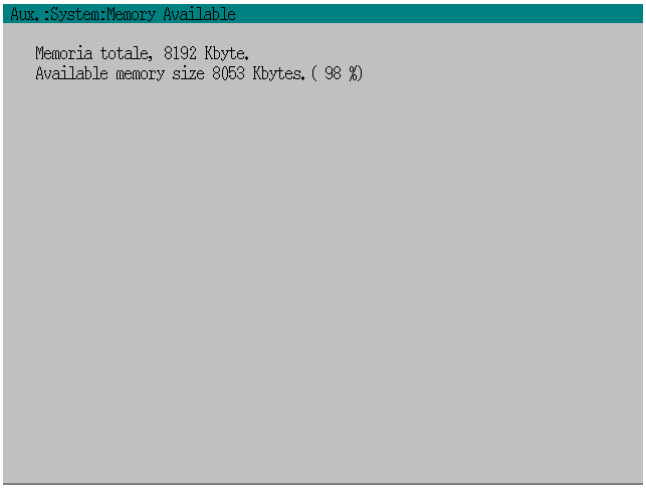


Displays a log of the changes/edits made to the spot weld conditions.

8. System

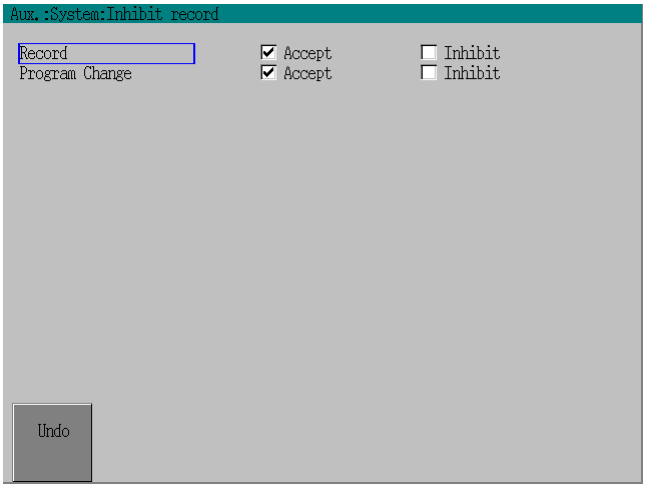


8.1. System: Memory Available



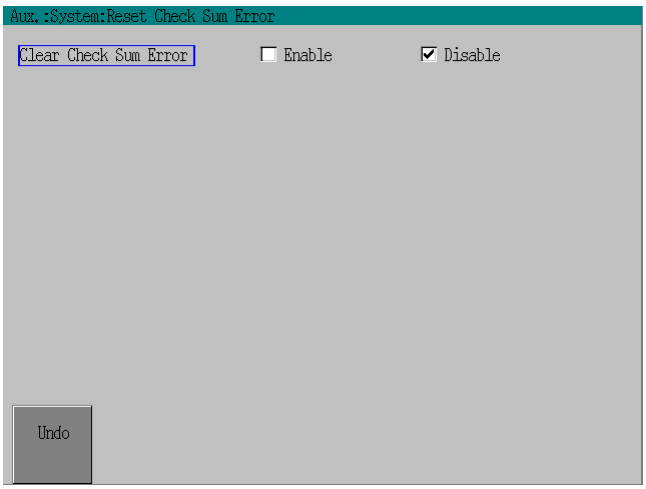
See 8.1 in 7.0 Service Functions.

8.2. System: Inhibit record



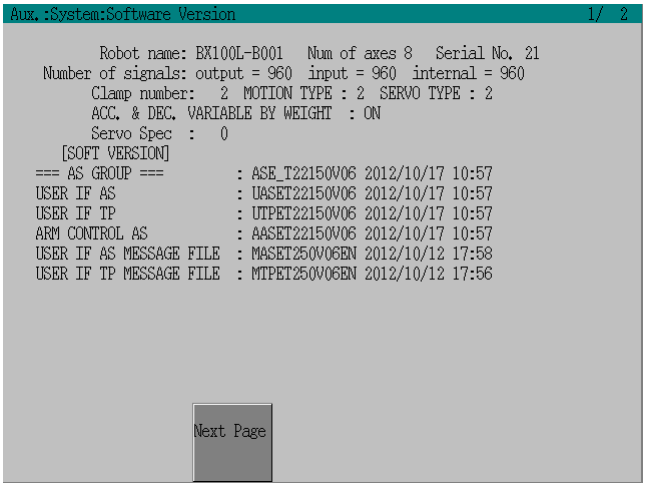
See 1.1 in 7.0 Service Functions.

8.3. System: Reset Check Sum Error



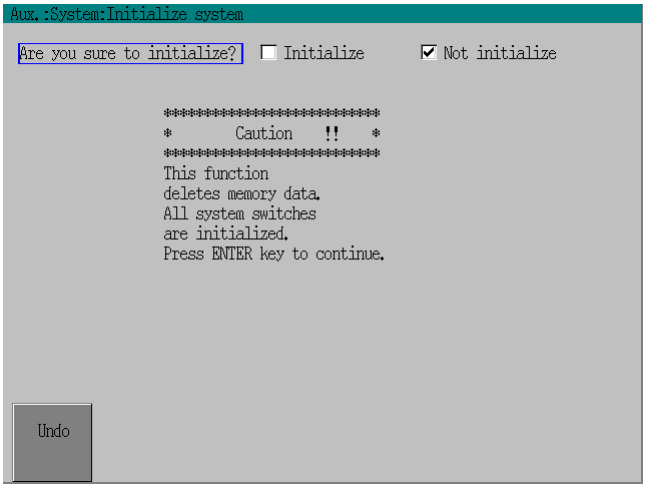
See 13.1 in 7.0 Service Functions.

8.4. System: Software Version



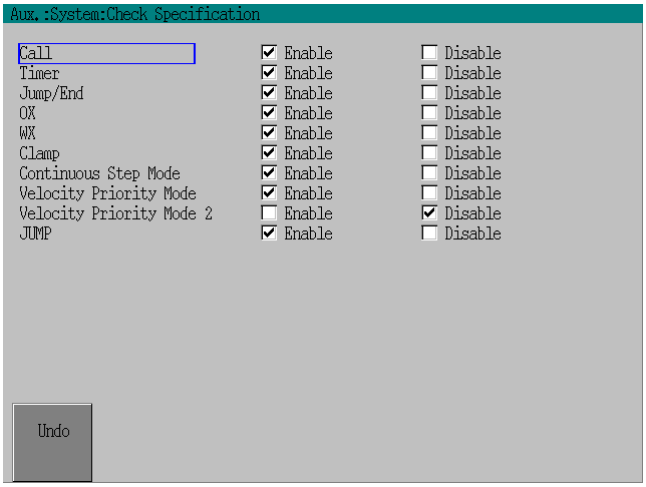
See 8.2 in 7.0 Service Functions.

8.5. System: Initialize system



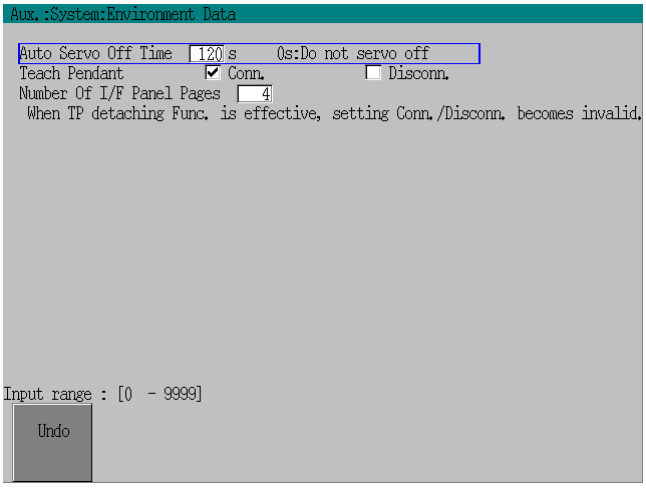
See 11 in 8.0 Constant Functions.

8.7. System: Check Specification



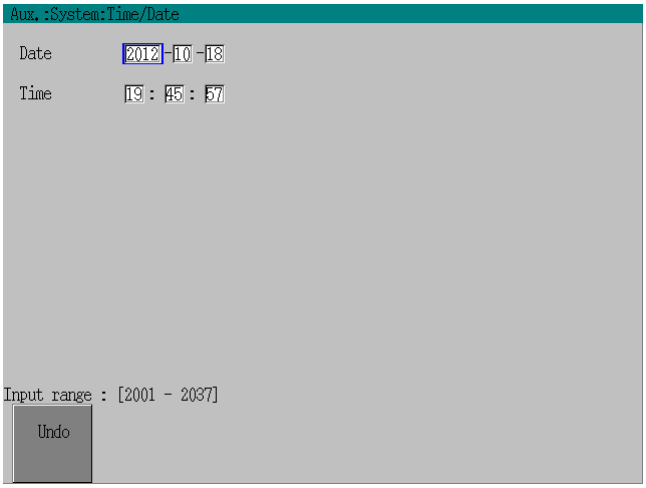
See 1.4 in 8.0 Constant Functions.

8.8. System: Environment Data



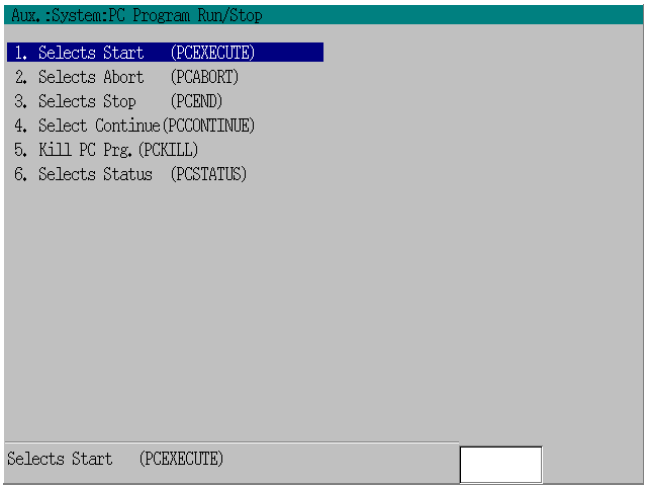
Sets the timing for turning OFF the servoing when robot stops. To operate robot automatically without a teach pendant connected, select [Disconn.] for [Teach Pendant] and execute the required operations. Also, the number of pages for the I/F panel can be set here.

8.9. System: Time/Date



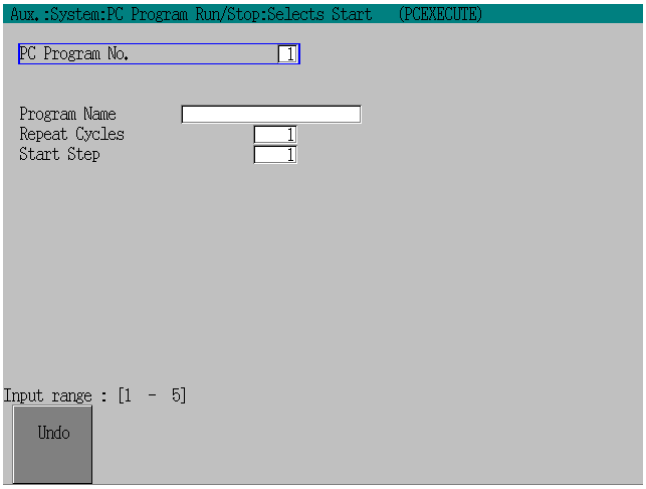
See 15 in 8.0 Constant Functions.

8.10. System: PC Program Run/Stop



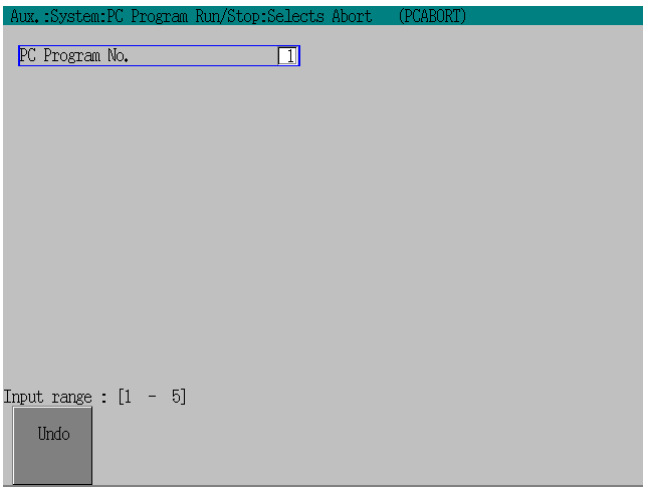
See 14 in 7.0 Service Functions.

8.10.1. System: PC Program Run/stop: Select Start (PCEXECUTE)



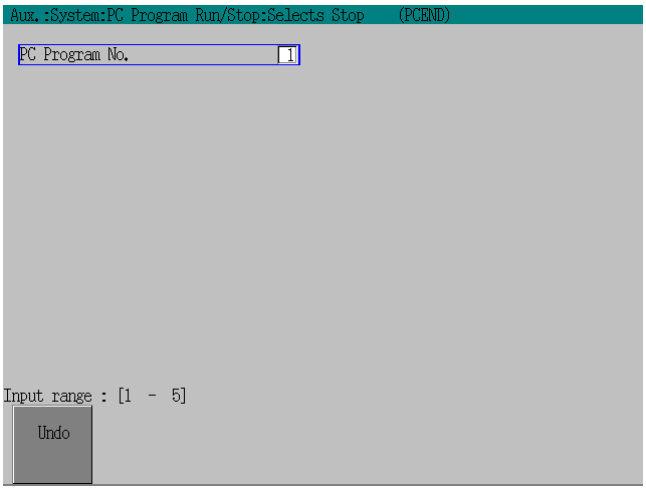
See 14.1 in 7.0 Service Functions.

8.10.2. System: PC Program Run/Stop: Select Abort (PCABORT)



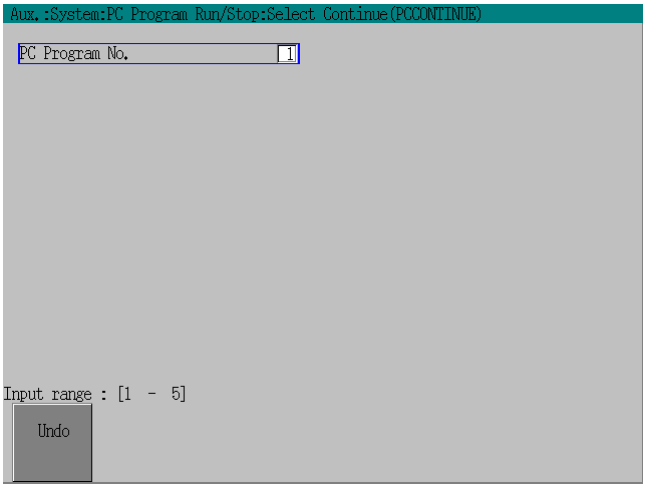
See 14.2 in 7.0 Service Functions.

8.10.3. System: PC Program Run/Stop: Select Stop (PCEND)



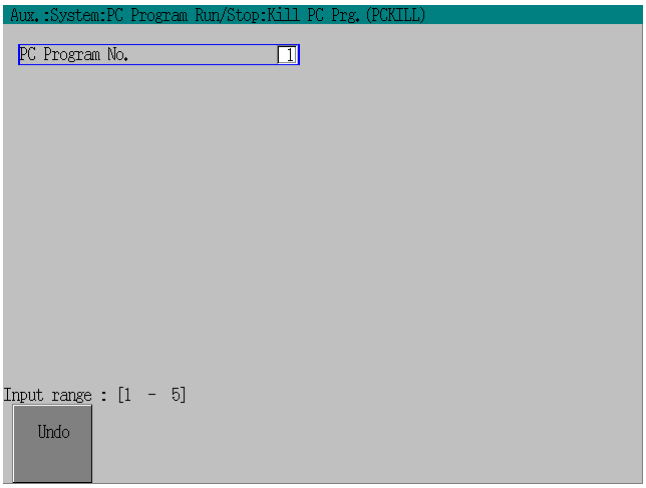
See 14.3 in 7.0 Service Functions.

8.10.4. System: PC Program Run/Stop: Select Continue (PCCONTINUE)



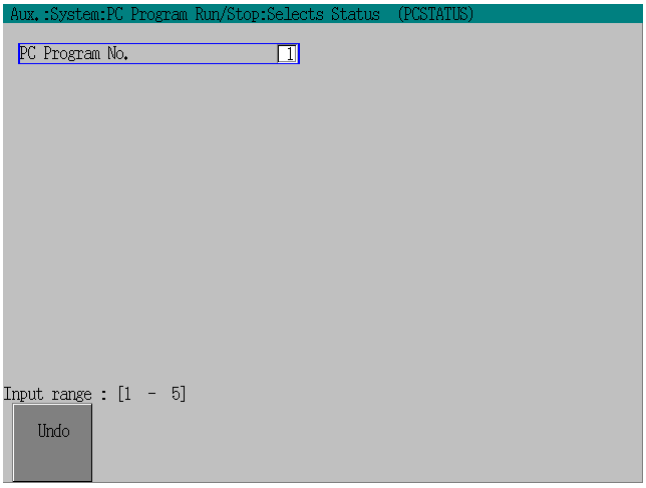
See 14.4 in 7.0 Service Functions.

8.10.5. System: PC Program Run/Stop: Kill PC prg. (PCKILL)

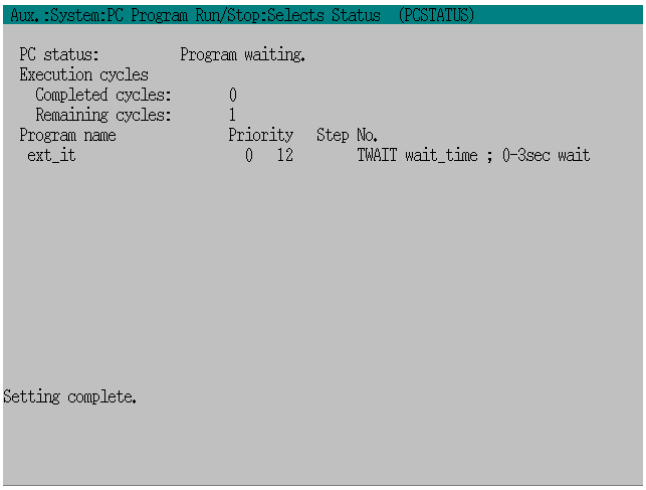


See 14.5 in 7.0 Service Functions.

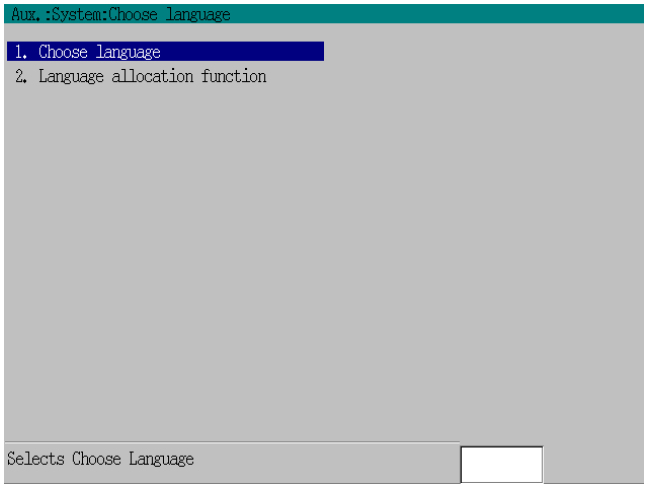
8.10.6. System: PC Program Run/Stop: Select Status (PCSTATUS)



See 14.6 in 7.0 Service Functions.

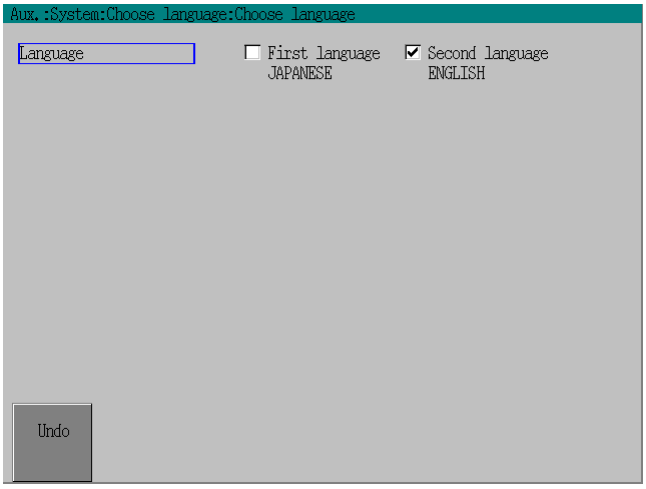


8.11. System: Choose language



Sets the default language displayed on teach pendant. Languages that can be selected differ according to the specifications.

8.11.1 System: Choose language



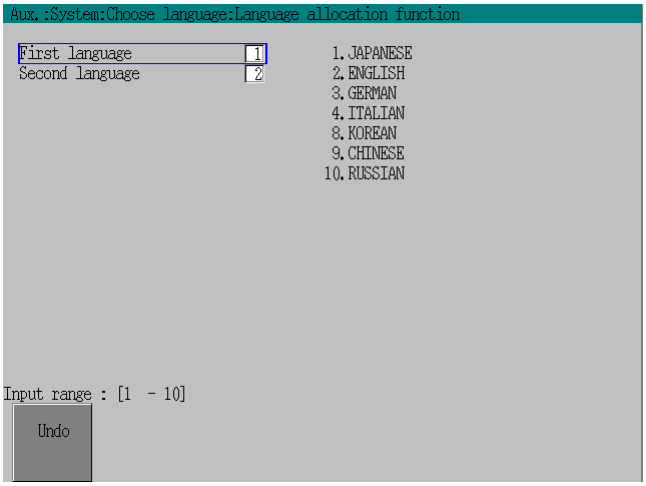
Select the language to use in the displays by pressing Enable + ←/→. If the selection is correct, press ↵. Selection is stored when “Setting complete.” is displayed.

The selected languages can be allocated to first and second language in Aux. 081102 Language Allocation Function.

[NOTE]

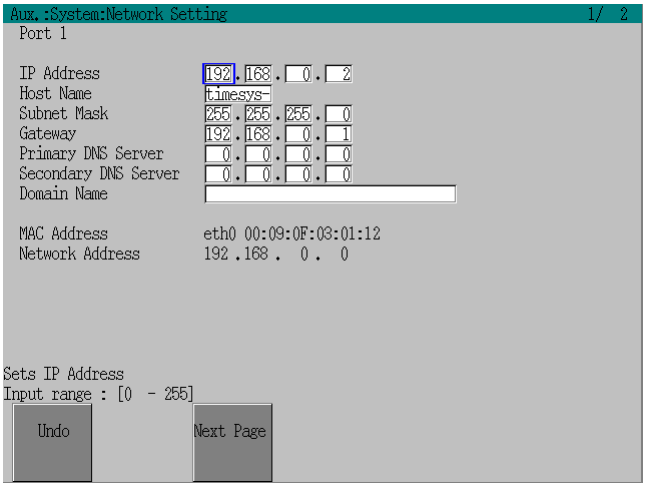
Pressing ↵ after changing the display language returns the screen displayed prior language selection. This is because the screen display is refreshed and all the displays are re-displayed. Some distortions in message display such as error display may be seen, but after the display is refreshed, the display language will change to the selected language.

8.11.2 System: Language allocation function



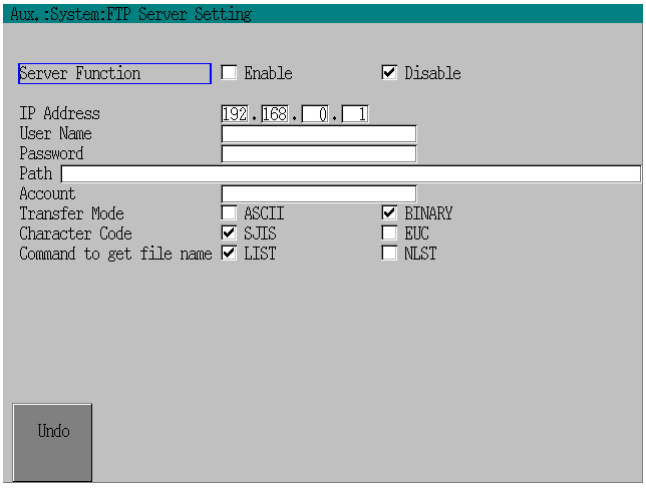
Input the number for the language to allocate to first and second language. If the selection is correct, press ↵. Selection is stored when “Setting complete.” is displayed.

8.12. System: Network Setting



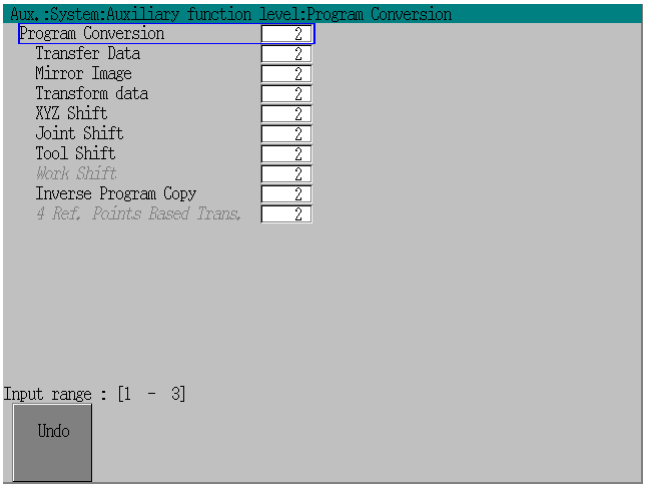
Makes necessary settings to treat robot as node on network.

8.15. System: FTP Server Setting



Makes necessary settings to connect robot controller with an external computer system, using the FTP client function via Ethernet connection.

8.97. System: Select auxiliary function

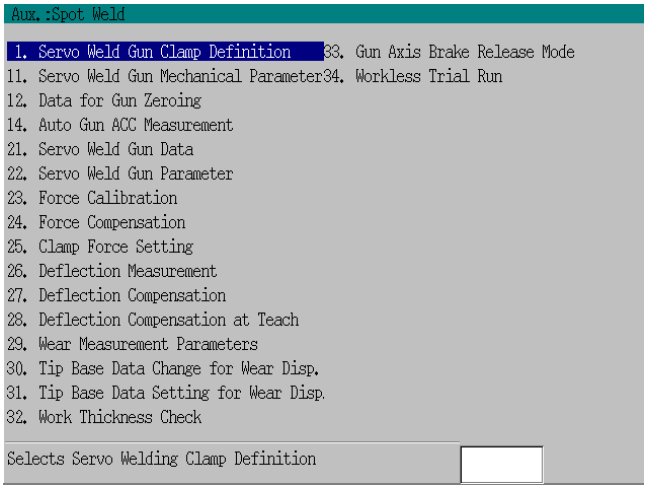


For each auxiliary function, it is possible to set an operation level and restrict access to the function. Levels 1 to 3 are available and setting higher level indicates more skill is required for the function. Setting level 3 prevents display of that function. To define the level, specify 1, 2 or 3 for each function shown here.

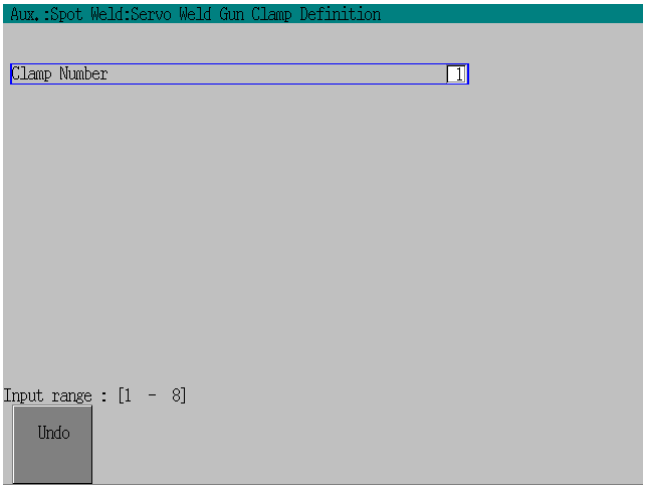
8.98. System: Change operation level

Displays or hides auxiliary functions. Specifying 2 for [Operation Level] enables execution of the level 1 and 2 auxiliary functions set in 8.97. Specifying 1 for [Operation Level] only enables execution of auxiliary functions set to level 1.

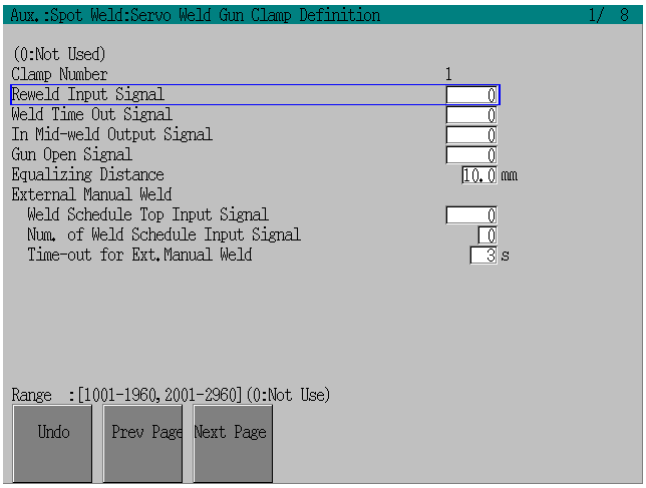
10. Spot Weld



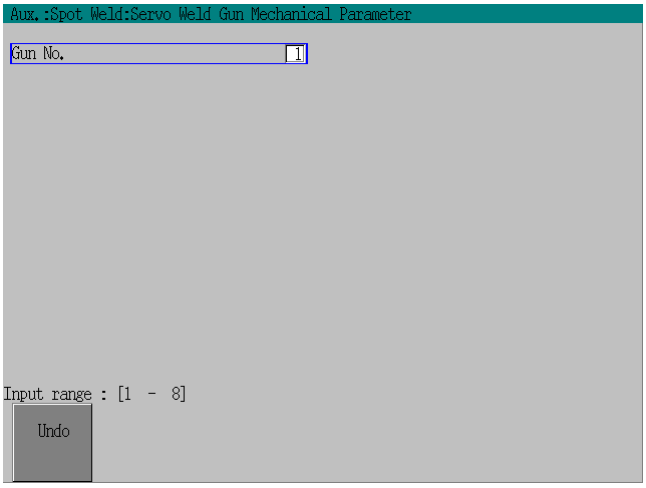
10.1. Spot Weld: Servo Weld Gun Clamp Definition



Sets the external input/output signals for each clamp number.

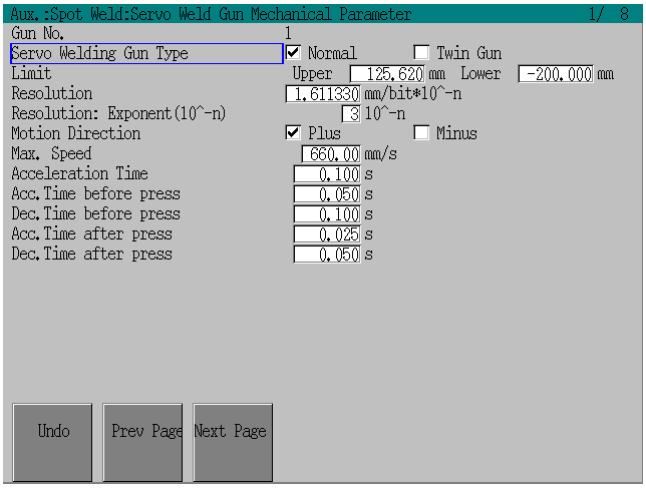


10.11. Spot Weld: Servo Weld Gun Mechanical Parameter

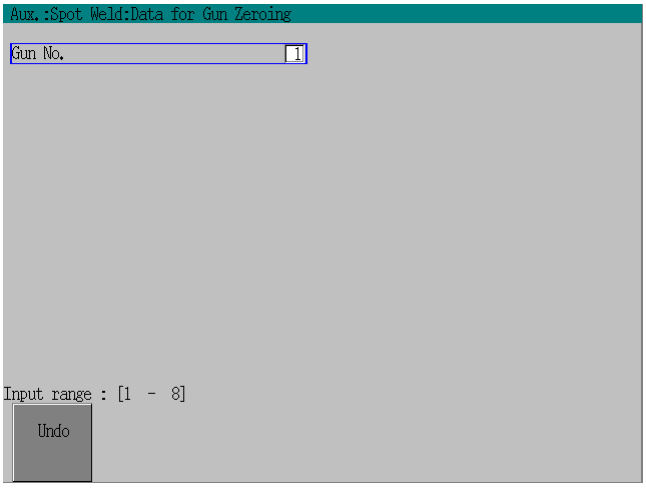


Sets mechanical parameters of servo weld gun for each gun number.

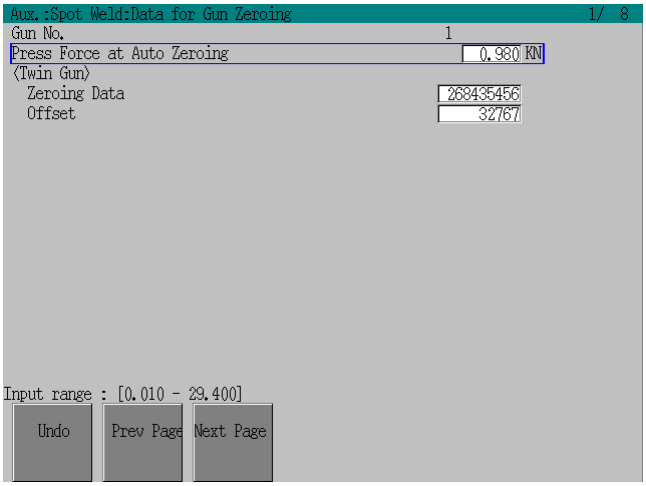
(10.11. Spot Weld: Servo Weld Gun Mechanical Parameter <page2>)



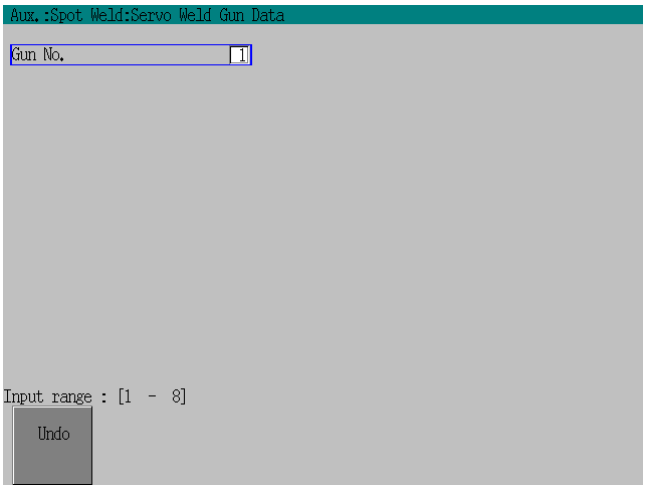
10.12. Spot Weld: Data for Gun Zeroing



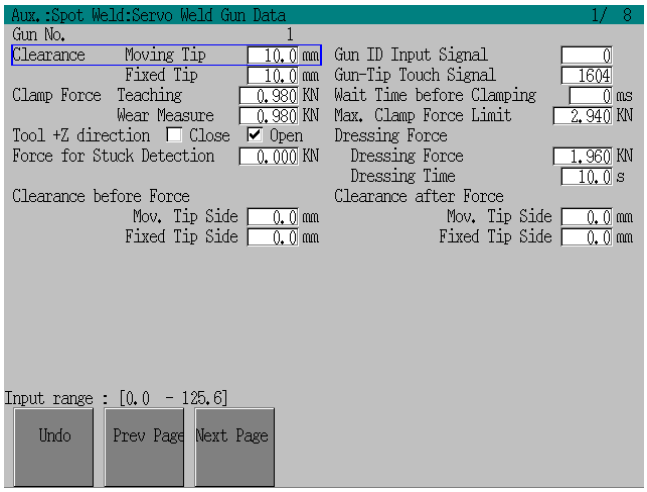
Set the force used when gun axis is zeroed by calibration motion, and the zeroing data when a twin gun is used.



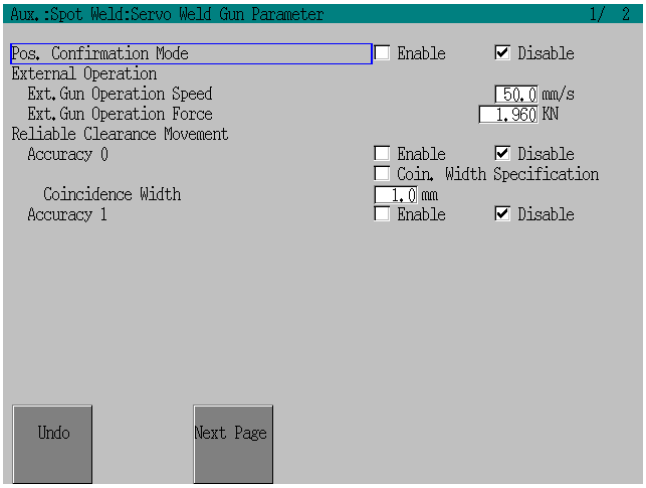
10.21. Spot Weld: Servo Weld Gun



Sets gun operating condition parameters for each gun number.

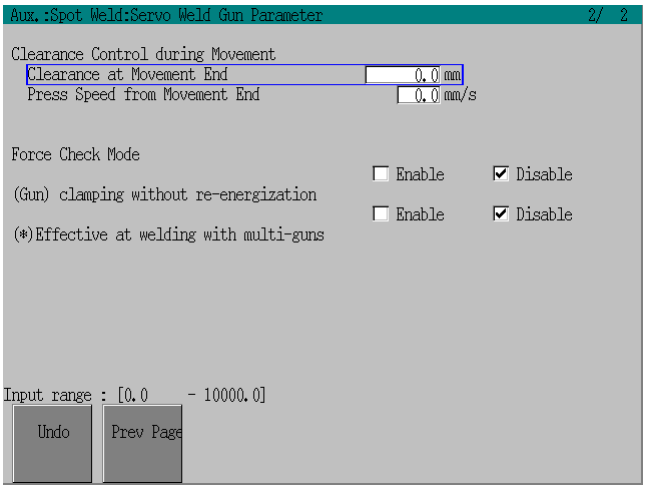


10.22. Spot Weld: Servo Weld Gun Parameter

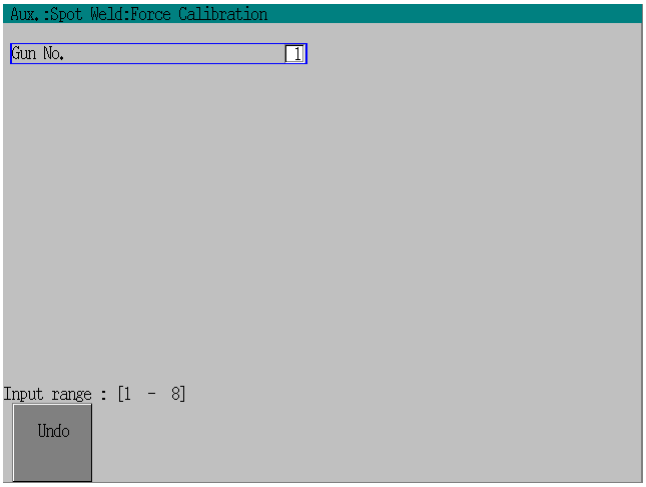


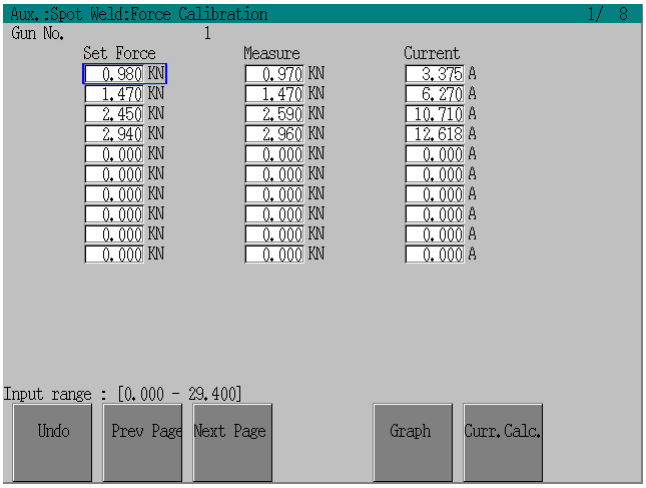
See 17.4 in 7.0 Service Functions.

(10.22. Spot Weld: Servo Weld Gun Parameter <page2>)



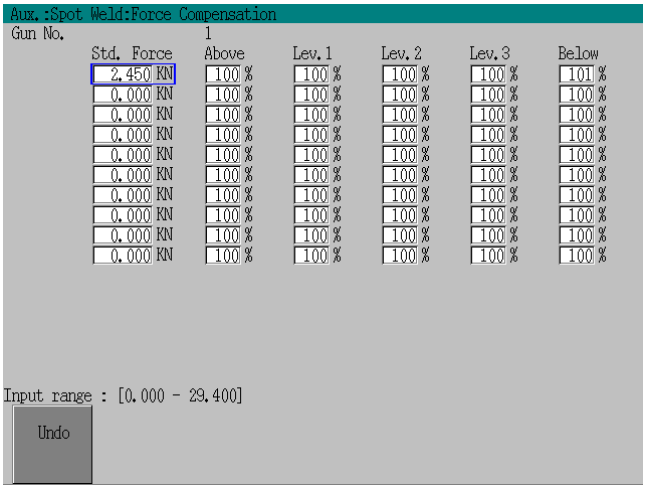
10.23. Spot Weld: Force Calibration





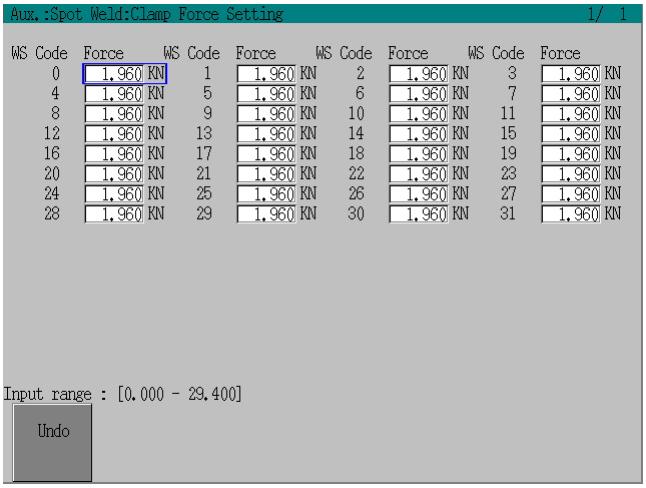
For each tip force setting in [Set Force], input the actual measured tip force value in [Measure]. Then, press <Curr. Calc.> to make the set and actual applied tip force become the same value. Check for abnormalities in the current to tip force relationship by pressing <Graph>, remeasure the tip force and ensure deviation between actual and set tip force values does not exceed permitted limit. If difference is too great, repeat the above mentioned operations until deviation becomes within the permitted limit.

10.24. Spot Weld: Force Compensation



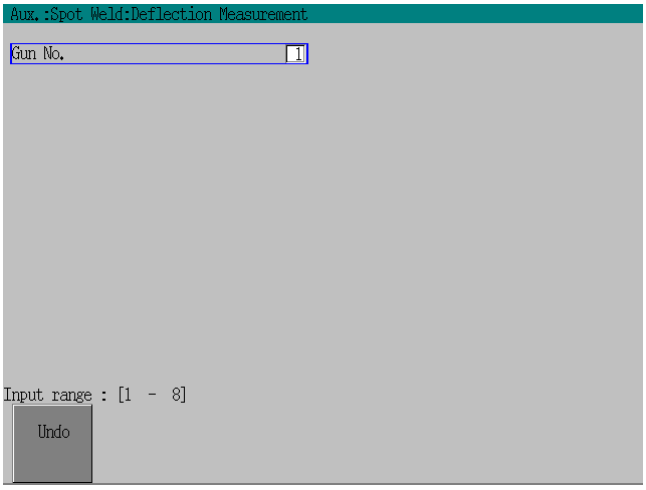
Compensates the effect of operation posture of the gun.

10.25. Spot Weld: Clamp Force Setting



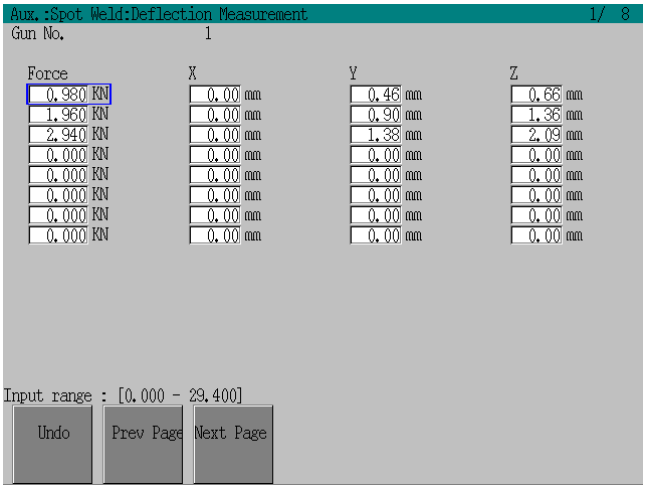
Sets the tip force to the WS code for the specifications where the tip force is set by WS codes.

10.26. Spot Weld: Deflection Measurement

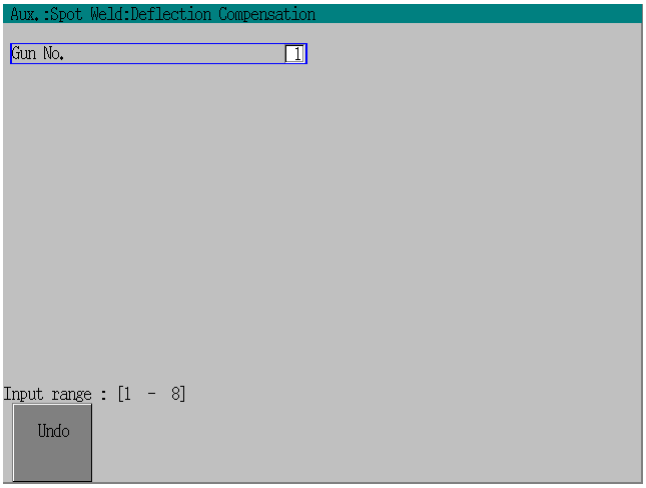


For each gun, measure the deflection at each tip force value in the 3 axes of the tool coordinates, and input the results. When pressurizing, robot compensates for the deflection based on this data.

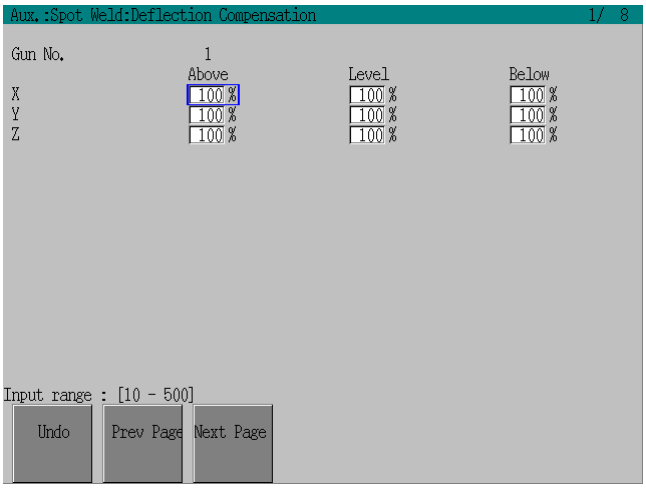
(10.26. Spot Weld: Deflection Measurement <page2>)



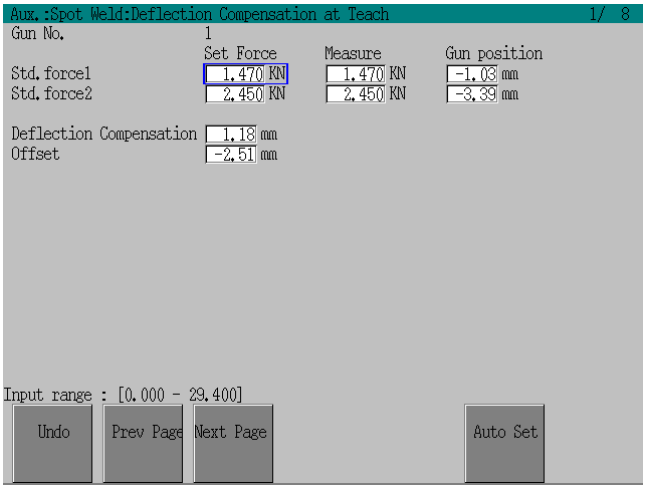
10.27. Spot Weld: Deflection Compensation



Deflection amount along X, Y and Z of the tool coordinates varies per gun posture due to the effect of posture.
To compensate set 100% to the X, Y, Z values of the standard posture used when welding, and for X, Y, Z of the other postures use values provided by the weld gun manufacturer.



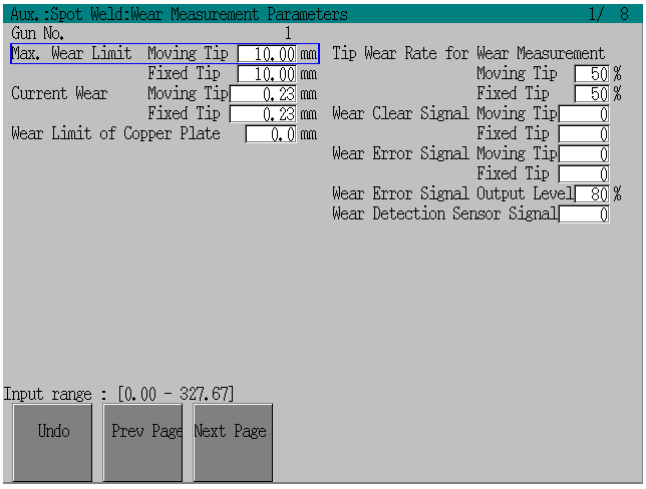
10.28. Spot Weld: Deflection Compensation at Teach



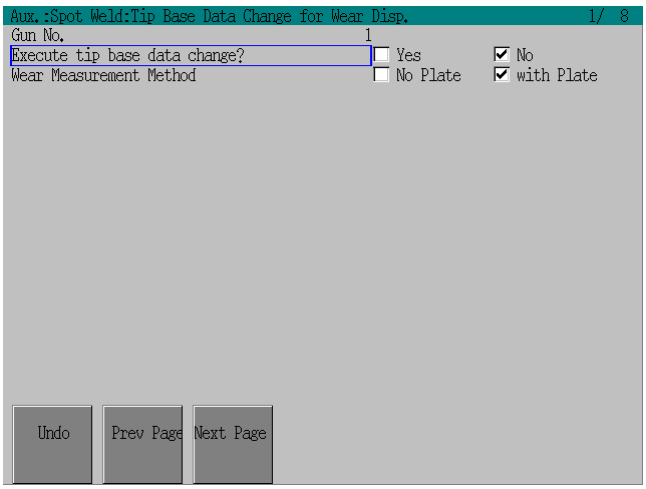
Set the deflection amount per 0.49 kN in the direction of tool Z axis when pressurizing servo weld gun.
Compensates for the deflection of the gun in Teach mode by the distance set here.

10.29. Spot Weld: Wear Measurement Parameters

Sets each of the parameters related to the tip wear.

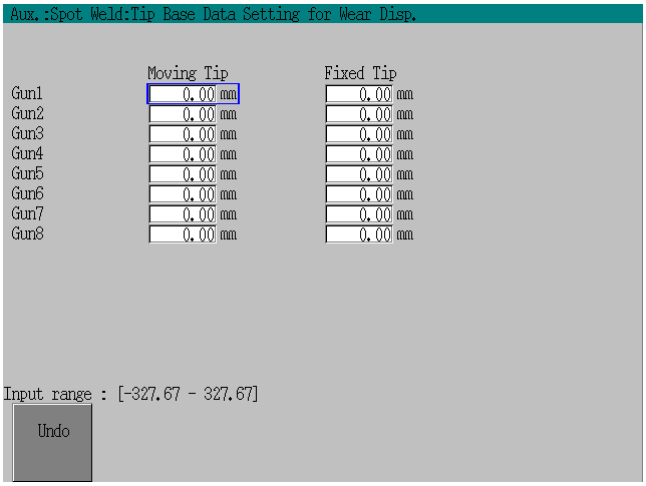


10.30. Spot Weld: Tip Base Data Change for Wear Disp.



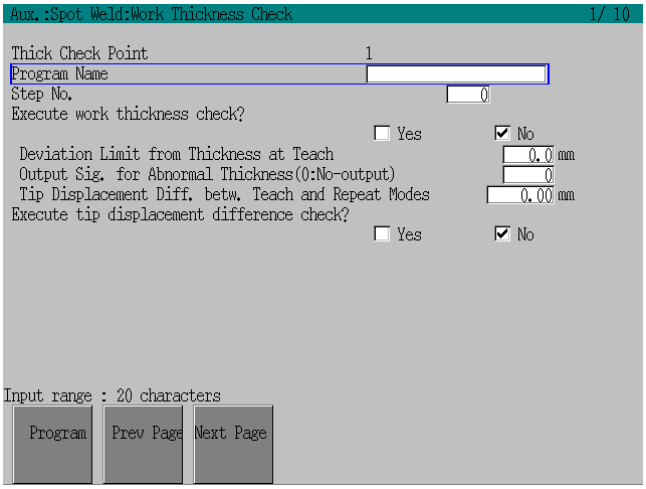
Select [Yes] for [Execute tip base data change?], then the result of the very next tip wear measurement will become the new base (reference) data, used thereafter for displaying current tip wear. And, sets the method for measuring the wear of the tips, no reference plate or with reference plate.

10.31. Spot Weld: Tip Base Data Setting for Wear Disp.



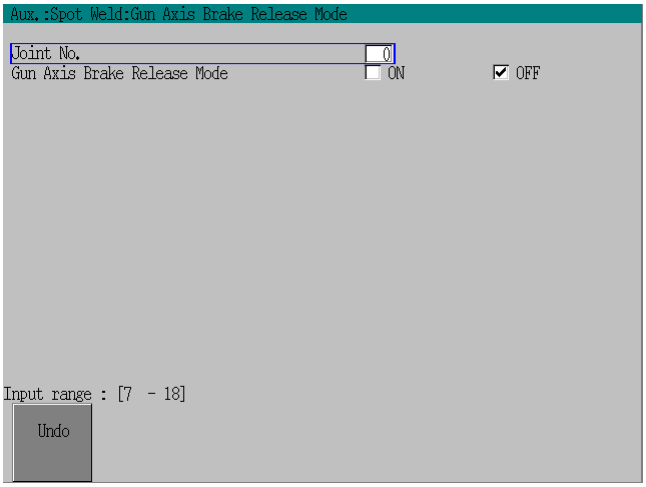
Sets correction value so that the tip wear amount in the current tip wear display becomes 0.

10.32. Spot Weld: Work Thickness Check



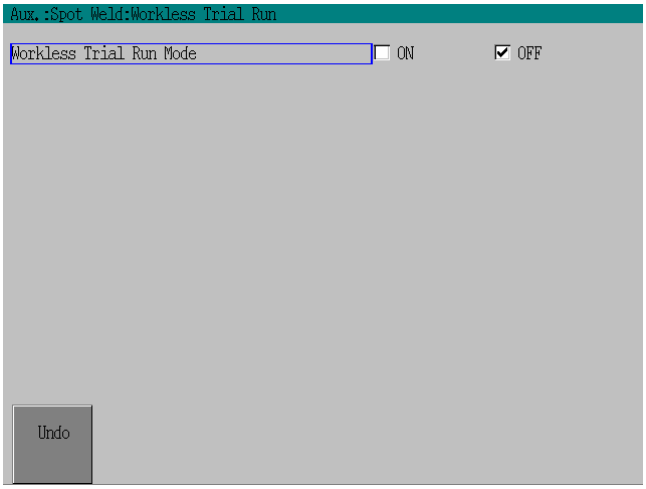
Setting thickness check conditions and selecting [Yes] for [Execute work thickness check?] displays the result in [Tip Displacement Diff. in Teach and Repeat Modes].

10.33. Spot Weld: Gun Axis Brake Release Mode



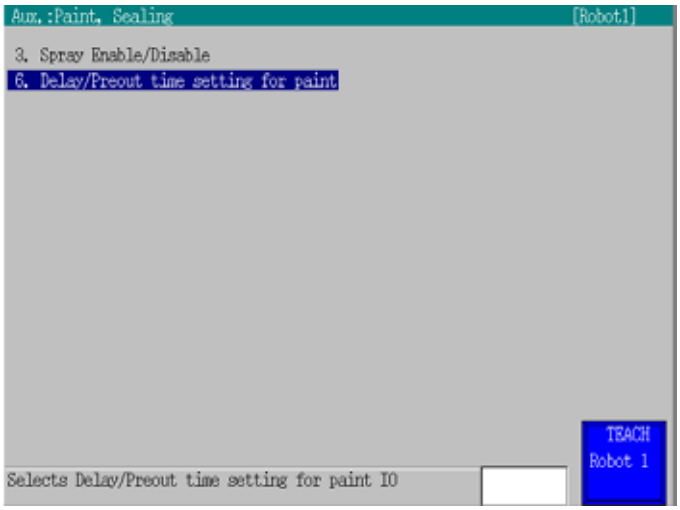
See 17.1 in 7.0 Service Functions.

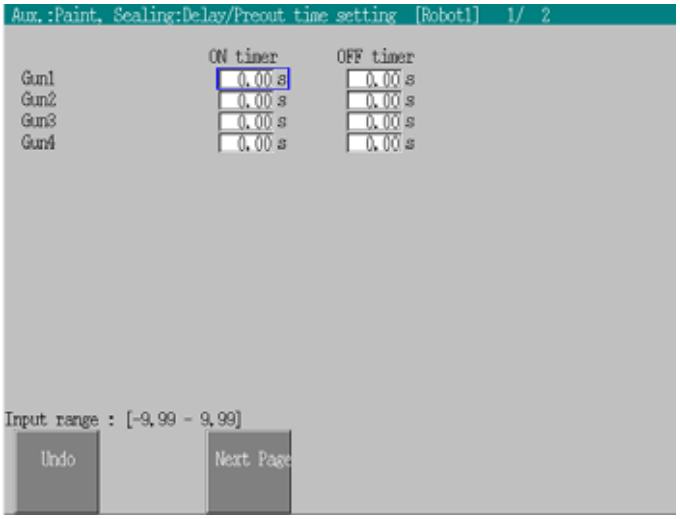
10.34. Spot Weld: Workless Trial Run



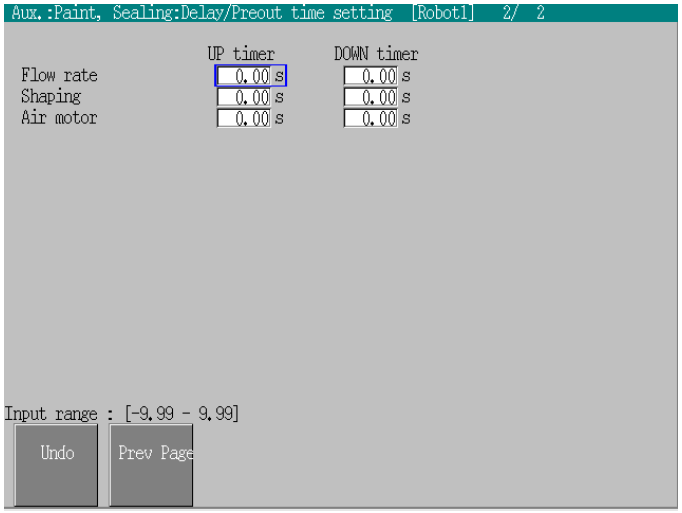
See 17.3 in 7.0 Service Functions.

12.6 Delay/Preout time setting for paint





Delays spray ON/OFF timing of each gun by putting positive values and advances spray ON/OFF timing by putting negative values.

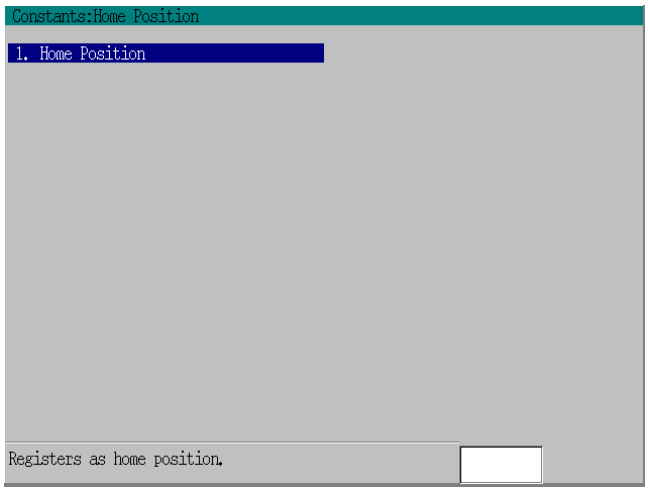


Delays upward/downward change of each paint dedicated signal by putting positive value and advances upward/downward change of paint dedicated signal by putting negative value.

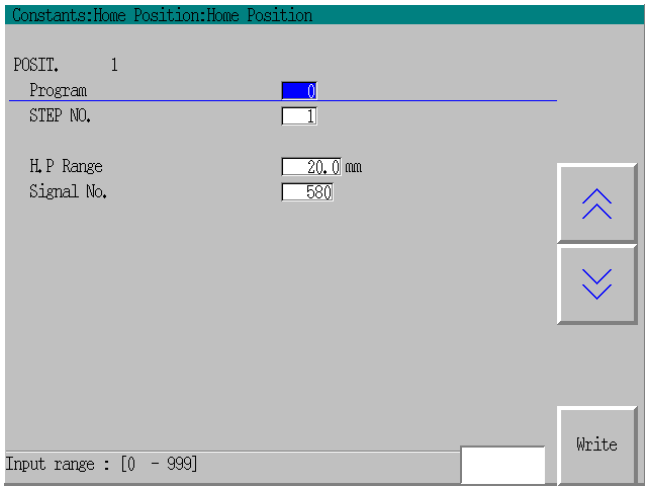
10.0 ROBOT WORKING HOME POSITION

This chapter describes how to specify the robot home position and the signal number that is output to external devices when robot reaches that position. A max. of 12 working home positions can be specified for each robot.

10.1 SETTING OF ROBOT WORKING HOME POSITION



1. Press <Cons.(tants)> and select [8. Home position] to display the left screen. Press [1. Home position]→↵ to display the screen below. Press <TEACH> to select the desired robot when several robot arms are controlled.



2. Input the parameters and output signal number using NUMBER and press ↵ to set the parameters. Press <Complete> to write the set data.

Program (Setting range: 0 - 999), **STEP NO.** (Setting range: 1 - 999)
Specify the program and step whose robot pose is set as the robot working home position. If the robot pose in the specified step is changed, the data set in the screen above (Constants: Home position) is updated with the changed pose data automatically.

H.P (Home Position) Range (Setting range: 0.1 - 9999.9 mm)
Robot has reached the working home position if it is within home position range, a specified distance from the TCP position set as the home position. The distance set in H.P Range is converted into home position range for each axis through internal processing*.

NOTE* The upper and lower limits of each axis within the home position range are calculated assuming only an axis moves the TCP by the [H.P Range] specified in the screen above. (TCP position is set in [Constants: Auxiliary data: Tool dimensions] screen.)

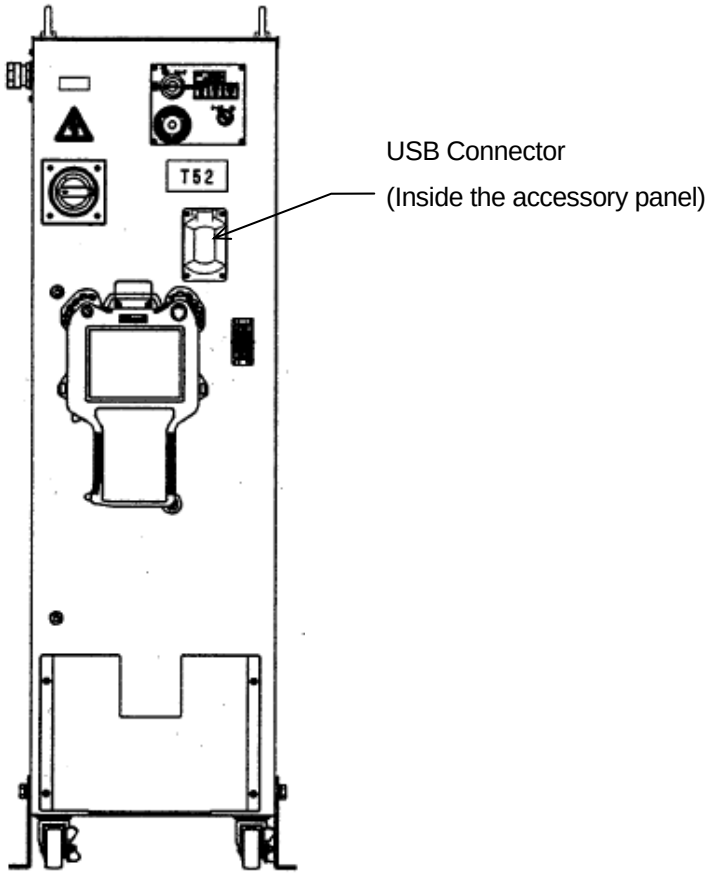
Signal No. (Setting range: 1 - max. signal no.)
Output signal indicating the robot has reached the working home position range. Input 0 if signal is unused. This signal turns ON all axes are within the individual home position ranges calculated for each axis based on the [H.P Range] set in the screen above.

Page Up/Down
Press < ⩓ > (< ⩔ >) to scroll through home position numbers in ascending (descending) order. Twelve pages are available for setting home positions 1-12 for each robot.

Complete
Press <Complete> to write the set data.

11.0 AUTO SAVE

This function backs up data stored in the robot memory to the USB flash memory. Back up can be done periodically according to specified schedule or can be triggered by external signal (dedicated signal). (Hereinafter this function is called Auto Save function). The data to be saved is not verified when executing this function.



Front View

1. Use a properly formatted USB flash memory for this function.
2. Only use USB flash memoryrecommended by Kawasaki.
3. Do not turn OFF controller power while Auto backup function is being executed.
4. Not complying with above may damage data on the PC card.

11.1 STARTING AUTO BACKUP FUNCTION

Auto backup function is executed:

1. According to set schedule.
2. When Auto save execution signal (dedicated signal) is input.

The data is saved under the specified file name with a file extension automatically added according to the data type being saved. The following types of data can be backed up:

All data (.AS)
Robot data (.RB)
Auxiliary data (.AU)
Programs (.PG)
Error logs (.EL)
Interface panel data (.IF)
System data (.SY)

When a new file is saved, any previous file with the same name and extension is saved as a backup file with “B” added before the extension. The next backup file overwrites the previous file.

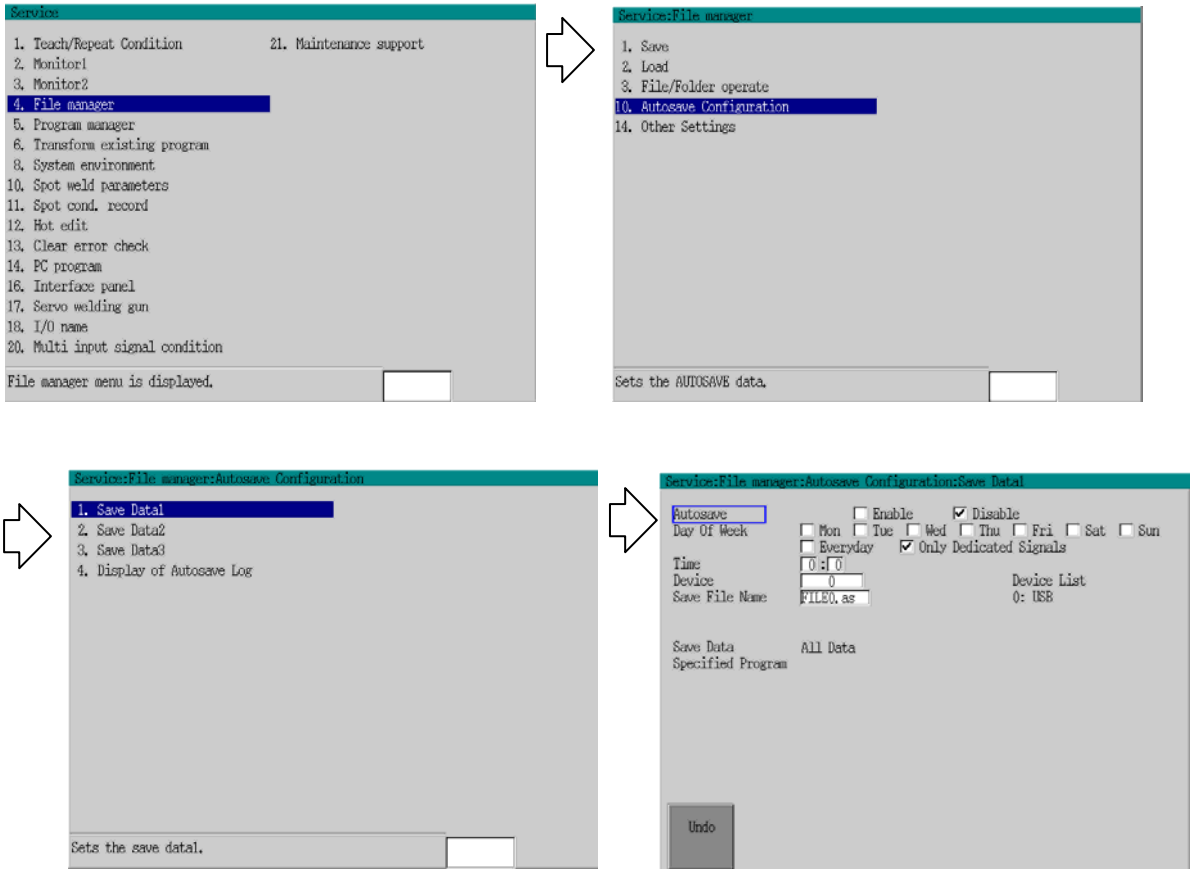
<Example> All Data is saved as AUTOSAVE

AUTOSAVE.AS	currently saved data
AUTOSAVE.BAS	the data previously saved

11.2 SETTING FOR AUTO BACKUP

11.2.1 SAVE DATA

Select [Service] → [4. File manager] → [10. Autosave Configuration] → [1. Save Data1] – [3. Save Data3], then specify the desired settings for autosave configuration. The schedule and the data type to be saved are set here. The autosave log can also be displayed.



Three different Autosave times, Save Data 1 – 3, can be set.

Autosave Enable

When [Enable] is selected, controller saves data automatically. If [Disable] is selected, auto is not executed. (Even if schedule data is set or the Autosave execution signal is input.)

Day Of Week

Sets the day data is saved. When [Only Dedicated Signals] is selected, controller executes at the signal input and [Day Of Week] and [Time] settings are ignored.

Time

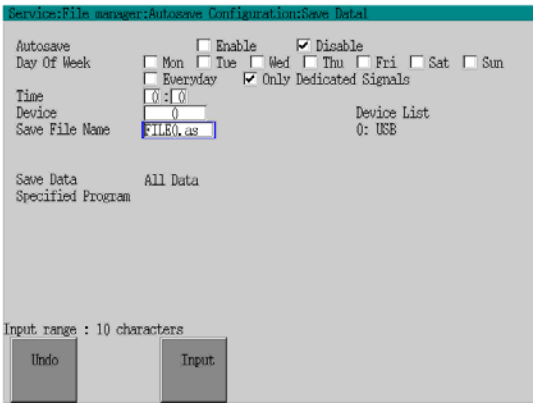
Set the time of day to save data. (24 hour clock setting)

Device

Set the device on which the data is to be saved.

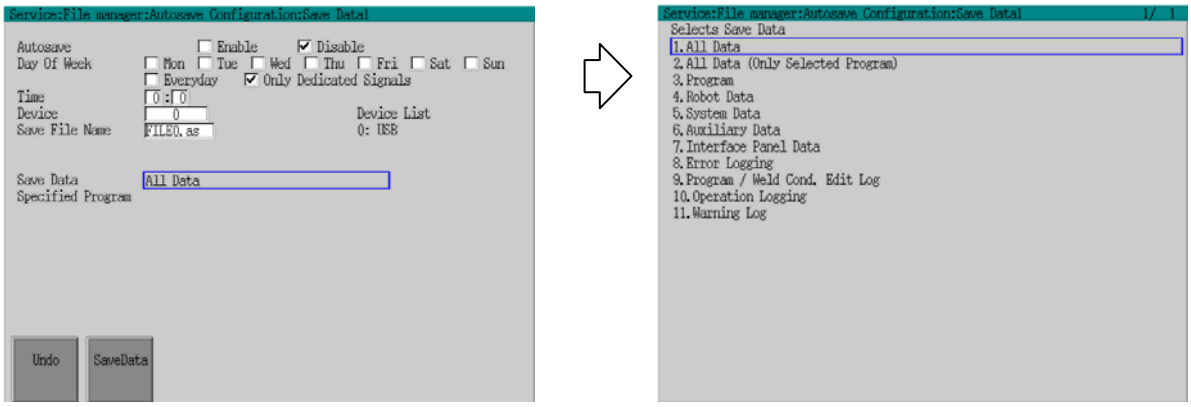
Save File Name

Enter the file name under which the data is to be saved. An existing file can be selected by pressing <File>. Up to 12 alphanumeric characters, starting with an alphacharacter can be specified.



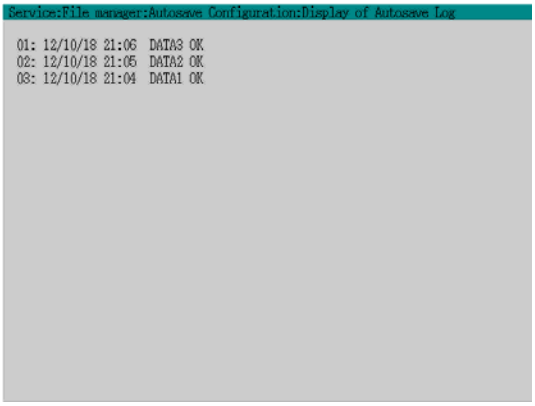
Save Data

Bring the cursor to this item and press <SaveData>. The screen changes to the input screen shown below. Set the data type to be saved. Select from: All Data, All Data (Only Selected Program), Program, Robot Data, System Data, Auxiliary Data, Interface Panel Data, and Error Logging.



11.2.2 OPERATION LOG

Choose [4. Display of Autosave Log] from the [Autosave configuration] menu shown in 13.2.1. The date, time, results, etc. of the back up are recorded in the log when auto save is completed. To see the log, select [4. Display of Autosave Log].



11.3 SIGNALS FOR AUTO SAVE

11.3.1 AUTO SAVE EXECUTION SIGNAL

Auto save function can be triggered by input of external signal whose signal number is dedicated for use with the Autosave function.

11.4 WARNINGS FOR AUTO DATA SAVE

Warnings are given if Auto data backup did not function normally or was interrupted for some reason. Warning messages that may occur are as follows:

Warning Message
USB memory not ready.
USB memory space unavailable.
[USB/CF] Could not load file

12.0 AUTO SOFTWARE LIMIT SETTING

This function adds greater convenience and functionality to R code 51 Software Motion Limit by enabling automatic setting of the motion range limits for each robot axis, based on the data in the taught points. An overview of the automatic setting procedure is described below in three steps.

1. Program selection

On program (Prog) list screen, select programs where software motion limits are to be applied. More than one program can be selected here.

2. Extraction of upper and lower motion limits

Pressing <Calculate> on Auto Motion Limits Setting screen extracts, upper and lower motion limits for each axis from the taught points data across the selected programs and the extracted motion limits are then displayed.

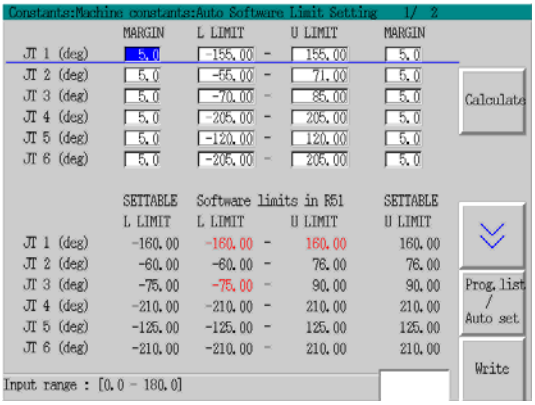
3. Auto setting of motion limits

Pressing <Complete> on Auto Motion Limits Setting screen stores the calculated values into R code 51 as motion limits (soft limits). The values stored for each axis are the sum: [motion limit from 2. above + margin]. Margins are manually input on this screen.

12.1 PROGRAM SELECTION

Select [Constants] → [2. Machine constants] → [5. Auto Software Limit Setting] and press ↵ to display the screen below.*

NOTE* This function can only be used in teach mode.



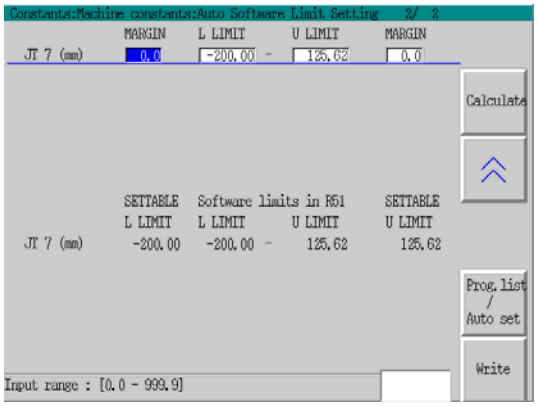
12.2 EXTRACTION OF UPPER AND LOWER MOTION LIMITS

Only the margins can be changed on the screen shown above. "Settable lower limit", "Settable upper limit" and "Motion limits in R51 (R51 Software Motion Limits)" shown on lower half of screen cannot be changed by direct input.

Margin (Settable lower limit)
Set margin to be subtracted from the lower limit.

Margin (Settable upper limit)
Set margin to be added to the upper limit.

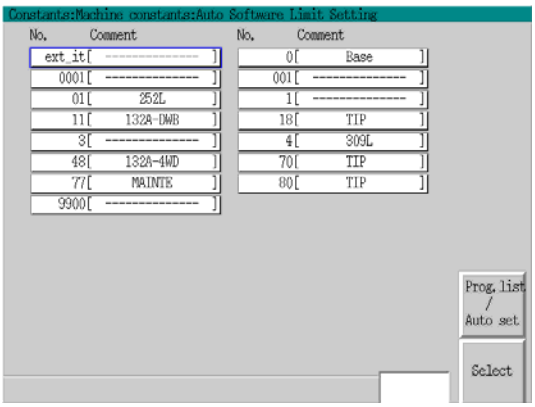
<Calculation>
Determines the upper/ lower motion limits for the selected program.
Pressing < ﹀ > and < ﹀ > switches setting screen between JT1-6 and JT7- as shown below.



<Complete>
Pressing <Complete> stores the upper/ lower limits whose values were adjusted by the input margin values.

<Prog. list/Auto set>

Pressing <Prog. list/Auto set> displays the program list screen as shown below. Select programs using arrow keys then press ↵ or <Select>. The selected programs are highlighted in blue.



Programs are all released from selection when;

1. Program has been edited/ modified (overwrite, position record, etc.)/ deleted/ added/ loaded.

2. Pressing <Complete> on the Auto Motion Limit Setting screen if upper/ lower motion limits were not extracted or motion limits were set manually after the extraction (Selections are not cleared when only margins are changed.).

3. Exiting the Auto Motion Limits Setting screen without setting motion limits after extraction or without completing the setting.

4. Pressing <Complete> irrespective of whether or not one of the selected programs was edited via the program editor screen or hot edit.

5. Changing setting values on any of these screens: [Constants] → [Machine constants] → [1. Motion Limits] and [5. Auto software limit setting] screen.

6. Pressing ↵ or REC without changing data.

To clear a selection, press ↵ or <Select> again after selecting the program.

12.2.1 EXTRACTION

Motion limits applicable to all programs selected on program list screen are extracted by pressing <Calculate>.

1. Upper/ lower limits can be changed before or after extraction (range: from settable lower limit to settable upper limit per axis).

2. Values extracted for the upper/ lower motion limits are not stored if exiting this screen without completing motion limit setting (currently selected programs are no longer selected.).

3. Upper and lower motion limits of each step are extracted only from taught points, and pose data between the taught points during linear interpolation operation are not considered here. Errors may occur depending on margins.

4. This function sets the upper and lower motion limits that were extracted as motion limits for all selected programs (not per selected program). Once the setting is completed, the limits remain until extraction is made again, saved data is loaded, system is initialized, or settings in R code 51: Software Motion Limits are changed.

[NOTE]

1. Motion limits are extracted from data taken from the selected programs, but taught points of subroutine programs called from the selected programs are not considered.
2. Robot cannot be operated during the extraction.

12.3 AUTO SETTING OF MOTION LIMITS

12.3.1 MARGIN SETTING

Margins added to extracted upper limits and margins subtracted from extracted lower limits can be set here (default: 5 degrees for rotational axes, 20 mm for translational axes).

1. Margins can be changed before or after extraction (range: 0 to 180.0 for rotational axes, 0 to 999.9 for translational axes).

2. Margins remain the same if this screen is exited without completing the motion limit settings after changing amount of margins.

3. When motion limits (extracted limits + margin (for upper limits) or – margin (for lower limits)) are not within the settable range (mechanical limit), limits set in R code 51 are not overwritten.

12.3.2 COMPLETE

Motion limits (extracted or manually input upper/ lower limits + margin) are set by pressing <Complete>.

1. None of the motion limits are set if, when <Complete> is pressed, one of the upper/ lower limits with margins is set outside the settable limits. This also happens if the limits are changed manually and the lower limit is set above the upper limit.

2. The motion limits are changed only when upper/ lower limits are set by pressing <Complete>, otherwise current motion limit settings remain.

[NOTE]

The motion and motion range of a servo weld gun axis change depending on the amount of tip wear and the gun number currently connected. Thus, this function cannot apply to servo weld guns.

13.0 PROGRAM PROTECTION FUNCTION

This section describes the protection function which prevents programs and setting data from being edited or changed.

This function can prohibit the following operations thereby protecting taught programs and data from being edited or changed accidentally by unauthorized personnel.

1. Edit/Modification/Deletion of protected programs
2. Repeat operation of unprotected program
3. Changing of comments and weld conditons in protected programs

13.1 PROTECTION

13.1.1 PROHIBITION OF PROGRAM CHANGE

For programs where protection function is set to [Enable] (hereinafter called protected programs), following operations are prohibited.

1. Recording data in Teach screen (overwriting, addition, deletion, pose modification)*
2. Program/Step deletion from the pop-up menu on Teach screen
3. Specifying the program as a destination program/step for copy from the pop-up menu on Teach screen
4. Program modification in Edit screen**
5. Program modification in Hot Edit screen**
6. Changing of the program name (Service→Program manager or Aux. 2-6)
7. Step copy (Service→Transform existing programs)
8. Inverse step copy (Service→Transform existing programs or Aux. 1-8)
9. Joint shift (Service→Transform existing programs or Aux. 1-5)
10. XYZ shift (Service→Transform existing programs or Aux. 1-4)
11. Tool shift (Service→Transform existing programs or Aux. 1-6)
12. Mirror conversion (Service→Transform existing programs or Aux. 1-2)
13. Data conversion (Service→Transform existing programs or Aux. 1-3)
14. Rewriting programs by these AS commands, which can change contents of programs, is prohibited.
    (1) EDIT, DELETE, RENAME commands (Specifying a protected program is prohibited.)
    (2) COPY, ZINVCOPY, XFER commands (Specifying a protected program as destination program for copy is prohibited.)
15. Weld condition edit (Weld conditions for spot weld specification only)

Operations in 1-15 above are prohibited only for protected programs. For copy related operations in 3, 7, 8, 14 above, specifying a protected program as a destination program is prohibited. However, specifying a protected program as a source program is possible, and an unprotected program is created as a destination program.

NOTE*: Recording data in the Teach screen is prohibited, but auxiliary data such as tool and accuracy can be changed.

NOTE **:In Edit/Hot edit screen, program modifications including auxiliary data modification are prohibited.

Attempting to change/register data in a protected program returns this error:
Error message: Already locked program.
Error lamp: OFF
Cycle start: ON
Motor power: ON
Error log: Not logged

Whether or not the program is protected, changing/registering following actual operation condition corresponding to each auxiliary data/arc welding conditions/MATEHAN pos. data is possible. However, changing the data may affect motion trajectory or weld conditions.

1. Speed (Constants→Auxiliary data and Aux. 3-1)
2. Accuracy (Constants→Auxiliary data and Aux. 3-2)
3. Tool dimensions (Constants→Auxiliary data and Aux. 3-4)
4. Timer (Constants→Auxiliary data and Aux. 3-3)
5. Edit arc on condition file/Edit arc off condition file/Arc constants (For arc spec. only)
6. MATEHAN pos. data/MATEHAN pos. No. (For servo MATEHAN spec. only)

13.1.2 PROHIBITION OF REPEAT OPERATION

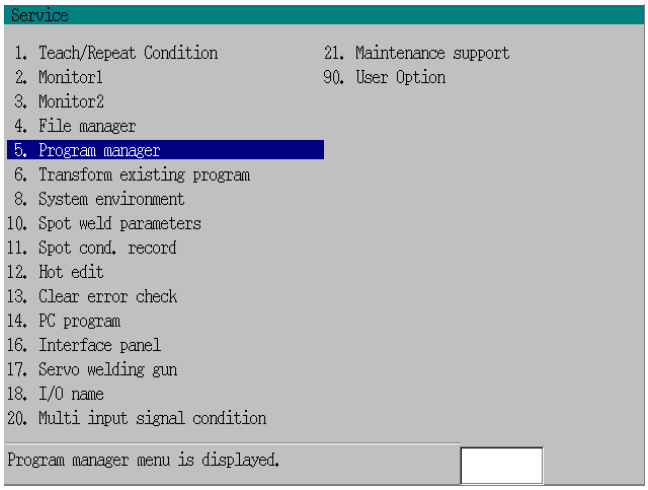
Robot error stops when trying to execute programs which are not protected (hereafter called unprotected programs), under these conditions:

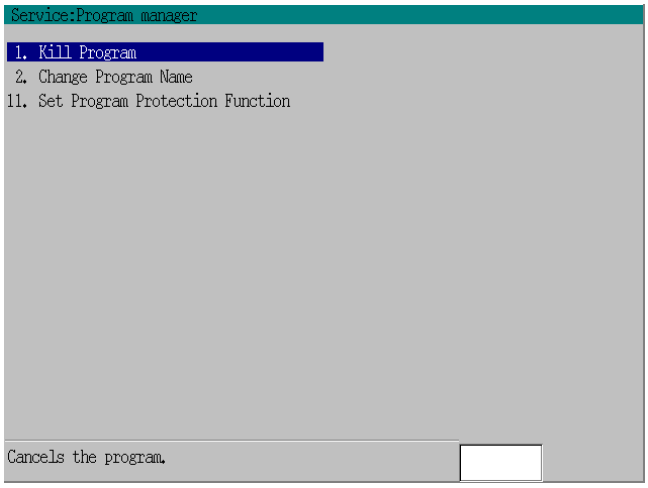
1. Trying to execute an unprotected program by pressing Cycle
2. Trying to call an unprotected program by JUMP/END command or CALL/FN80/FN81/FN82
   However, other robots will not stop. In check mode, no error occurs.

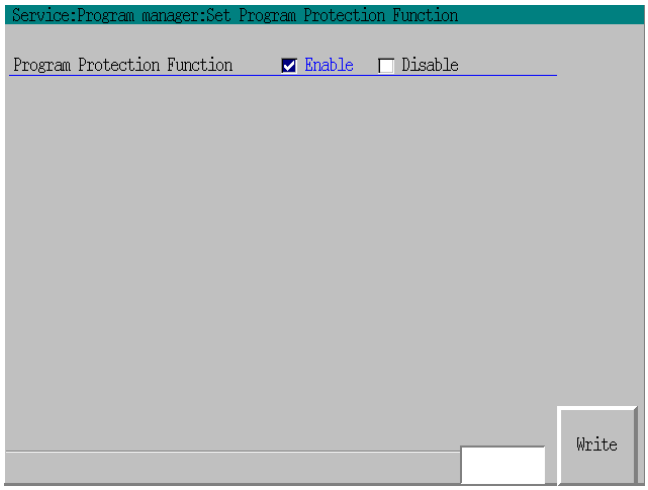
Following error occurs when above operation is executed.
Error message: Cannot execute program because unprotected.
Error lamp: ON
Cycle start: OFF
Motor power: ON
Error log: Logged

13.2 SETTING PROGRAM PROTECTION FUNCTION TO ENABLE

To use the program protection function, set the program protection function to [Enable], following the procedure below.







1. Input "314" in the R code input screen, and press ↵ to enable a service engineering code.

2. Press <Serv.> on Teach screen to display the service function menu screen.

3. Move cursor using ↑/↓ to [5. Program manager] or input item number (5) in the box on the lower right side of the screen, and press ↵.

4. Move cursor using ↑/↓ to [11. Program Protection Function Setting] or input item number (11) in the box, and press ↵ to display the screen below.

NOTE*: Inputting "711" in R code input screen also displays the screen.

Selecting [Enable] enables the program protection function, and allows use of the functions in 13.1, 13.3-13.5. Selecting [Disable] disables the program protection functions, and:

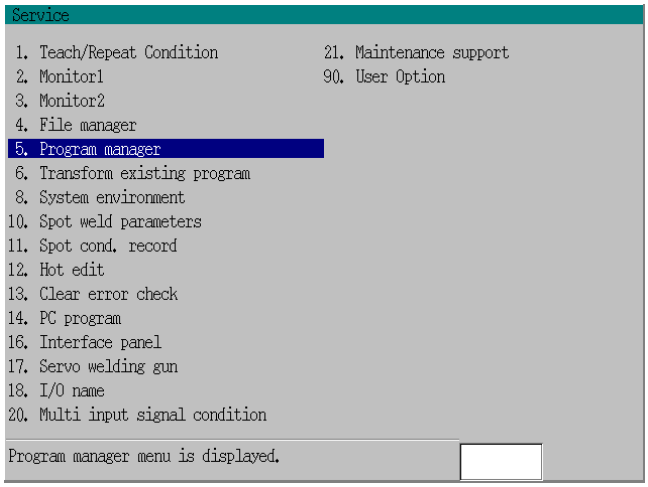
1. [10. Protect program] is not displayed in the Program manager menu.
2. Functions in 13.1, 13.3-13.5 cannot be used.

[NOTE]

When [Disable] is selected, the program protection function will not work at all, and unprotected programs are also executed.

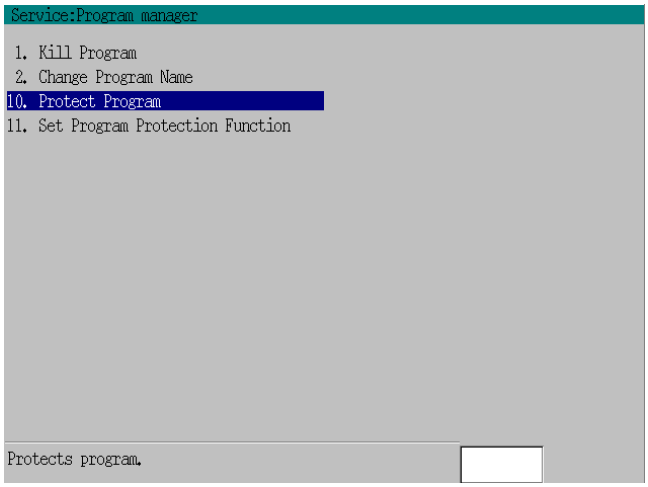
13.3 HOW TO SET/RELEASE PROTECTION

This section describes how to set/release the program protection.

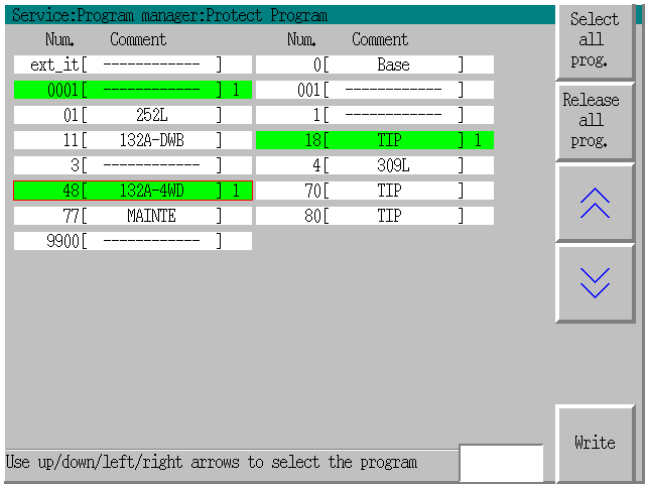


1. Press <Serv.> on Teach screen to display the service function menu screen.

2. Move cursor using ↑/↓ to [5. Program manager] or input item number (5) in the box on lower right side of screen, and press ↵.



3. Move cursor using ↑/↓ to [10. Protect program] or input item number (10) in the box, and press ↵ to display the screen on the next page.



Program selection

Select a program highlighted in white (unselected program) by <↑>/<↓> and press ↵ to determine the selection. Programs highlighted in blue are unprotected and those in green are currently protected. Pressing <Select all prog.> selects all programs.

Program selection release

Select a program highlighted in blue or green (selected program) by <↑>/<↓> and press ↵ to release the selection. The program is highlighted in white. Pressing <Release all prog.> releases all programs from selection.

Program protection

Pressing <Complete> displays input prompt, “Change protect. status? (1: Yes, 0: No)”. Pressing ↵ after inputting “1” protects the selected program.

Protected status of program

A program is protected if “1” is displayed next to the comment for that program.

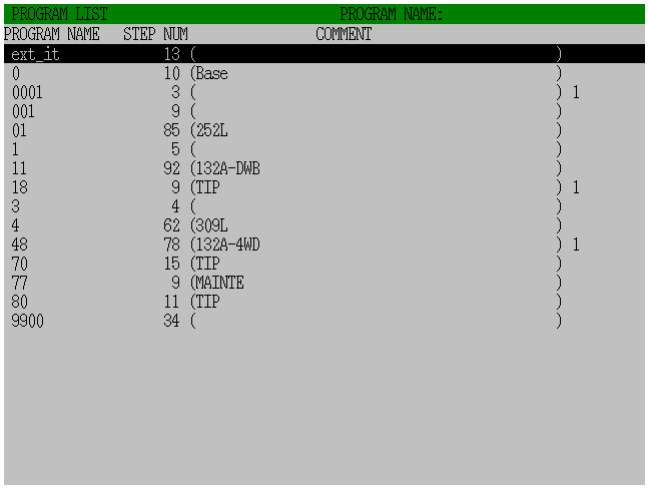
[NOTE]

1. Protection cannot be released for a program that is in cycle motion, and trying to do displays “Cannot unlock protection while program running”. In this case, the program and other programs selected for release remain in protected status.
2. If a program called by CALL command or FN80/FN81/FN82 is currently running, the protection of the source program cannot be released.

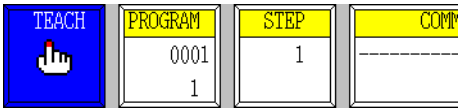
13.4 PROTECTION STATUS CHECK

Program protection status can be checked on the screens below.

1. On the program list, protected programs have [1] displayed next to the comment.



2. On the program button on the Teach/Repeat screen, protected programs are displayed with [1].



3. For servo weld gun specification, [1] is also displayed on the weld program list.
4. [1] is also displayed in Auto Software Limit Setting screen.

Program protection must be set per each robot. Press <TEACH> on the lower right side of the screen and select the robot to be set with program protection. When program protection is enabled for a program that is also used by other robots, the program will be protected for all robots.

13.5 SAVING/LOADING

Protection status is saved/ loaded. A program may or may not be overwritten depending on its protected/unprotected status, shown in left column of the table below. On controllers without the Program Protection Function, protected programs cannot be loaded. To load a protected program to a controller without this function, release the program from protection and save the program then load he saved data to the controller.

"!" indicator on saved files:

1. Protected program .PROGRAM !pg0()
2. Unprotected program .PROGRAM pg0() same as normal file

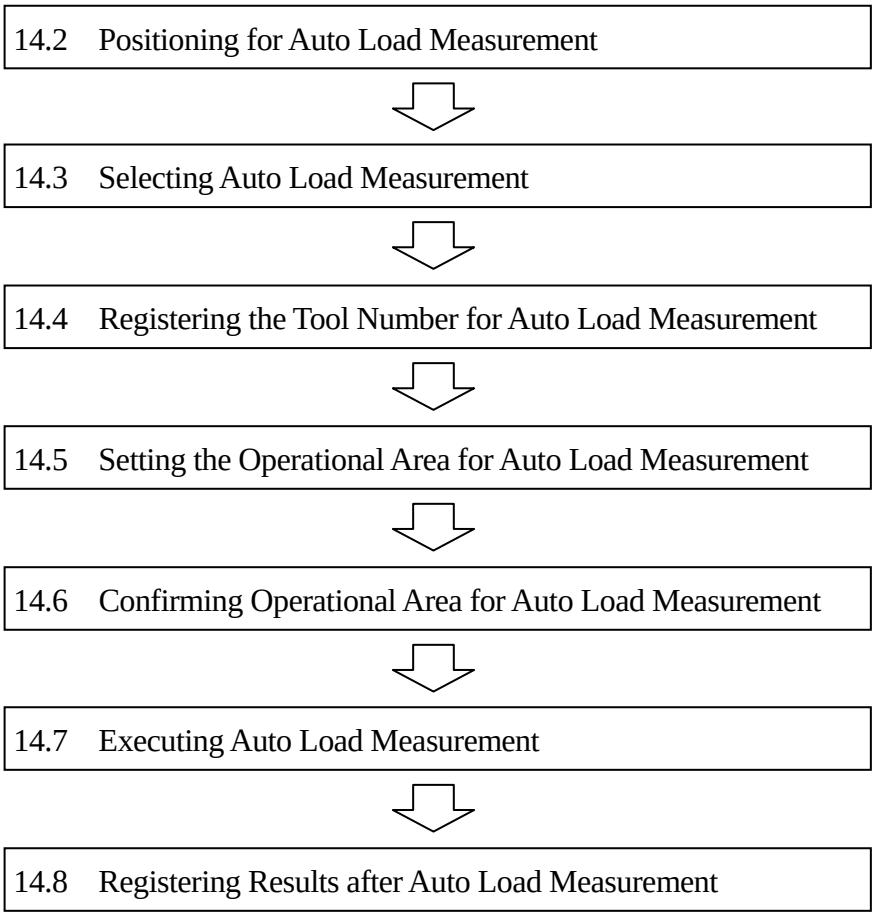
	Program with same name	Controller with protection function		Controller w/o protection function
		Protection: Enabled	Protection: Disabled	
Protected program	No	Loaded as a protected program		Not loaded
	Yes	Not loaded. Original program remains.	Overwritten as a protected program	Not loaded. Original program remains.
Unprotected program	No	Loaded as an unprotected program		Loaded
	Yes	Not loaded. Original program remains.	Overwritten as an unprotected program	Overwritten

14.0 AUTO LOAD MEASUREMENT

This function is used with the actual load (tool and workpiece) mounted at the end of robot arm to automatically measure the load mass and load center of gravity. Controller measures and calculates the data as it moves JT 3, 4, 5 and 6.

14.1 EXECUTION PROCEDURES

The following flowchart describes the seven steps/procedures for measuring the load automatically by using this function.



See the following sections for a description of each step/procedure.

14.2 POSITIONING FOR AUTO LOAD MEASUREMENT

This section describes positioning procedure for auto load measurement.

1. Make sure that the tool is mounted to the robot flange firmly.

2. As shown in Figure 14.1, guide the robot to a pose that provides:
   (1) Enough clearance for the arm to move without interfering with surrounding objects (devices, etc.)
   (2) Sufficient gravitational torque to act upon each axis of the arm.

3. Then, set the switches on the operation panel as follows:
   (1) HOLD/RUN : HOLD
   (2) MASTER ON : OFF
   (3) MODE SELECTOR : MAN.

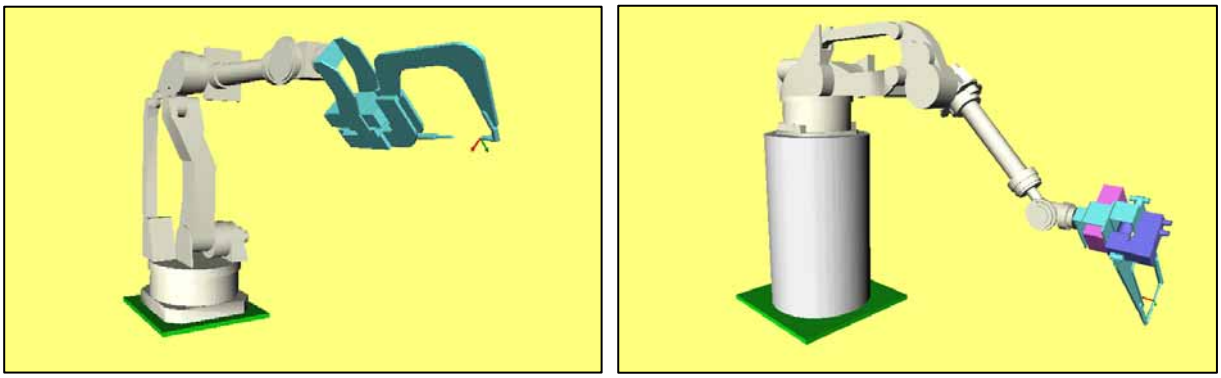


Figure 14.1

⚠ CAUTION

For safety and accuracy, fix the tool and workpiece firmly without fail.

14.3 SELECTING AUTO LOAD MEASUREMENT

This section describes how to select the screen for auto load measurement.

1. Press <STATUS> and select <FUNCTION> from pull-down menu to display the auxiliary function screen.

2. Select Auxiliary Function 0406 as shown in Figure 14.2.

3. The auto load measurement screen shown in the next page is displayed.

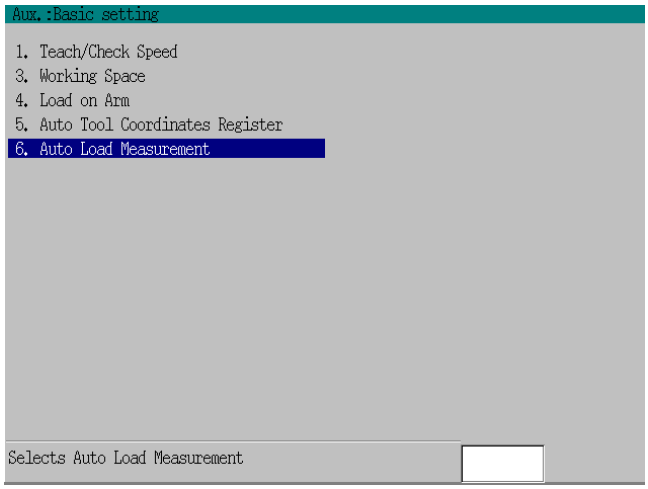


Figure 14.2

14.4 REGISTERING THE TOOL NUMBER FOR AUTO LOAD MEASUREMENT

In this section, set the tool number to be measured and registered. This tool number corresponds with the data set for the same tool number in Auxiliary Function 0304.

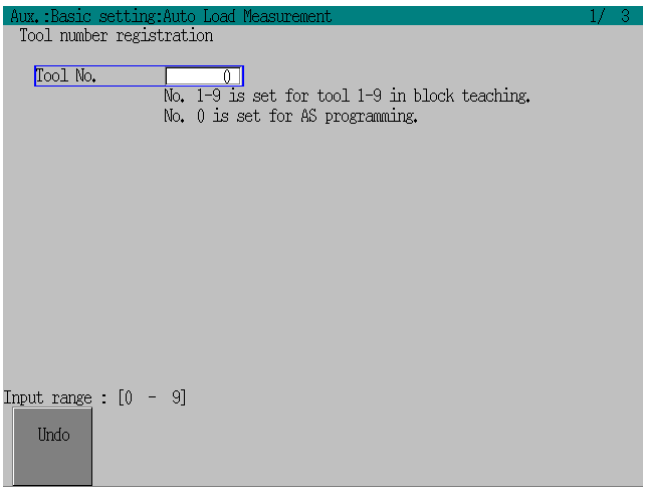


Figure 14.3

1. Input the tool number to correspond with the load to be measured by NUMBER (0-9). Confirm setting and press ↵. (Setting range: 0-9)

   Pressing RESET returns to Figure 14.3.

[NOTE]

If the setting is incorrect, message is displayed as shown in Figure 14.4. In this case, try registering again.

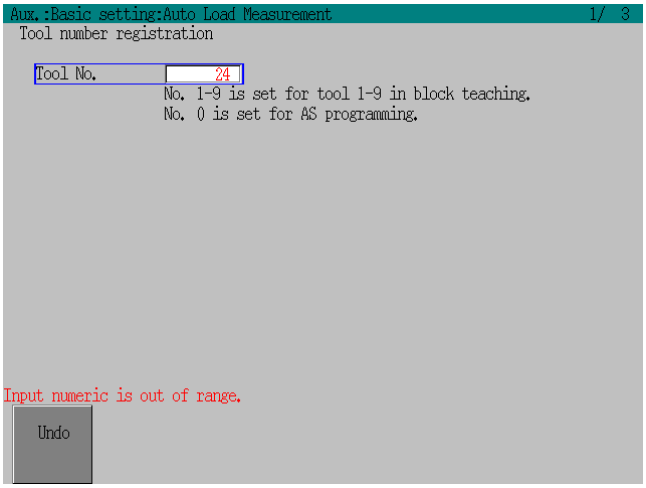


Figure 14.4

[NOTE]

Because program data is set by this auto measurement function, robot motion must be stopped before proceeding to the next step. When message is displayed as shown in Figure 14.5, follow the instruction shown on the screen.

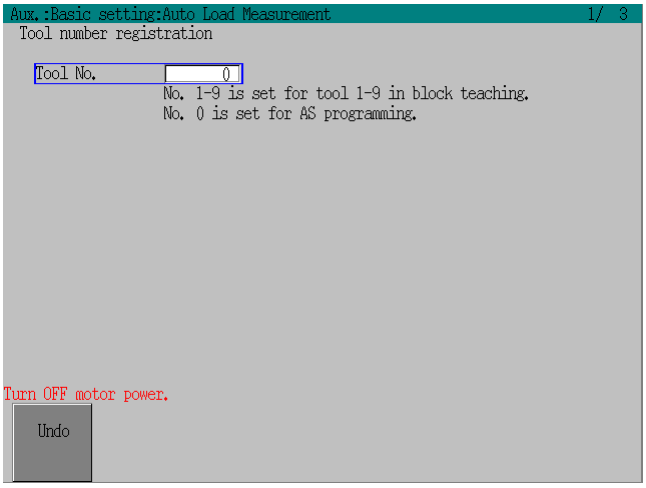


Figure 14.5

[NOTE]

1. When message is displayed as shown in Figure 14.6, the operational area set for auto load measurement may not be secured. This area is set in section 14.5. Check the robot pose and correct it.
2. Upper limit of the input range displayed on screen in section 14.5 is the value registered in Aux. Function 0507. Lower limit is determined by the conditions of the minimum required motion range for measurement. If after the operational area is set and the area is then reset smaller than the values in Aux. 0507, message in Figure 14.6 is displayed. In this case, correct the value.

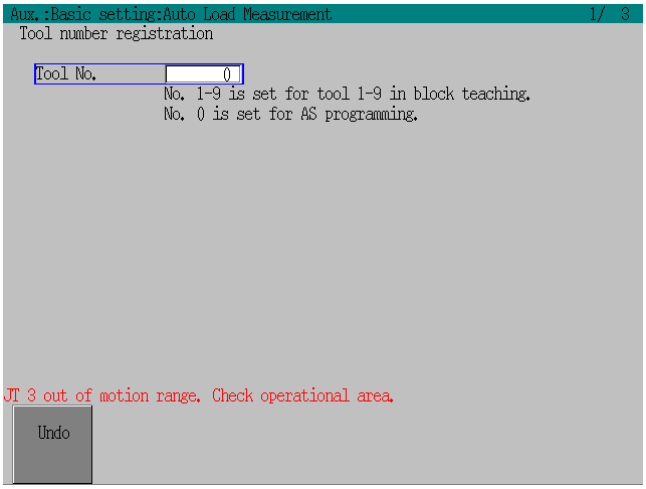


Figure 14.5

14.5 SETTING THE OPERATIONAL AREA FOR AUTO LOAD MEASUREMENT

In this section, set the operational area for auto load measurement. During measurement, robot moves within the operational area set here only to plus direction from the current position and not to minus direction. Set the data making sure that robot does not interfere with the surrounding devices, objects, etc.

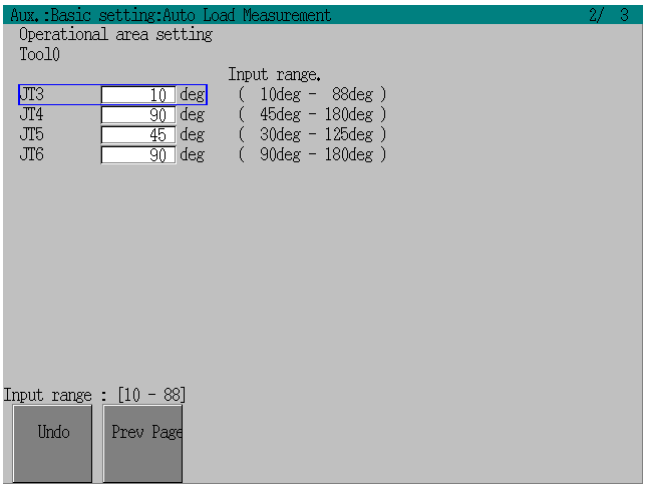


Figure 14.7

1. Set the operational area for each axis by NUMBER (0-9).

   Pressing RESET returns to the last step, section 14.4.

2. Set the operation panel as follows:
   (1) AUTO/MANUAL SELECTOR : OFF
   (2) MODE SELECTOR : MAN.
   (3) MASTER ON : ON
   (4) HOLD/RUN : RUN

3. If the setting is correct, press ↵.

[NOTE]

"Input numeric is out of range." is returned when attempting to set a value outside the range. See Figure 14.8. Check the setting and correct it.

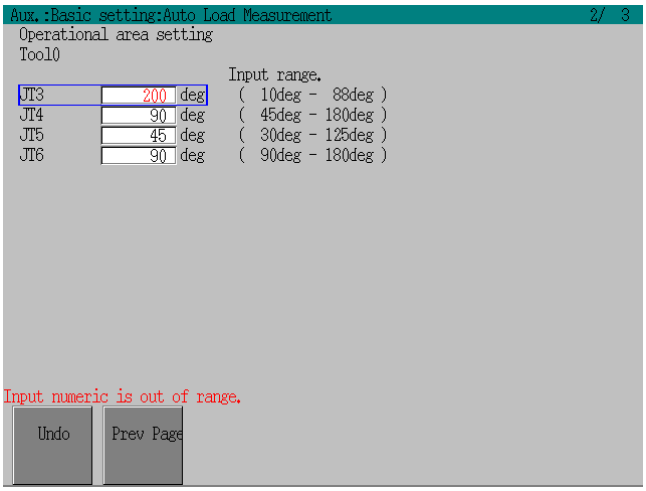


Figure 14.8

[NOTE]

1. If there are any problems besides the set data, the cause of the problem is displayed. Refer to Figures 14.9 to 14.11.
2. Even if all conditions are correct, proceeding to the next step is not possible if robot is currently running.
3. If all settings are correct, proceed to 14.6 Confirming Operational Area for Auto Load Measurement.

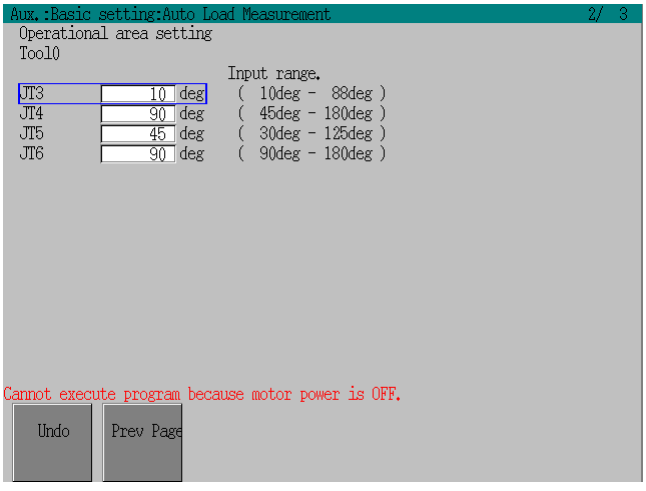


Figure 14.9

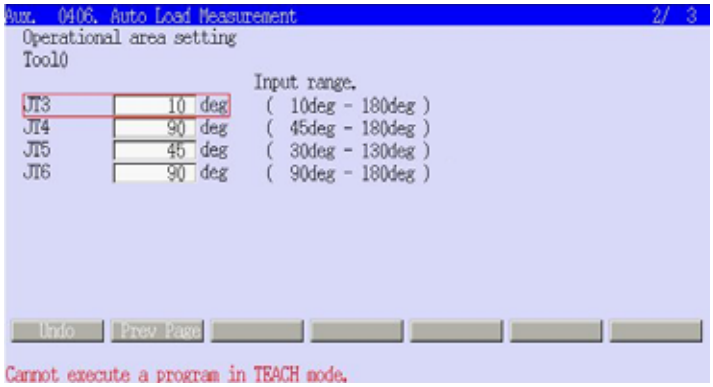


Figure 14.10

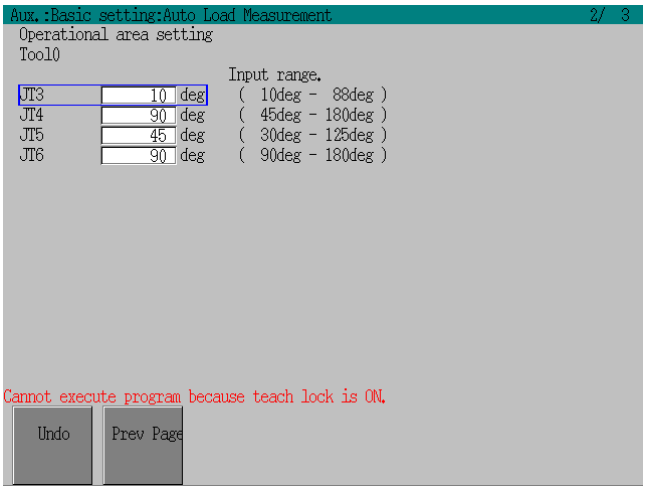


Figure 14.11

14.6 CONFIRMING OPERATIONAL AREA FOR AUTO LOAD MEASUREMENT

In this section, check the operational area of auto load measurement in low speed.

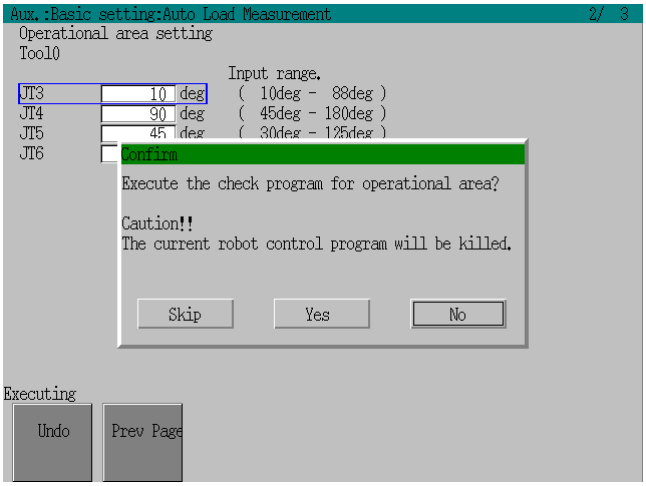


Figure 14.12

1. Screen shown on the left is displayed. Selecting <Skip> skips the contents in this section and proceeds to 14.7 Executing Auto Load Measurement. Selecting <Yes> sets the check program. Selecting <No> returns to the last step, section 14.5.

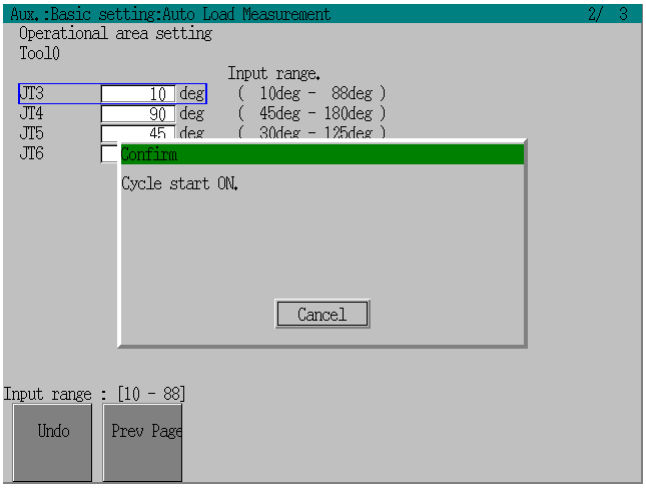


Figure 14.13

2. Selecting <Yes> in step1 displays "Cycle Start ON". Now press START (Cycle Start) button. Pressing <Cancel> before cycle start returns to the last step, section 14.5.

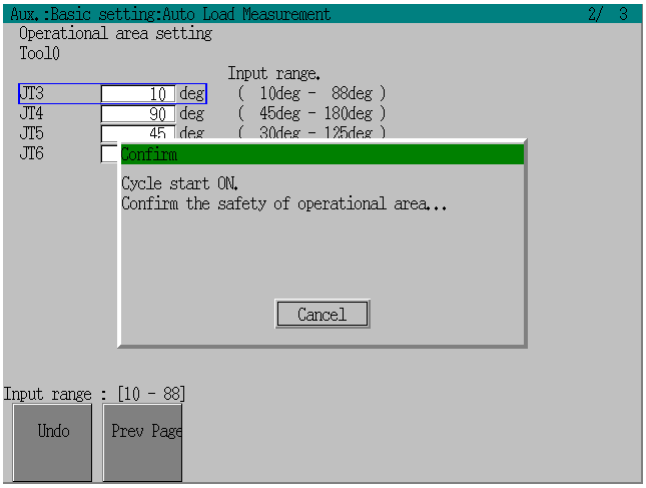


Figure 14.14

3. While operational area is checked, "Confirm the safety of operational area…" is displayed. Once completed, automatically moves to next step, section 14.7.

[NOTE]

1. If robot stops for some reason while checking the operational area, the error message “Robot stopped. Checking operational area stopped.” is displayed as shown in Figure 14.15.
2. Selecting <Reset> in Figure 14.15 displays confirmation screen indicating “Failed in auto load measurement.” shown in Figure 14.16. Select <Close> and retry after removing the cause of error.
3. Selecting <Close> in Figure 14.15 displays confirmation screen indicating “Failed in auto load measurement.” without resetting the error. Reset error and retry after removing the cause of error.

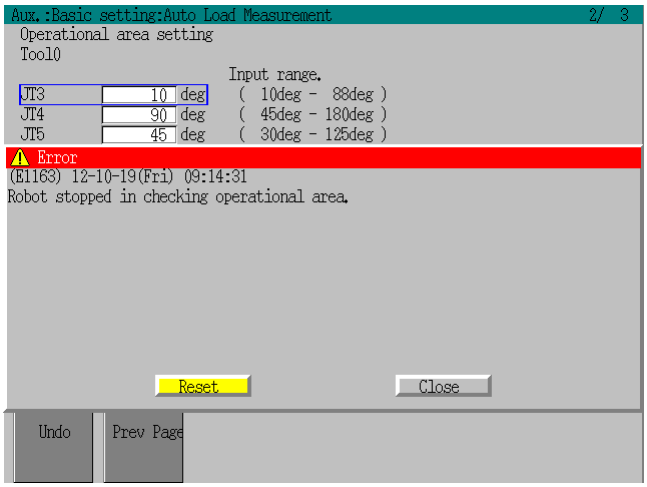


Figure 14.15

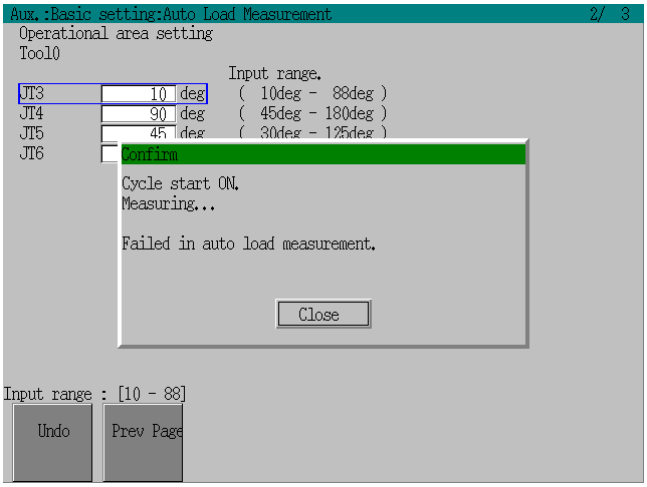


Figure 14.16

14.7 EXECUTING AUTO LOAD MEASUREMENT

After confirming the safety of the operational area for auto load measurement and no problem is found, execute auto load measurement.

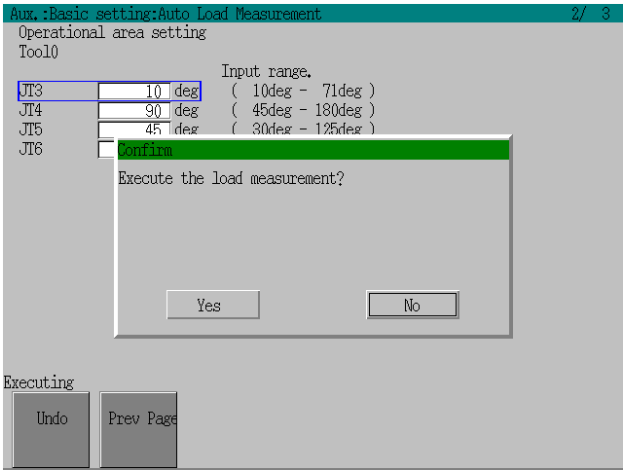


Figure 14.17

1. Selecting <Yes> sets the measurement program. Selecting <No> returns to section 14.4.

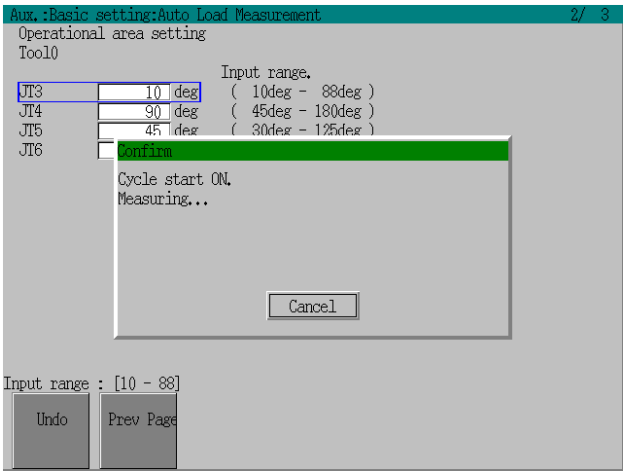


Figure 14.18

2. Selecting <Yes> in step1 displays "Cycle Start ON". Now press START (Cycle Start) button. During auto load measurement, "Measuring…" is displayed.

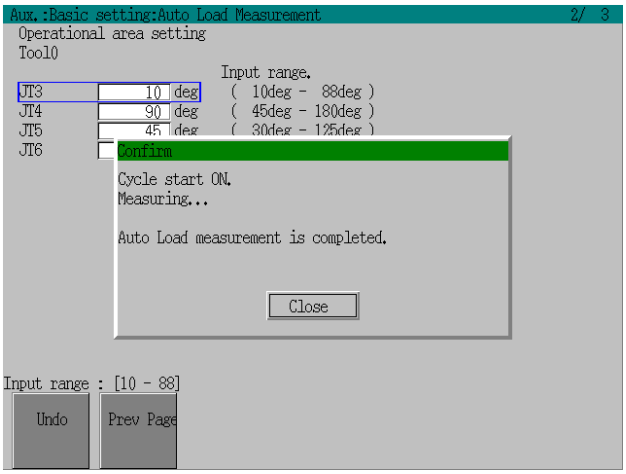


Figure 14.19

3. "Auto Load measurement is completed." is displayed when process is finished. Then, press <Close>.

[NOTE]

Pressing <Cancel> before cycle start in step2 above displays the confirmation screen. Selecting <Close> returns to the last step, section 14.6.

[NOTE]

1. If robot stops for some reason while measuring, the error message “Motor power OFF. Measurement stopped.” is displayed as shown in Figure 14.20.
2. Selecting <Reset> in Figure 14.20 displays confirmation screen indicating “Failed in auto load measurement.” shown in Figure 14.21. Select <Close> and retry after removing the cause of error.
3. Selecting <Close> in Figure 14.20 displays confirmation screen indicating “Failed in auto load measurement.” without resetting the error. Reset error and retry after removing the cause of error.

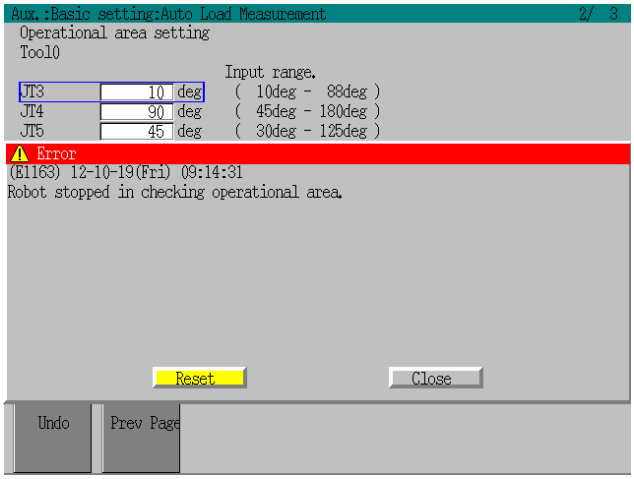


Figure 14.20

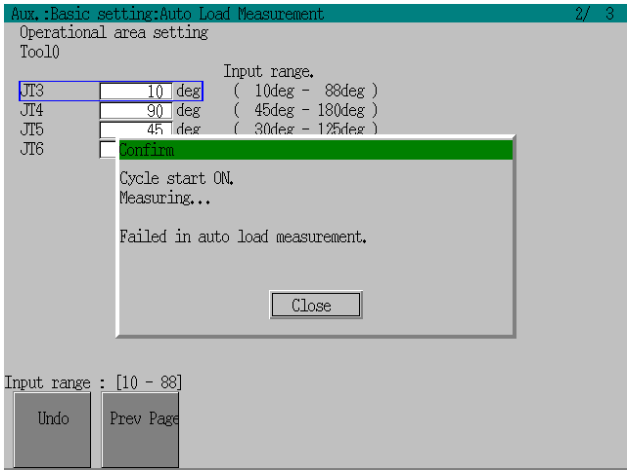


Figure 14.21

14.8 REGISTERING RESULTS AFTER AUTO LOAD MEASUREMENT

If measurement process completes with no problem, the results are displayed. Results can be edited at this time by inputting numbers directly.

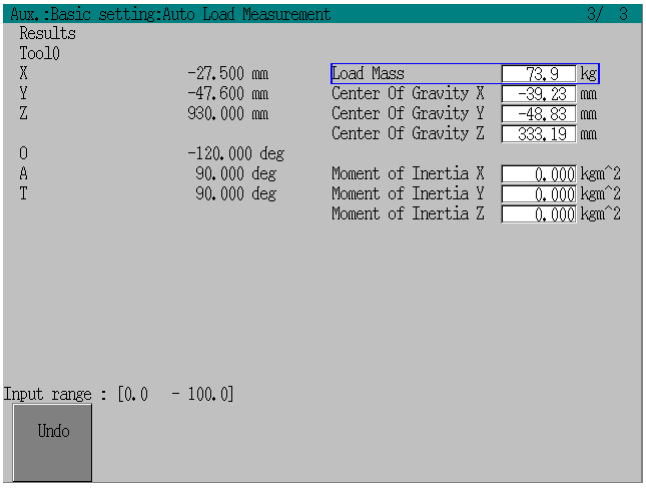


Figure14. 22

1. The results are displayed.

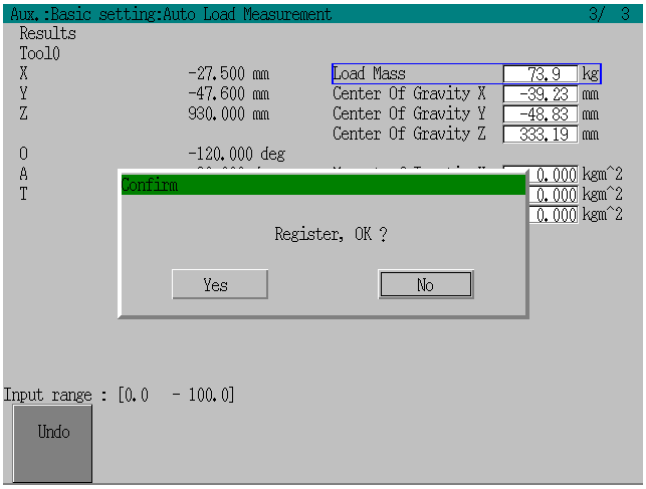


Figure14. 23

2. Pressing ↵ displays the confirmation screen.

   Selecting <Yes> registers the load information to the tool number set in section 14.4.

   Selecting <No> does not register the setting data.

[NOTE]

1. Selecting either <Yes> or <No> will show this screen.
2. Pressing RESET either before or after registration returns to section 14.4.
3. The result cannot be registered if the load mass value is beyond weight capacity (load rating) as shown in Figure 14.24.
4. For moment of inertia, note that the result can still be registered even if it exceeds the max. allowed moment, only a warning is displayed as shown in Figure 14.25.

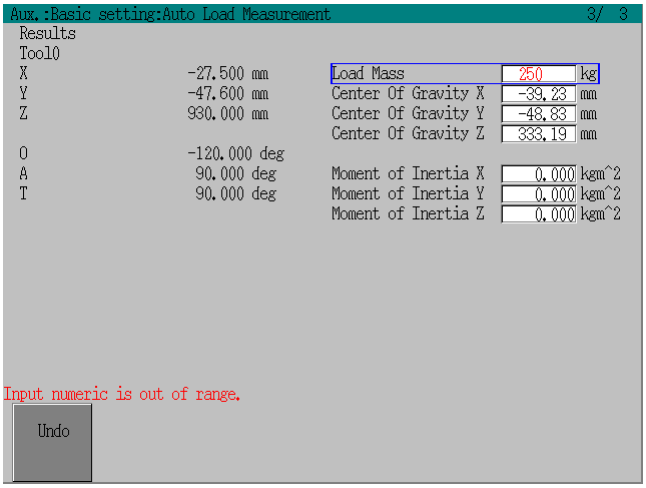


Figure 14.24

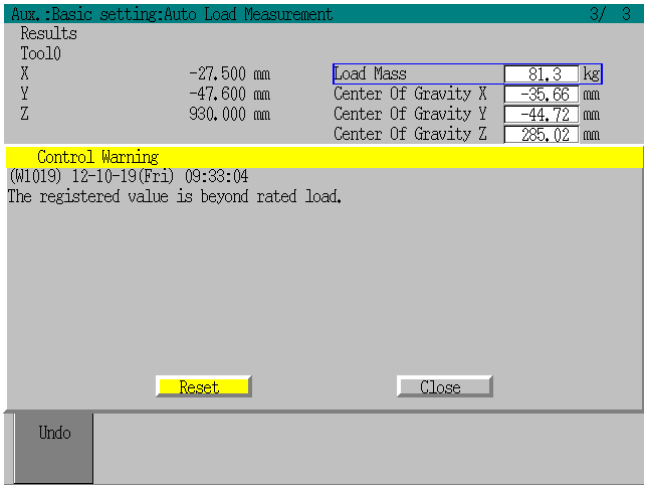


Figure 14.25

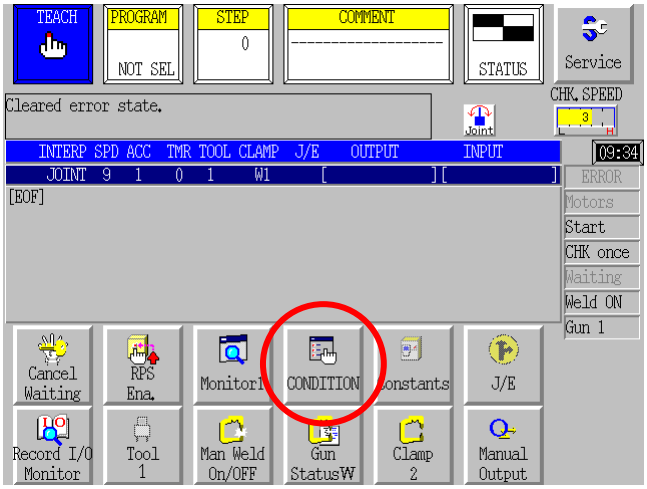
15.0 DISCONNECT/CONNECTION OF EXTERNAL AXIS

This function makes it possible to operate robot at the time of robot failure, etc. by setting an external axis to disconnect on the screen. When reconnecting a disconnected external axis, make sure that the zero position of the axis does not deviate. If so, adjust the zero position by zeroing operation.

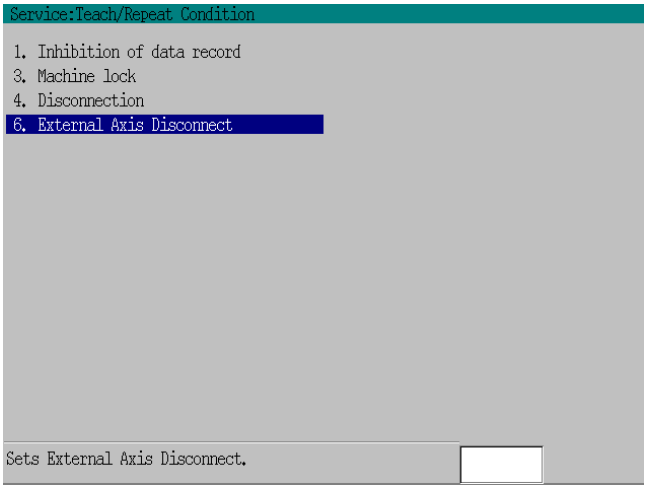
15.1 HOW TO SET EXTERNAL AXIS CONNECTION/SEPARATION

Follow the procedure below to set external axis disconnect/connection.

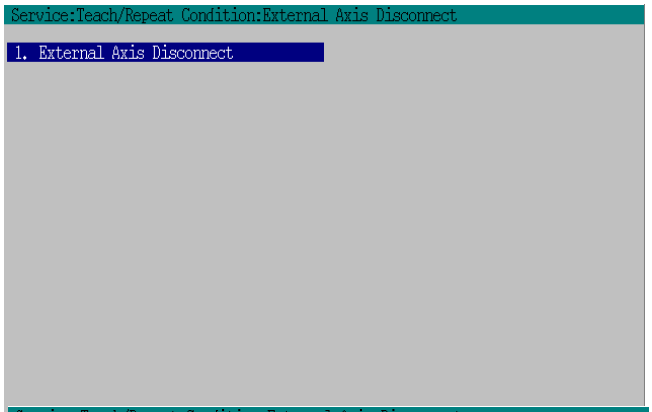
1. Display the condition setting screen by pressing ENABLE and function key <Condition> at the same time.



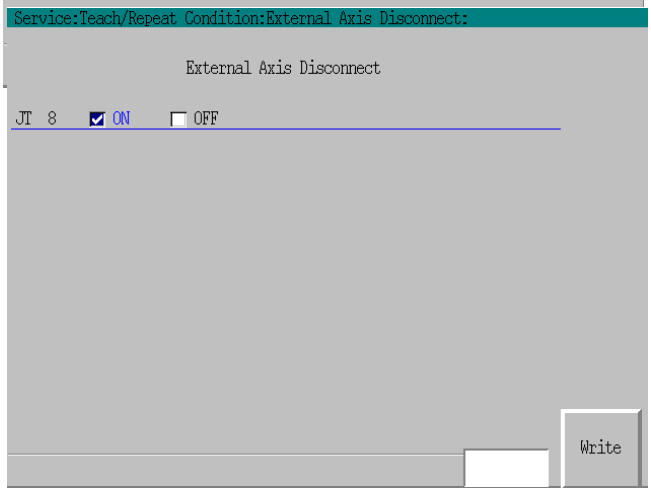
2. Select [6. External Axis Disconnect] on the screen.



3. Select [1. External Axis Disconnect].



4. Select [ON] when disconnecting the external axis and [OFF] when connecting the external axis. Then press <Write> to confirm the setting.



[NOTE]

- Disconnect/Connection can be set only for external axes, and servo weld gun cannot be disconnected/connected. However, all axes can be disconnected/connected for the NC robot, and JT1 to JT8 are displayed on the setting screen regardless of the number of axes of the robot.
- It is not possible to disconnect/connect external axes when the motor power is ON.
- When teaching with an axis disconnected, the position of the separated axis is taught as “-2000 mm”. Therefore, reteaching is required after connecting the axis.

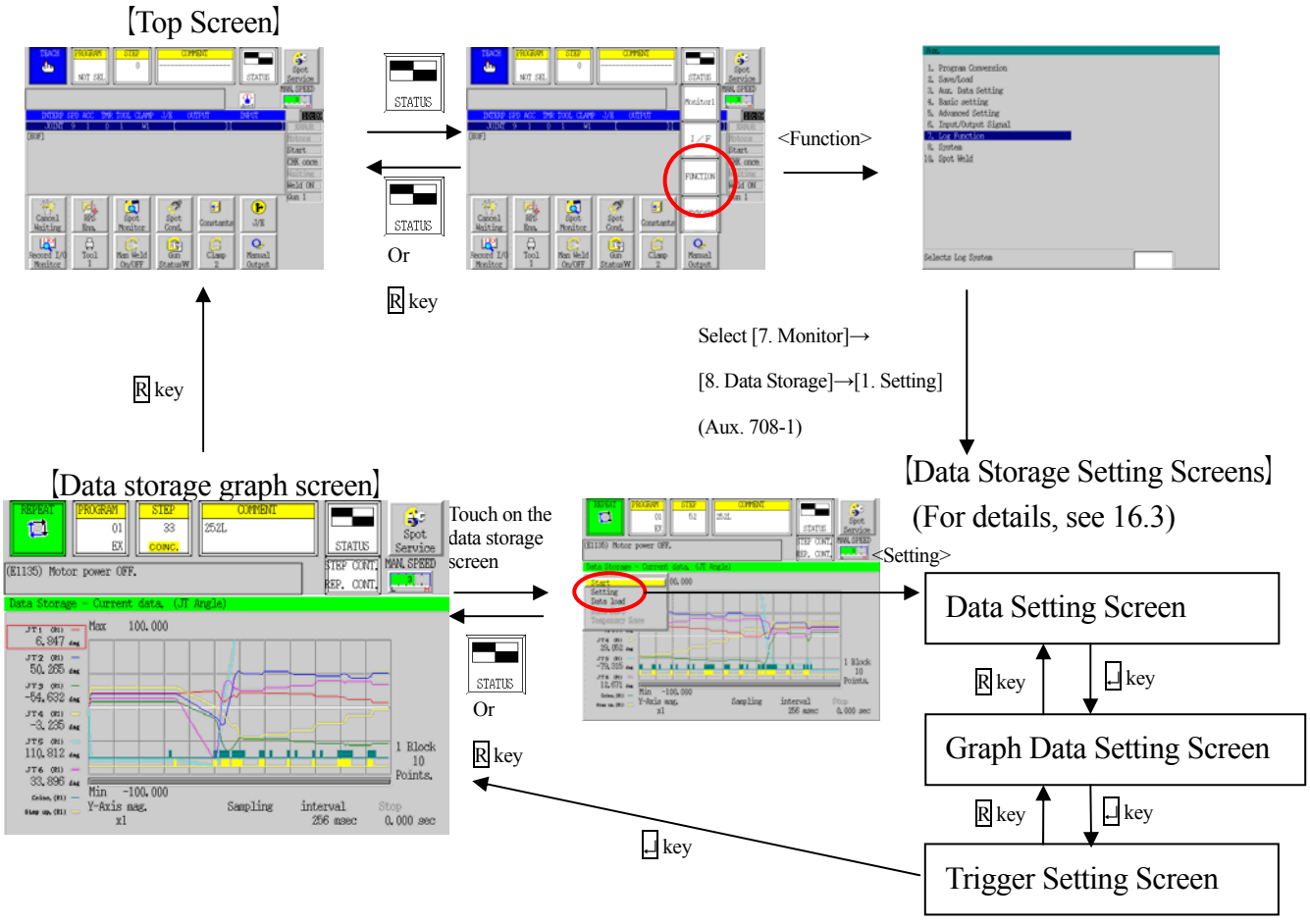
16.0 DATA STORAGE FUNCTION

16.1 OUTLINE OF DATA STORAGE FUNCTION

This function enables data such as joint angle, speed, deviation, I/O signal, etc. to be displayed in graph form on the LCD screen of the teach pendant. Displayed graph data can be saved in CSV format. In addition, the trigger function of the data storage function enables the graph data to be recorded automatically at a wide variety of specifiable times, such as when error occurs, motor power is turned ON, at signal ON or OFF, etc.

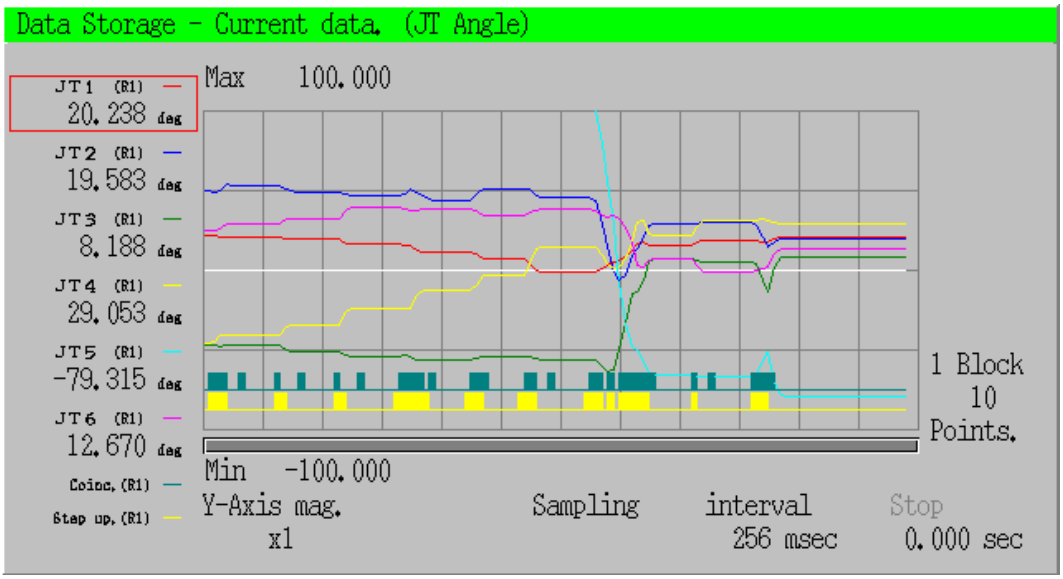
16.2 DATA STORAGE FUNCTION SCREENS

The screens used in the data storage function are configured as shown below.



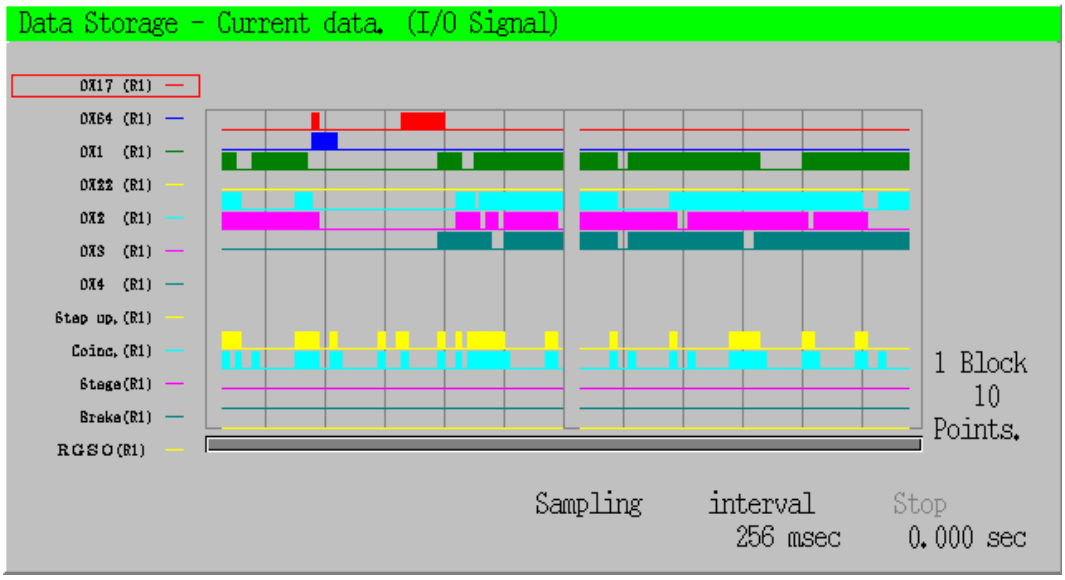
16.2.1 OUTLINE OF GRAPH SCREEN

1. Joint data display screen



· Current data storage condition and data type name are displayed on the title bar.
· Legend (data names, their colors and values in the currently displayed graphs) is displayed on the left of the graph.
· The cursor (red square) is displayed on the name of the graph data. Move the cursor by pressing ↑ / ↓ to select a data item. Pressing ↵ enables/disables displaying the selected data.
· Upper and lower limits of Y-axis are displayed next to [Max] and [Min].
· Y-Axis mag. indicates Y-axis magnification. Press ENABLE+↑/ ENABLE+↓ to magnify / reduce Y-Axis mag. Magnification range is 2^n (-6 ≦ n ≦ 6).
· [Sampling interval] (ms) is displayed at the bottom of the screen. Shorter sampling interval allows more detailed graph data.
· [1 Block 10 Points] indicates X-axis magnification. 1 block has interval between gray grid lines on the graph. X-axis magnification is represented by the number of the samples per block. 10 points of graph data are displayed per block in the figure above.
· Press ENABLE+→/ ENABLE+← to magnify / reduce X-axis mag. Magnification range is 1, 5, 10, 50, 100 points (samples) per a block.
· Press <STATUS> to display the data storage pull-down menu. The pull-down menu that is displayed differs according to the screen that is being displayed. The pull down menu is described in detail in 16.2.2.

2. I/O signal display screen



Current data (I/O Signal) screen displays the graph with only the I/O signal data. The screen display is basically the same as that of Joint Data except that only up to 16 I/O signal data are displayed and magnifying / reduction of Y-axis are not available.
Graph data from signal channel CH1 to CH16 are displayed starting from the top. Data of CH1-CH8 and CH9-CH16 are indicated by the same colors.

16.2.2 DATA STORAGE CONDITION AND MENU CONTENTS

Pressing the data storage screen while the data storage graph screen is being displayed shows a pull-down menu. The selection items available in the pull-down menu vary depending on the currently selected data storage condition that is displayed on the title bar. The sections below describe each data storage condition and the menu contents.

1. Current Data

Current data is displayed in real-time. Data logging is not started at this time. Menu contents displayed in this condition are below.

Menu items	Descriptions
Setting	Sets graph data.
Start	Starts data logging.
Data load	Displays saved graph data.
Data Save (unavailable)	-
Temporary Save (unavailable)	-

2. Trigger Detection Wait

Data logging is started and running until the set trigger is detected. Menu contents displayed in this condition are below.

Menu items	Descriptions
Setting	Sets graph data.
Data load	Displays saved graph data.
Data Save (unavailable)	-
Temporary Save (unavailable)	-

3. Logging now

Data logging is running now. During logging execution the “STOP” displayed at bottom right of screen changes to blinking “Logging…” and the elapsed time is shown counting upward. Menu contents displayed in this condition are below.

Menu items	Descriptions
Stop	Stops data logging.
Setting	Sets graph data.
Data load (unavailable)	-
Data Save (unavailable)	-
Temporary Save (unavailable)	-

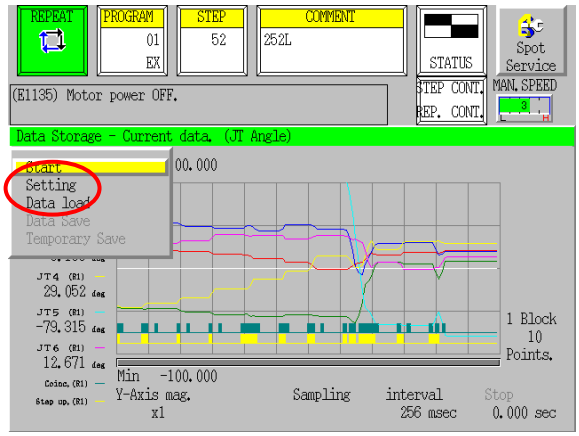
4. Data Display

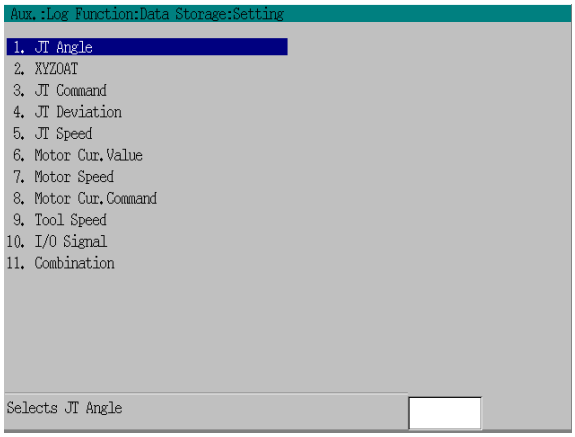
Data logging has completed and the logged graph data is displayed. Menu contents displayed in this condition are below.

Menu items	Descriptions
Delete Cur. Data	Deletes the log data.
Setting	Sets graph data.
Data load	Displays saved graph data.
Data Save	Saves currently displayed graph data.
Temporary Save	Temporarily saves currently displayed graph data. This data is cleared at controller power OFF → ON.

16.3 DATA SETTING

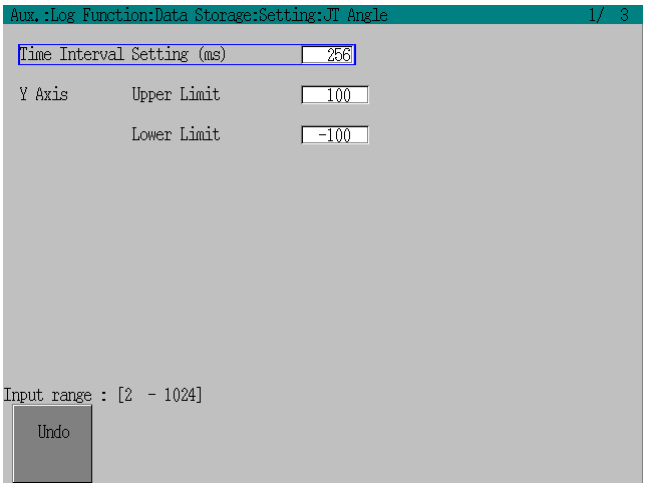
Press the data storage screen in the data storage graph display screen to display the pull-down menu. Selecting [Setting] in the pull-down menu displays data types (1-11) below. When the data storage function screen is not displayed, this screen can be called up by selecting [Aux.708-1. Setting] directly via the Auxiliary Function menu Or by selecting <STATUS>-<Function>-[7. Monitor] – [8. Data Storage]-[1. Setting].





16.3.1 SETTING OF SAMPLING INTERVAL, Y-AXIS UPPER AND LOWER LIMIT

Select a data type from 1 to 11 and press ↵ to call up the setting screen below. Time Interval Setting (Sampling interval) and Y Axis Upper Limit and Lower Limit are set in this screen.



[Time Interval Setting] is the acquisition interval for the graph data. Setting 256 ms reads and logs data every 256 ms. Inputting data for the [Upper Limit] and [Lower Limit] specifies the Y axis scale in mag. factor of 1 when displaying it on the graph screen.

* The input ranges and default settings for each item are as follows:

Time Interval Setting Input range:2-1024 Default:256
Y Axis Upper Limit Input range: –99999-99999 Default:1000
Y Axis Lower Limit Input range: –99999-99999 Default:1000

Input the necessary data and press ↵. The display changes to the graph data setting screen.

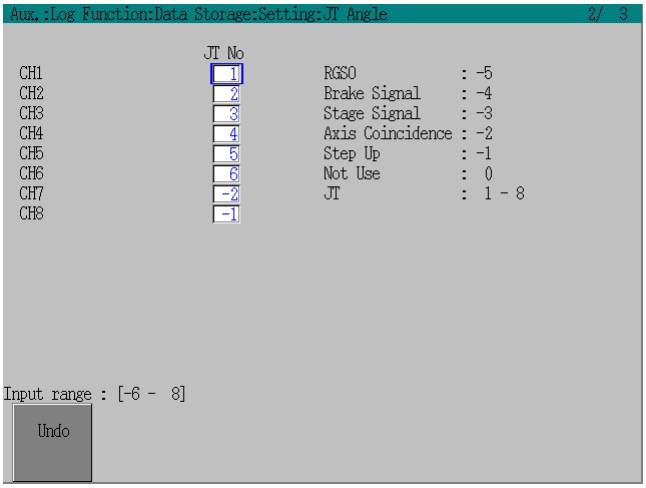
When [10. I/O Signal] is selected in [Aux. 708-1. Setting], the Y axis upper/ lower limits are not displayed.

16.3.2 SETTING OF GRAPH DATA

Graph data setting screens vary depending on the data type selected in Aux.708-1 screen. The following sections describe the setting screens for each data types.

After the values are correctly input, press ↵ to move onto the trigger setting page.

1 Joint data (EXCEPT FOR XYZOAT, TOOL SPEED, I/O SIGNAL, COMBINATION)



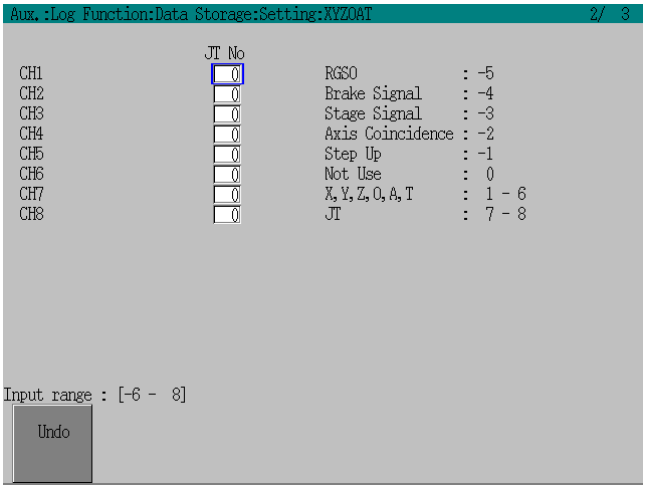
CH1-CH8 indicate the channel number of each graph data. Settable data items and the respective numbers that specify them are on the right of the screen. The data set by numbers -5 to -1 output as 1 when the conditions of data become the ones in the figure below, and its graph data is displayed like signal data. Input 0 (Not Use) to set a channel unused. JT No represents joint numbers. The contents of setting screen for each axis data is the same regardless of the type of the graph data.

Input the number that specifies data item to be displayed on the log graph and press ↵ to jump to the trigger setting screen. If all channels are set to 0 (unused), error occurs and trigger

setting screen is not displayed. Setting the same number into several channels causes overlap error and trigger setting screen is not displayed.

Data	Condition in which 1 is output
RGSO	Outputs 1 when robot gets ready for its motion and starts the motor control.
Brake Signal	Outputs 1 when a motor brake is released.
Stage Signal	Outputs 1 when robot gets ready. (In repeat mode: Motor power is turned ON. In teach mode: Trigger is turned ON.)
Axis Coincidence	Outputs 1 when robot reaches the target pose at each step.
Step Up	Outputs 1 when step of program in progress is switched.

2. XYZOAT data

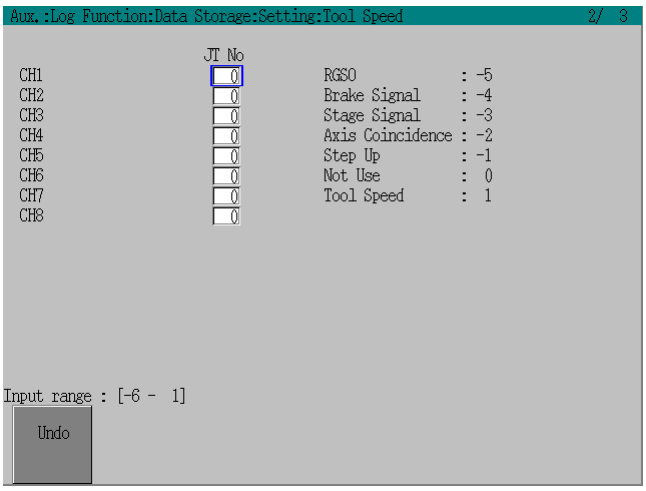


Except for XYZOAT, the data setting is the same as in JT Angle screen. The numbers that specify data 1-6 are allocated to each data of X, Y, Z, O, A and T. The number 7 and above are for external axes.

Input the number that specifies data item to be displayed on the log graph and press ↵ to jump to the trigger setting screen.

If the input number is outside the settable range shown on the right or if all channels are set to 0 (unused), error occurs and trigger setting screen is not displayed.
Setting the same signal number into several channels causes overlap error and trigger setting screen is not displayed.

3. Tool Speed

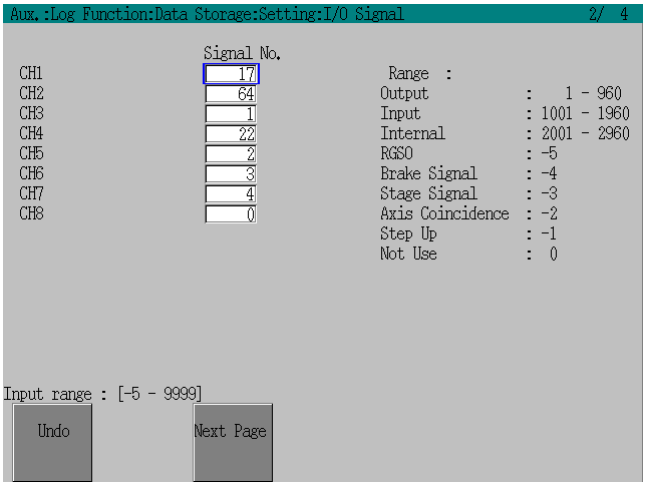


Except for Tool Speed, the data setting is the same as in JT Angle screen. Data number 1 is allocated to Tool Speed, while JT No. can not be set in this screen.

Input the number that specifies data item to be displayed on the log graph and press ↵ to jump to the trigger setting screen.

If the input number is outside the settable range shown on the right or if all channels are set to 0 (unused), error occurs and trigger setting screen is not displayed.
Setting the same signal number into several channels causes overlap error and trigger setting screen is not displayed.

4. I/O Signal



Sixteen channels, CH1-CH16, can be set in the screen above. Settable data items and the respective numbers that specify them are on the right of the screen.

Input the number that specifies data item to be displayed on the log graph and press ↵ to jump to the trigger setting screen.

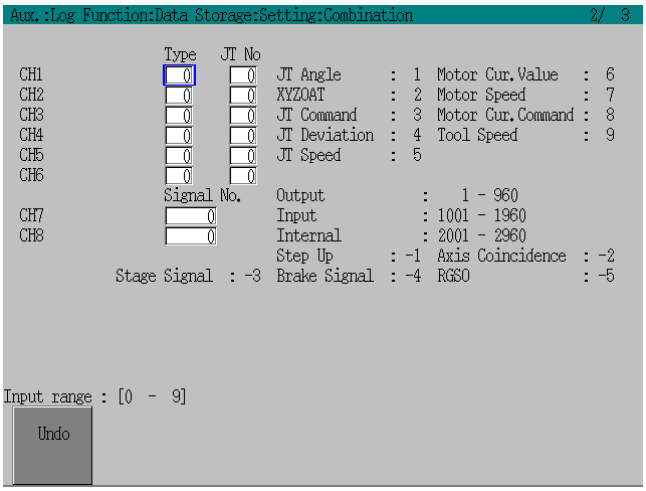
If the input number is outside the settable range shown on the right or if all channels are set to 0 (unused), error occurs and trigger setting screen is not displayed.
Setting the same signal number into several channels causes overlap error and trigger setting screen is not displayed.

The input range of the signal is the maximum number of signals.

When 0 is specified for the robot number and output/ input signal is specified, the signal with the absolute address is displayed. When a robot number other than 0 is specified and output/ input signal is specified, the signal according to the I/O map is displayed. If the specified signal do not match the I/O map, error occurs.

Pressing <Next Page> displays the input screen for CH9 - CH16.

5. Combination



CH1-CH6 and CH7-CH8 are allocated to joint data and signal data respectively in the screen above. Input numbers 1-9 to specify data from the right side into [Type] of CH1-CH6. Input 0 to set the channel unused. Set joint numbers into [JT No] of CH1-CH6. The following combinations of Type and JT No. cause error when recording the set data.

Combinations	Errors
Type = 0, JT No. = 0- max. joint num.	Error occurs when registering if all channels are set unused. Set Joint No. is recorded as it is.
Type ≠ 0, JT No.= 0	Error occurs if registering without setting JT No. However, no error occurs and trigger setting screen is displayed if another channel is valid.
Type ≠ 0, JT No. ≠ 0	Overlap error occurs if the same combination of Type and JT No. is set to other channels.

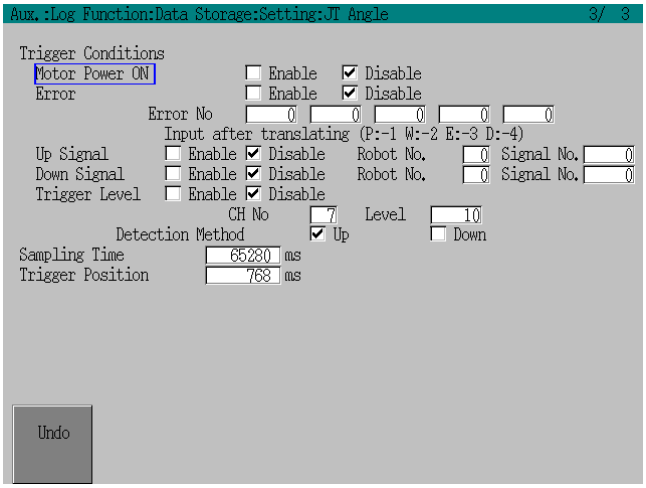
Set data numbers of OX, WX, INT, Step Up, Axis Coincidence, Stage Signal, Brake Signal and RGSO into CH7 and CH8. Input 0 for [Signal No.] to set the channel unused. If the same numbers are set into CH7and CH8, overlap error occurs and trigger setting screen is not displayed.

Input data to be displayed and press ↵ to jump to trigger setting screen.

If all channels are set unused (0), error occurs and trigger setting screen is not displayed.

16.3.3 TRIGGER SETTING

Trigger setting screen below is displayed when data setting has been completed properly.



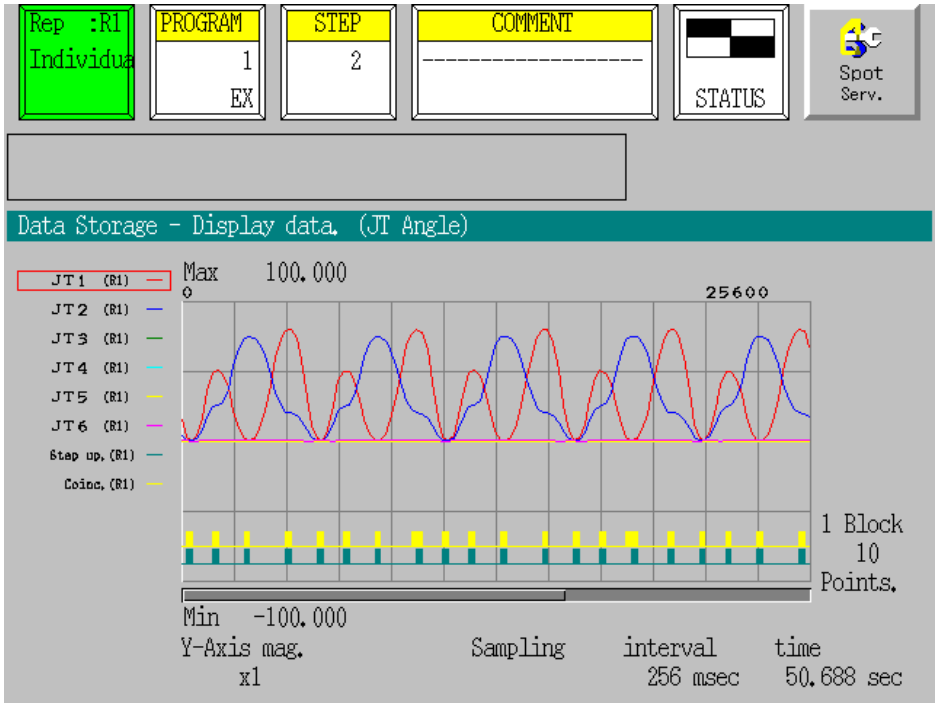
Setting Trigger Conditions allows data logging to start per the conditions specified here. Trigger Conditions and descriptions are below.

Trigger Conditions	Descriptions
Motor Power ON	Data logging starts when the motor power is turned ON.
Error	Data logging starts if a specified error occurs. Set all Error No. to 0 to start data logging when any error occurs. If an Error No. is set to any numbers other than 0, data logging does not start until the specified error occurs. 5 Error Nos. can be specified.
Up Signal	Data logging starts when a specified Signal No. is turned ON.
Down Signal	Data logging starts when a specified Signal No. is turned OFF.
Trigger Level	Data logging starts when data value of a specified CH No. exceeds (Up) or falls below (Down) the specified level. If a specified CH No. is a signal data such as RGSO and Signal number, the specified level is ignored and data logging starts only when the signal data is turned ON or OFF.

Each Trigger Condition only works if set to [Enable]. If several Trigger Conditions are set to [Enable], logging starts when any of them is detected. Specify [Sampling Time] to automatically end the data logging started by trigger detection. Settable maximum [Sampling Time] is determined by the Sampling interval. A Sampling interval of 2 ms allows data logging for maximum of 2028 ms, Sampling interval of 1024 ms allows maximum of 1038336 ms. Specify [Trigger Position] (ms) to set a time for the logging to start before trigger is detected. If [Sampling Time] is set to 10000 ms and [Trigger Position] is set to 100 ms, logging starts 100 ms before the specified trigger is detected and ends after 9900 ms. In case of Sampling Time $\leqq$ Trigger Position, error occurs when registering by pressing ↵.

16.4 GRAPH DATA DISPLAY

Logging data is displayed when logging has completed.



The following key and touch panel operations are available while graph data is displayed.

- Press ← to move graph back 6 blocks.
- Press → to advance graph 6 blocks.
- Holding down on ← or → to move to the head or the end of the graph. The place where the button is released is displayed in the center of the screen.

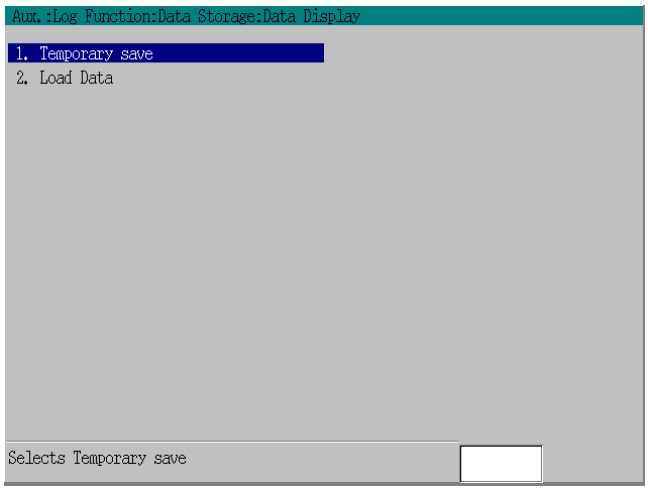
The vertical white line in the graph indicates logging start position. This moves depending on the [Trigger Position] when logging was started by trigger detection

16.4.1 DATA MANAGEMENT

Logging data is cleared when turning controller power OFF→ ON. Several logging data can be stored in the internal memory. In addition, logging data can be saved on to and loaded from an external memory device.

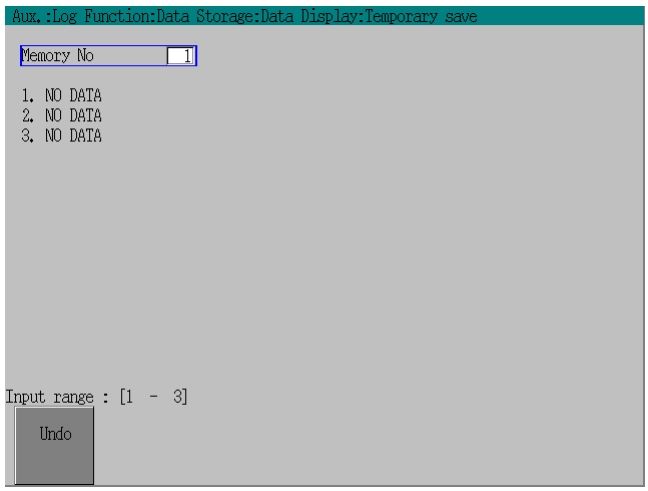
16.4.2 DATA DISPLAY

Select [Data load] from the pull down menu displayed by pressing <STATUS> in the data storage graph screen. The screen shown below is displayed.

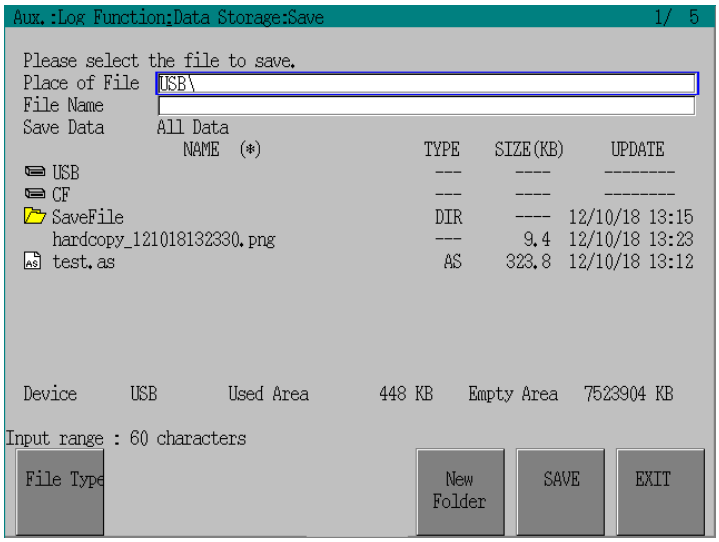


16.4.2.1 TEMPORARY SAVE

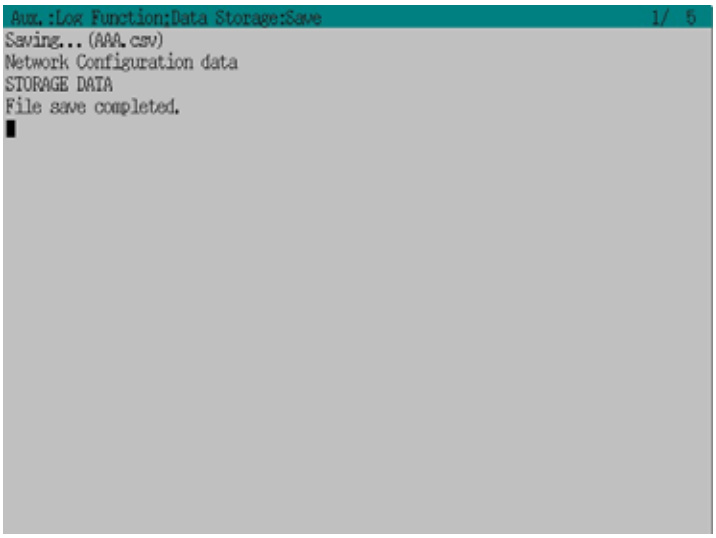
Select [1.Temporary save] to display the screen shown below. Input number of data to be displayed to [Memory No.] and press ↵ to load and display the graph data on the data storage graph screen.



16. 4.3 DATA SAVE



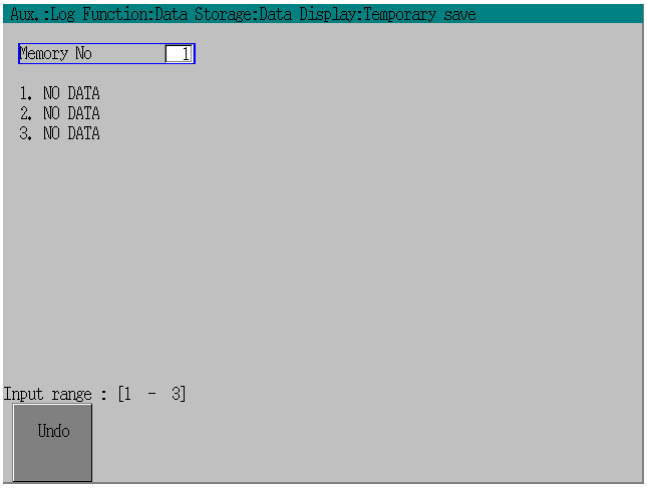
Pressing data storage screen in the data storage graph display screen displays the pull-down menu. Select [Data Save] from the menu to display the screen as shown on the left. See 16.4.2.2 on how to select a file name.



Pressing ↵ saves currently displayed logging data.

Graph data is converted into CSV format when saved on to an external device. For details on CSV data format, refer to 16.5. To save the temporary saved data, the data first needs to be loaded and displayed from Aux.708-4-1 screen before saving. For data display steps, refer to 16.4.2.

16.4.4 TEMPORARY SAVE



Pressing the data storage screen in the data storage graph display screen displays the pull-down menu. Select [Temporary Save] from the menu to display the screen as shown on the left. Input number of data to be saved to Memory No] and press ↵ to copy currently displayed logging data into temporary save area.

Temporary saved data is cleared when turning controller power OFF→ ON.

16.5 DATA SAVING FORMAT

Graph data is converted into CSV format when saved on to an external device. The contents of the converted data are below.

```
.STORAGE
TITLE, Joint value
INITIAL,625,1,8
TRG_TIME,4,1,28,11,43,51
TRG_MTR,0
TRG_ERR,0
TRG_ECODE,0,0,0,0,0
TRG_USIG,1,10
TRG_DSIG,0,0
TRG_RNO_USIG,0
TRG_RNO_DSIG,0
TRG_LVL,0,1,0,0
TRG_SAMPLE,625
TRG_SET_SEC,6
TRG_SEC,6
SAMPLE_TIME,16
UL_LIMIT,1000,-1000
LOG_TIME,1075257831
UNIT,[s], 1[deg], 2[deg], 3[deg], 4[deg], 5[deg], 6[deg], -2, -1
RNO, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
DATA 1,0.016,-5.741,30.455,-28.996,3.238,5.695,15.025,0,0
DATA 2,0.032,-5.740,30.410,-28.104,3.235,4.339,14.717,0,0
DATA 3,0.048,-5.739,30.365,-27.202,3.233,2.960,14.404,0,0
DATA 4,0.064,-5.739,30.319,-26.303,3.232,1.578,14.089,0,0
DATA 5,0.080,-5.738,30.273,-25.420,3.230,0.211,13.776,0,0
                    ...
DATA 621,9.936,-5.737,30.183,-23.736,3.226,-2.421,13.171,0,0
DATA 622,9.952,-5.736,30.141,-22.949,3.224,-3.662,12.885,1,0
DATA 623,9.968,-5.735,30.101,-22.207,3.223,-4.840,12.612,1,1
DATA 624,9.984,-5.735,30.063,-21.513,3.221,-5.949,12.355,1,1
DATA 625,10.000,-5.734,30.027,-20.870,3.220,-6.985,12.114,0,0
END
.END
```

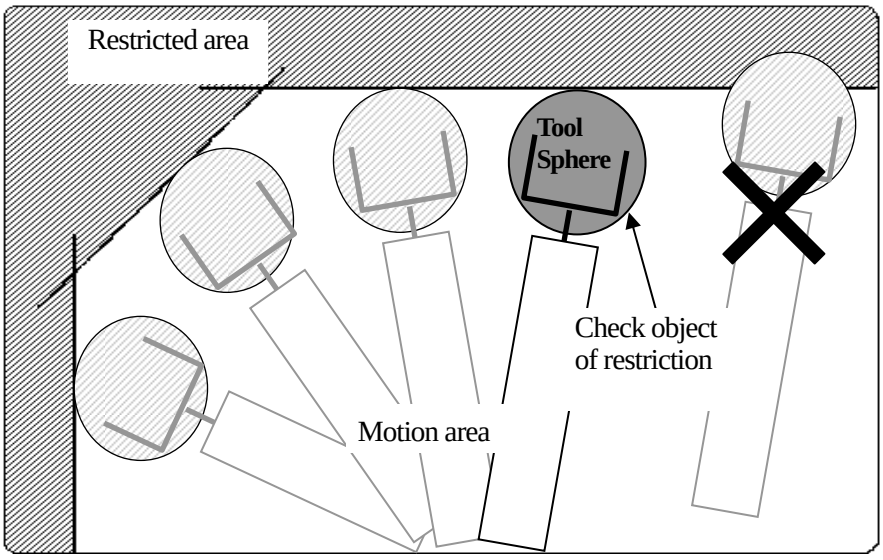
Tag	Descriptions
TITLE,[Character strings]	Title of graph data.
INITIAL, [Data points], [Data type], [The number of channels]	Internal data to be loaded.
TRG_TIME,[yy],[mm],[dd],[H],[M],[S]	Logging start time in yy/mm/dd H:M:S format.
TRG_MTR,[ON=1/OFF=0]	Trigger Conditions: Motor Power ON Enable / Disable
TRG_ERR,[ON=1/OFF=0]	Trigger Conditions: Error Enable / Disable
TRG_ECODE,[ERR1], ... ,[ERR5]	Error No. 1-5
TRG_USIG, [ON=1/OFF=0], [Signal No.]	Trigger Conditions: Up Signal Enable / Disable
TRG_DSIG, [ON=1/OFF=0], [Signal No.]	Trigger Conditions: Down Signal Enable / Disable
TRG_RNO_USIG, Robot No.	Robot No. with Up signal
TRG_RNO_DSIG, Robot No.	Robot No. with Down signal
TRG_LVL, [ON=1/OFF=0], [Channel No.], [Level], [Up= 0 / Down= 1]	Trigger Conditions: Trigger Level Enable / Disable
SAMPLING_TIME, [Sampling Interval]	Sampling Interval
UL_LIMIT,[Upper Limit], [Lower Limit]	Y-Axis Upper Limit / Lower Limit
LOG_TIME,[GMT]	Internal data of logging time
UNIT, [s], [CH1-Info], ... , [CH8-Info]	Graph data information related to DATA tag below. [s] is time elapsed since logging start. [CH*-Info] is displayed in format below: XYZOAT : (XYZOAT, external joint no.) [unit] I/O signal : Signal number Others : Joint no. [unit]
RNO, [CH1-robotInfo], ... , [CH16-robotInfo]	Robot No. of the channel
DATA [Data No.], [Logging time], [CH1-Data], ... , [CH 8-Data]	Channel Data For signal data ; ON=1 / OFF=0.
END	End of channel data

Data may be not displayed correctly if any of the above data is changed.

17.0 VIRTUAL SAFETY FENCE FUNCTION

The virtual safety fence function restricts robot motions to prevent the robot from colliding with peripheral devices due to careless operations in teach mode and keeps the robot within a specified motion area in repeat mode.

The area the robot is not allowed to enter is called restricted area, and is defined by specifying eight lines, called restricting lines. Seen from the robot center, anyplace outside the defined lines is restricted area, and inside the lines is motion area. As shown below, interference is detected when the "check object of restriction" enters the restricted area. The check object is defined for each tool by spheres and/or box. Also, robot models are defined for each robot to check interference of robot body itself.



Error occurs and robot comes to a stop if it enters or tries to enter the restricted area, or tries to start motion within the restricted area.

In teach and check modes, robot stops before entering the restricted area and a warning is given.

Partial restriction areas can be defined within the motion area to set more detailed restrictions.

17.1 RESTRICTED AREA AND CHECK OBJECTS OF RESTRICTION

17.1.1 RESTRICTED AREAS

In VSF function, two types of restrictions can be set: restricted area, limiting the motion area of all robots controlled by a controller, and partial restriction area, setting a restriction area within the motion area.

17.1.1.1 RESTRICTED AREA

Restricted area is set per controller. This area is outside of the specified restricting lines, set by a max. of 8 lines. The restricting lines are defined with respect to world coordinates defined per controller. Upper and lower limits of the restriction can also be set in the Z axis direction.

17.1.1.2 PARTIAL RESTRICTION AREAS

Partial restriction areas are specified by a quadrangular prism defined with respect to the world coordinates set per controller. Inside the quadrangular prism is the partial restricted area, and the robot is inhibited to enter that area. Max. of eight partial restriction areas can be defined within a motion area.

17.1.1.3 COORDINATES ORIGIN OF RESTRICTED AREA

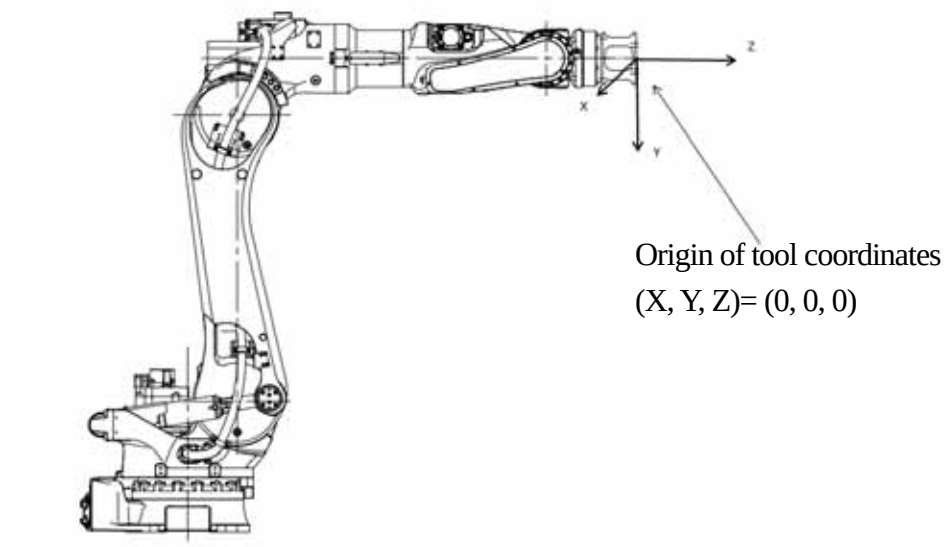
Restricted area and partial restriction areas are set with respect to the world coordinates defined per controller. The world coordinate system can be defined freely according to the conditions for each application.

When using more than 1 robot per controller, installation poses must be recorded for all the robots in order to be able to check interference with the virtual safety fence.

17.1.2 CHECK OBJECT OF RESTRICTION

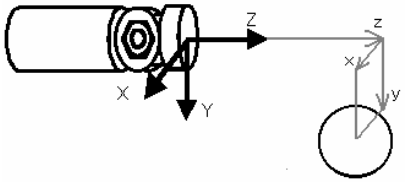
17.1.2.1 TOOL MODEL

Tool model is defined by tool sphere(s) or by a combination of tool sphere(s) and box (cuboid). As when defining a normal tool, the tool sphere center and offset of the tool box are defined with respect to the tool coordinates, whose origin is the center of the robot flange surface.



Defining by tool sphere

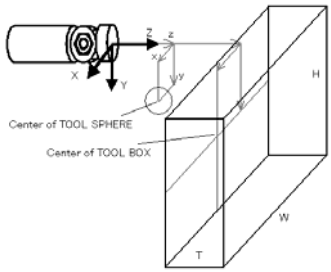
Up to 20 spheres can be defined to represent different tool shapes. The tool sphere center is defined by its X, Y, Z value with respect to the tool coordinates and by the radius (mm) of the sphere.



Necessary parameters:
(mm)
X, Y, Z, radius

Defining by tool box and tool sphere

One cuboid and two tool spheres are defined to represent a tool. Tool box is defined as shown in the diagram below.



Necessary parameters: (mm)
Rotation R
Offset X,Y, Z
Thickness T
Width W
Height H

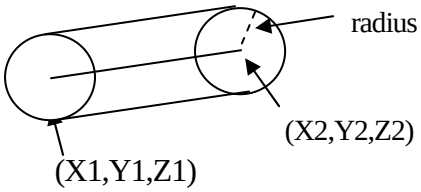
Tool sphere defined with tool box rotates by rotation R together with the cuboid.

[NOTE]

Tool model can only be defined in BX, ZX, RS and KJ/KF series robot.

17.1.2.2 ROBOT MODEL

BX, ZX, RS and KJ/ KF series robot models can be defined as a set of links to prevent non-tool sections of the robot arm from interfering with the restricted area. Each link is expressed as a capsule shape having a length defined as line segment between two points (start and end points) and a thickness set by a specified radius from that segment. The link is defined together with parameter data identifying its corresponding joint/part and robot model. (Details described in 17.3.2.3). The values for the start and end points are defined with respect to the robot base coordinates when all joints at 0 degrees. This applies even if robot is mounted on traverse axis.



BX200L model

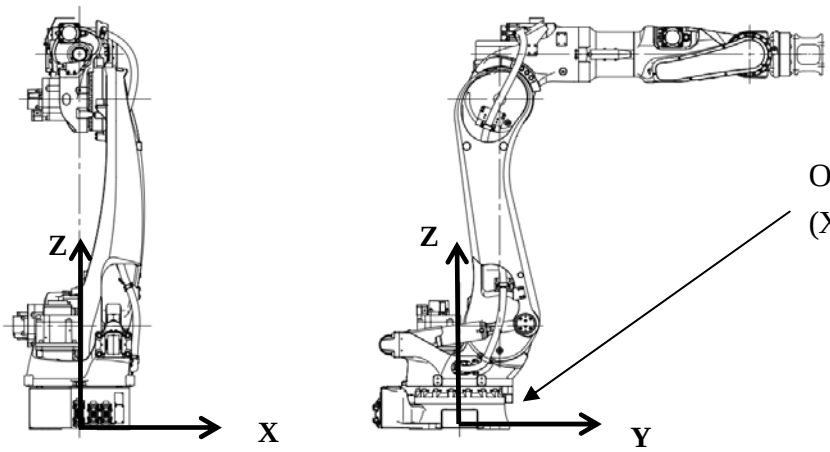
Corresponding Joint/ Part parameter sets to which joints or parts the set links correspond. The settable joints/ parts in each robot series are:

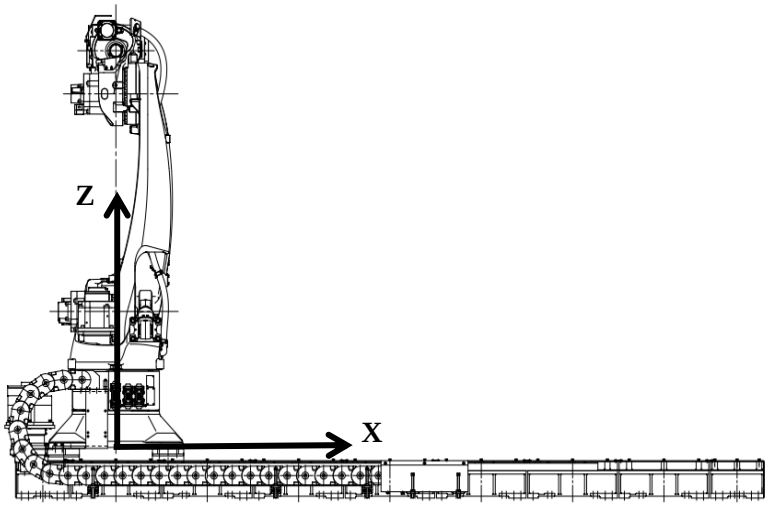
	BX300L/ZX	BX(not including BX300L)/RS	KJ/KF
JT1	OK	OK	OK
JT2	OK	OK	OK
JT3	OK	OK	OK
JT4	OK	OK	OK
JT5	OK	OK	OK
Link H	OK	-	-
Link V	OK	-	-

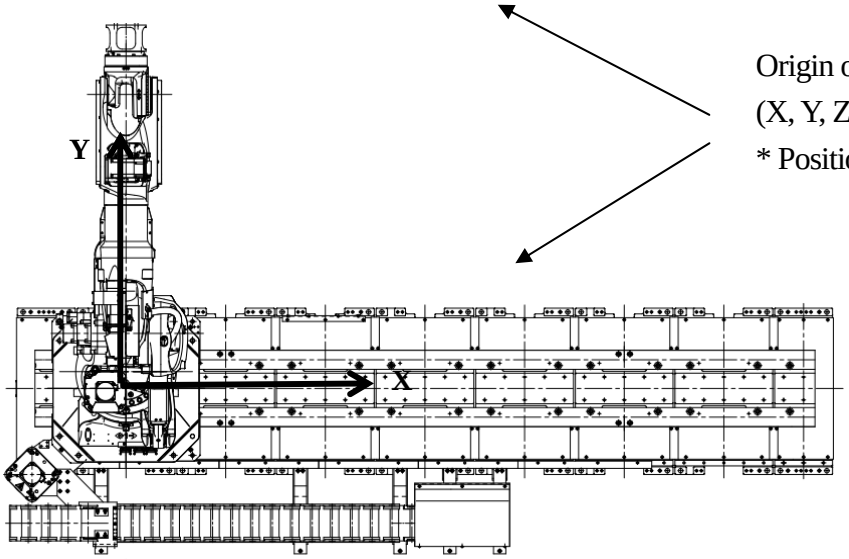
1. Link H and Link V are outer support sections for JT3 motor and parallel link, respectively.
2. Links H and V cannot be set in BX series (not including BX 300L) and KJ/KF series which have no parallel links.
3. For robots other than those described above, such as NC/ DL series robots, arm models are not defined.

Origin of Robot model coordinate system

The pose of the robot model link is registered in respect with each robot's base coordinate system. Link for robot with traverse unit is also defined in respect with the robot's base coordinates and is not affected by the position of the traverse unit.

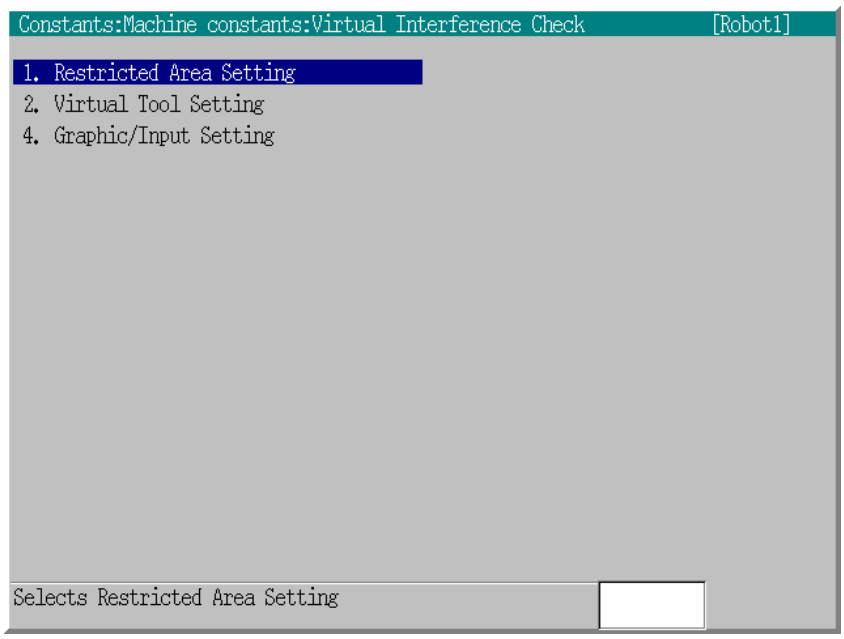






17.2 SETTING SCREENS FOR VSF FUNCTION

This is the main menu screen for the VSF function. To display this menu, press <Constants> on TP screen and select [2. Machine constants]- [24. Virtual Interference Check Function]. (Password is necessary to enter this screen.)



Restricted Area Setting
This screen sets the restricting lines defining the restricted area, sets the partial restriction areas, and displays the restricted areas graphically.

Virtual Tool Setting
This screen sets the tool spheres and box.

Graphic/Input Setting
This screen changes the display and input conditions for the VSF function.

Above settings can be done only when in teach mode and with the motor power OFF.

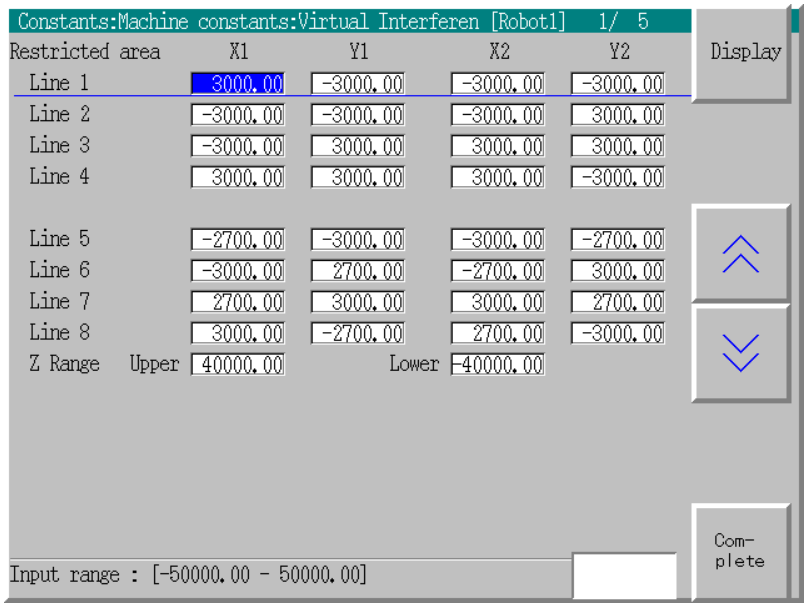
17.2.1 SETTING RESTRICTED AREA AND PARTIAL RESTRICTION AREA

Selecting [1. Restricted Area Setting] from the menu displays the screen below. Restricting lines for defining the restricted areas are set here. Enter the XY values of the world coordinate system defined to each controller for both end points of a line to set one restricting line.

The restricted area is defined by eight restricting lines setting the area limit on 2-dimensional plane and by the range set in Z direction setting the vertical limits. The robot motion space is inside these restricting lines. X, Y and Z are values with respect to the world coordinates set per controller.

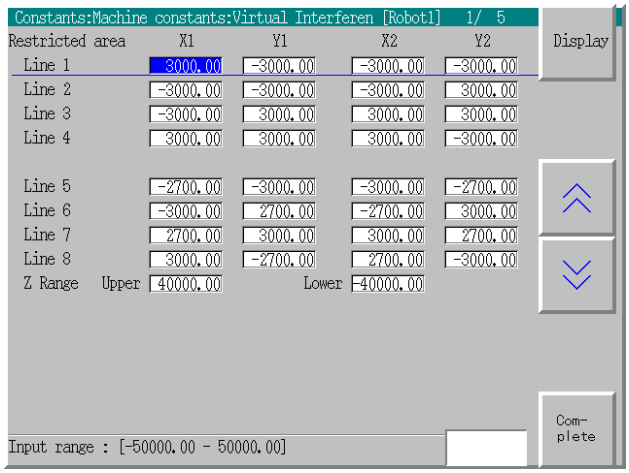
Partial restriction areas can be set within the motion area. A partial restriction area is defined by a quadrangular prism determined by four restricting lines and by height set by Z value. The robot cannot enter the quadrangular prism defined by these. The screen for setting partial restriction areas is displayed by pressing the <arrow> keys at the right hand side of the screen.

Press <Display> to open the graphic display of set restricted areas.



17.2.1.1 SETTING RESTRICTED AREA

Selecting <Constants>- [2. Machine constants] - [24. Interference check function]- [1. Restricted Area Setting] displays the screen below.



Line 1-8

Enter the XY coordinate values for the two points determining the restricting line. Warning is given when the values of the two points are the same. When parameters X1, X2, Y1, Y2 are all set 0.00, the area will not be restricted by that restricting line.

Input aid function

To make input easier, the values input to X1 and Y1 in Line 1 are reflected to X2 and Y2 values in Line 4. Similarly, X1 and Y1 values in Lines 2-4 are reflected to X2 and Y2 values in Lines 1-3. This function is activated only when [Enable] is selected for [Auxiliary Input of Line] in [4. Graphic/ Input Setting].

Z Range

Set the upper and lower limits in Z direction (height) of the restricted area. Enter the Z coordinate value with respect to the world coordinates defined per controller. Setting 0-0 places no limits on motion in the Z direction.

<Display>

Changes to graphic display screen of the restricted area and partial restriction areas.

< ⋀ ⋁> (Up and down arrow keys)

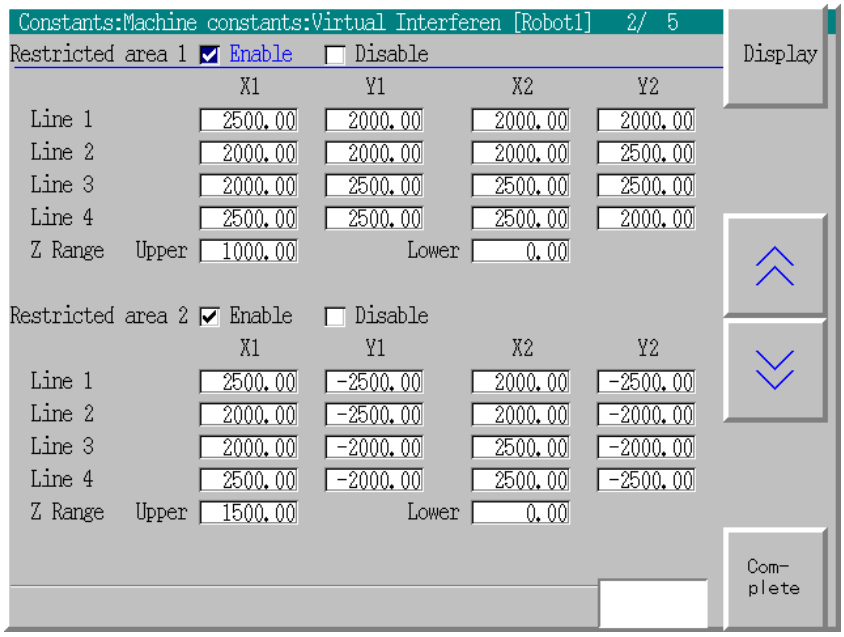
Switches to setting screen for partial restriction areas.

<Complete>

Records the set data.

17.2.1.2 SETTING PARTIAL RESTRICTION AREAS

Pressing the down arrow key on the right side of restricting line setting screen displays the screen below for inputting the values of partial restriction areas.



Enable/ Disable

Sets if robot motion is restricted by that partial restriction area or not. Selecting [Disable] allows robot to enter that partial restriction area.

Line 1-4

Enter the XY values with respect to the world coordinates defined per controller to set the two ends of the restricting line. When parameters X1, X2, Y1, Y2 are all set to 0.00, the area will not be restricted by that restricting line.

Warning message is displayed when <Complete> button is pressed if:

- same coordinate values are entered for the two ends of a line
- three restricting lines pass through a same point
- less than two restricting lines are specified.

Input aid function

To make input easier, the values input to X1 and Y1 for Line 1 are reflected to X2 and Y2 values in Line 4. Similarly, X1 and Y1 values for Lines 2-4 are reflected to X2 and Y2 values in Lines 1-3. This function is activated only when [Enable] is selected for [Auxiliary Input of Line] in [4. Graphic/ Input Setting].

Z Range

Set the upper and lower limits in Z direction (height) for the partial restriction area. Enter Z values with respect to the world coordinates defined per controller. Setting 0-0 places no limits on motion in the Z direction.

<Display>

Changes to graphic display screen for the restricted area and partial restriction areas.

< ∧ ∨ > (Up and down arrow keys)

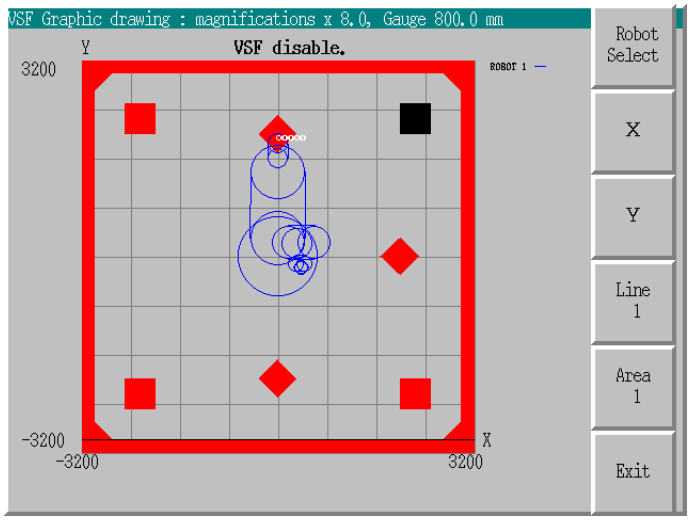
Switches to setting screen for restricted area.

<Complete>

Records the set data.

17.2.1.3 GRAPHIC DISPLAY OF THE RESTRICTED AREAS

Pressing the <Display> button on the value input screen displays the screen below.



The restricted area is the area outside of the restricting lines set in the value input screen when seen from the center of Robot 1. The restricted area is shown in red on the display. Partial restriction areas, if any, are also shown in red.

The robot model is shown as a set of links (cylinders with spheres of same radius on both ends) drawn in blue lines. The tool sphere(s) and box representing the tool are drawn in white lines.

With the above screen being displayed, when operating the robot manually, the models, box and spheres are displayed in real time. This may be convenient when jogging the robot away from VSF.

However, note that VSF function is nullified and interference is not checked when the graphic is displayed in teach mode.

<Robot Select>

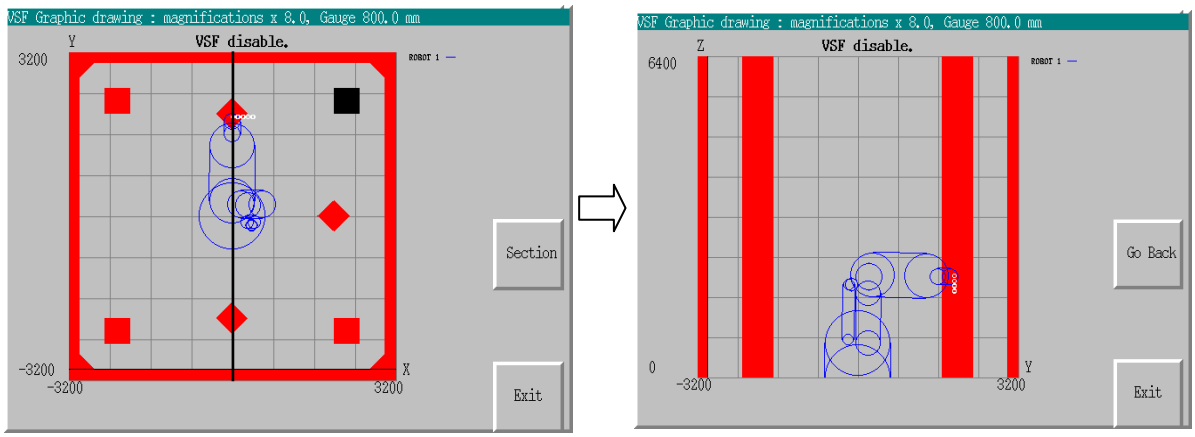
Selects whether or not the specified robot model is displayed on screen. Interference check with the restricted area is done even when the robot is not displayed.

<X/ Y>

Displays the cross-section view line (black bold line). Use the cursor keys to shift the line to the desired place and press <Section>. Then, cross-sectional display in X-Z or Y-Z direction is shown. The restricted area and partial restriction areas are displayed as a cross-section cut along the specified cross-section line. All the robots selected to be displayed are shown in the cross-sectional display.

<Section>

Displays the cross-section of the restricted areas along the specified cross-section view line.

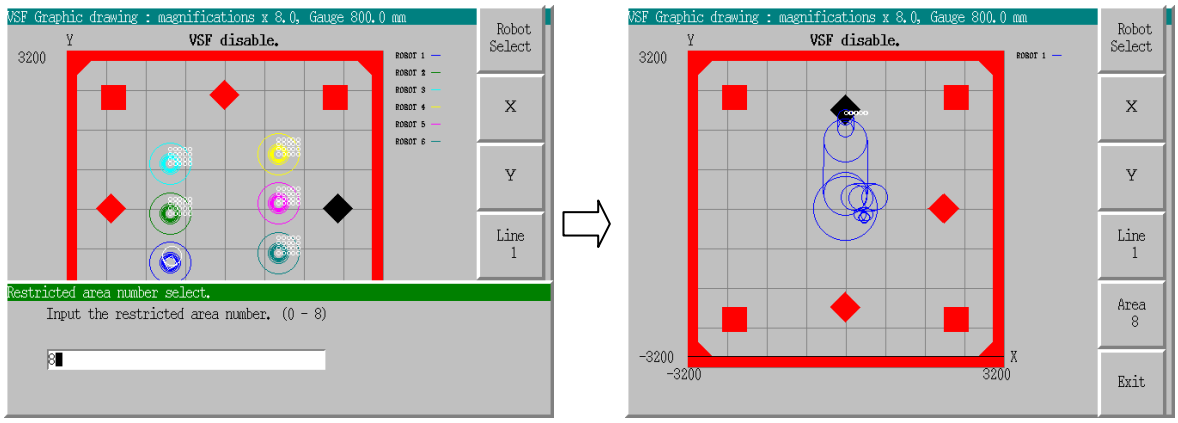


<Line>

Displays the input dialog box for specifying restricting line number. Enter the number of the restricting line to show in black. Entering 0 for line number nullifies the selection.

<Area>

Displays the input dialog box for specifying partial restriction area number. Enter the number of the area to show in black. Entering 0 for area number nullifies the selection.



<Exit>

Exits the graphic screen and returns to the data input screen for restricted area.

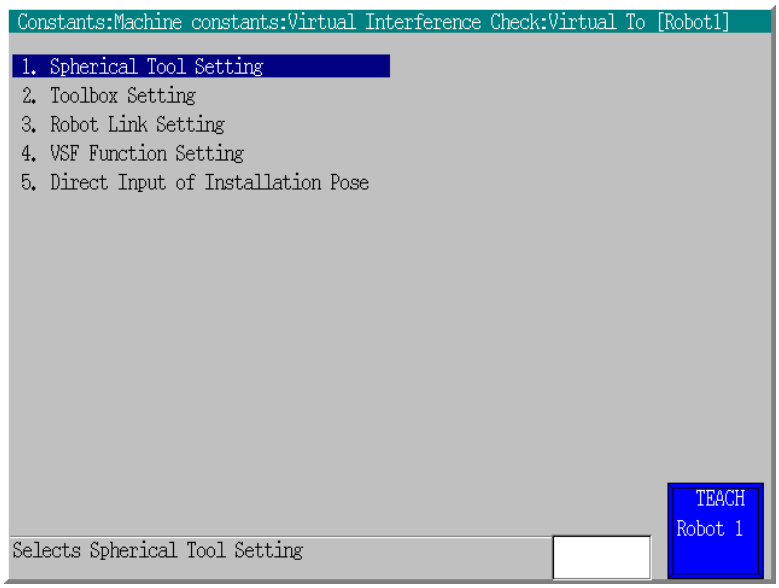
TP key operations in the graphics screen

Keys	Functions
ENABLE + ↑	Zoom in
ENABLE + ↓	Zoom out
↑	Moves up the center of the display
↓	Moves down the center of the display
←	Moves the center of the display to the left
→	Moves the center of the display to the right
R (reset)	Exits graphics screen and returns to Range Setting screen

17.2.2 SETTING CHECK OBJECTS OF RESTRICTION

Check objects of restriction are set by defining tool sphere, tool box and/ or robot arm model via the below menu. Other settings necessary for VSF function are also done from this menu screen.

Press <Constants> on TP screen and select [2. Machine constants]- [24. Virtual Interference Check Function]. Then select [2. Virtual Tool Setting] to display the screen shown below.



Spherical Tool Setting
Displays the screen to set the tool sphere(s) for a tool.

Toolbox Setting
Displays the screen to set a tool box for a tool.

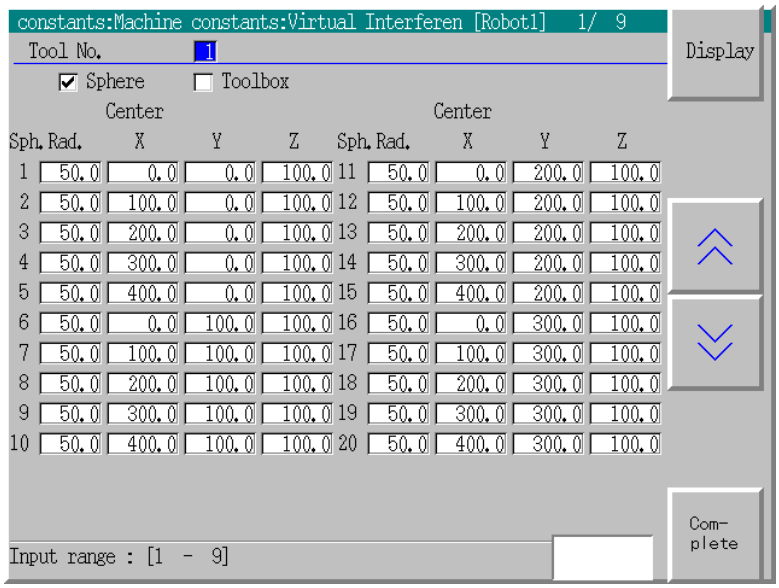
Robot Link Setting
Displays the screen to set the links used to represent a robot model on the graphic display.

VSF Function Setting
Displays the screen to set optional settings such as traverse unit settings.

Direct Input of Installation Pose
Displays the screen to set robot installation poses. Contents of each screen are explained in the next sections.

17.2.2.1 SETTING TOOL SPHERE

Selecting [1. Spherical Tool Setting] displays the screen below.



For each tool, specify the radii and the center positions of the spheres.

Tool No.

Enter the number of the tool to be set with a tool sphere. To change tool number, enter the desired tool number and press ↵, or use the up/down arrow keys to switch screens.

Sphere/ Toolbox

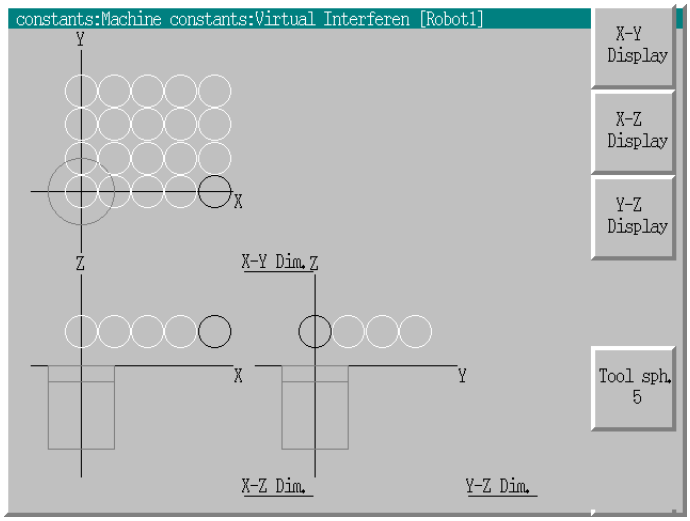
Specifies if tool sphere or tool box is to be set.

Sph. 1-20

Enter the radius and the coordinates value of the center of the tool spheres. Up to 20 spheres can be defined to each tool number. The center of the sphere is defined with respect to the flange (null-tool) coordinates. Entering 0 for the radius nullifies that sphere. Entering 0 for radius of all spheres nullifies interference check for that tool number via settings made on this screen.

<Display>

Displays a 3-views of the specified tool as shown below.



<X-Y Display>/ <X-Z Display>/ <Y-Z Display>

Displays detailed view selected by these buttons.

<Tool sph.>

This button displays an pop-up screen for inputting a tool sphere number. Enter the number of the sphere to be shown in black line. Inputting 0 for tool sphere number cancels the selection.

< ∧ ∨ > **(Up and down arrow keys)**

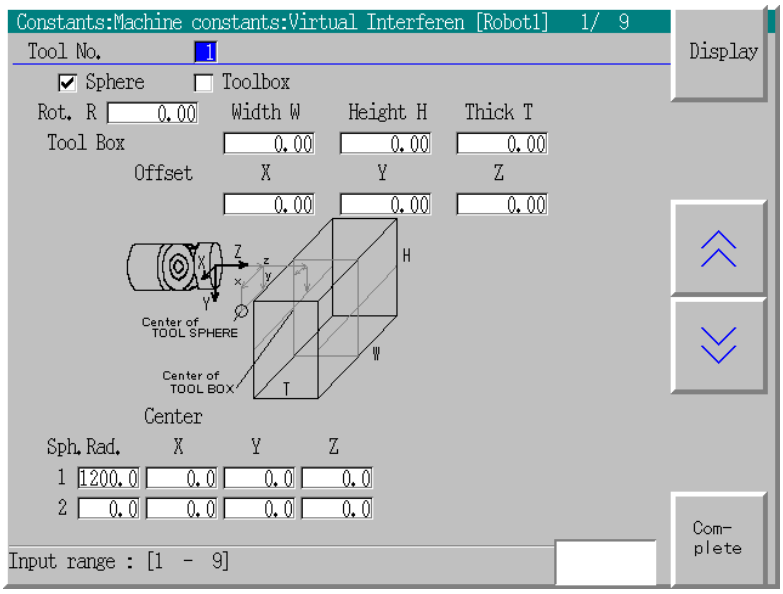
Switches between tool numbers.

<Complete>

Records the set data, and starts monitoring for interference according to the tool sphere(s) set to the selected tool number.

17.2.2.2 TOOLBOX SETTING

Selecting [2. Toolbox Setting] displays the following screen.



A tool box can be set for each tool number. At the same time, two tool spheres can also be set to the same tool.

Tool No.

Enter the number of the tool to set with a tool box (and tool spheres). To change the tool number, enter the desired tool number and press ↵, or use the up/down arrow keys to switch screens.

Sphere/ Toolbox

Specifies if tool sphere or tool box is to be set.

Rot.(ation) R

The tool sphere rotates together with the tool box by the angle set here around the Z axis of the null tool coordinates.

Tool Box

Enter the width (W), height (H), and thickness (T) of the cuboid. Unit is mm.

Offset

Enter the offset value from the center of the flange surface by XYZ values defined with respect to the tool coordinates.

Sphere 1-2
Up to two spheres can be defined together with the tool box. Set the necessary values for the tool spheres as described in the prior section. Entering 0 for the radius nullifies that sphere.

<Display>
Displays a 3- views of the specified tool.

<X-Y Display>/ <X-Z Display>/ <Y-Z Display>
Displays the detailed view selected by these buttons.

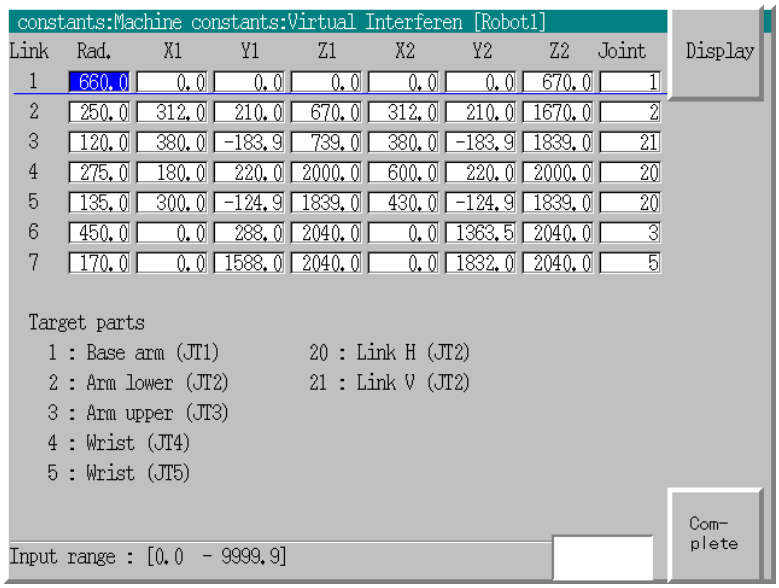
<Tool shp.>
This button appears on screen when <Display> is pressed. Press to display an pop-up screen for inputting a tool sphere number. Enter the number of the sphere to show in black line. Inputting 0 for tool sphere number cancels the selection.

< ∧ ∨ > (Up and down arrow keys)
Switches between tool numbers.

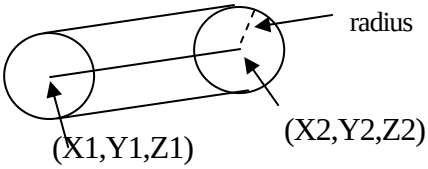
<Complete>
Records the set data.

17.2.2.3 SETTING ROBOT LINK

Selecting [3.Robot Link Setting] displays the following screen.



Link data are set so that an outline body for the robot model can be seen in the graphic display and checked for interference. As shown below, robot links are set as capsule shapes with length: start point (X1, Y1, Z1) to end point (X2, Y2, Z2), and thickness determined by the set radius.



Start and end points are defined with respect to the base coordinates of robot model (all joints at 0).

Link 1-7

Enter the XYZ values with respect to the base coordinates for the start and end points of the link. For radius, enter the distance from the segment determined by the start point and end point. Entering 0 for radius nullifies that link.

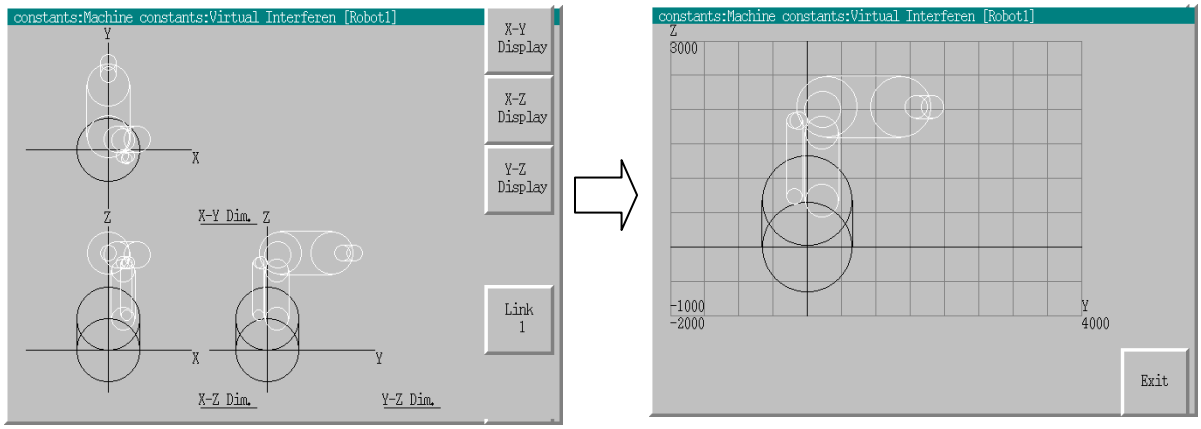
For [Joint] parameter, enter the number of the joint or part to which the link corresponds. The numbers are shown under [Target parts] in lower part of screen. Links 20/ 21 can be set only for robot models with parallel link structure such as ZX series. In models without parallel link structure such as ZB, links 20/ 21 cannot be set.

<Display>

Shows 3-views of the robot.

<X-Y Display>/ <X-Z Display>/ <Y-Z Display>

Displays the detailed view selected by these buttons.



<Link #>

This button displays a screen for inputting a link number. Enter the number of the link to show in black line. Entering 0 for link number nullifies the selection.

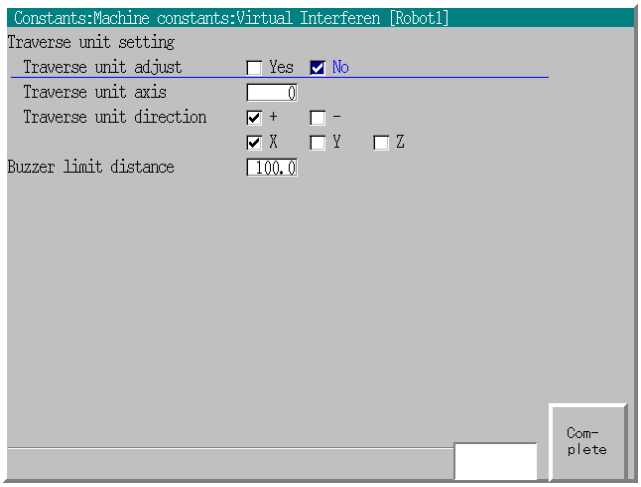
<Complete>

Records the set data.

17.2.2.4 VSF FUNCTION SETTING

[4. VSF Function Setting] screen is for traverse unit and buzzer setting.

Selecting [4. VSF Function Setting] in the menu shown in 17.3.2 displays the following screen.



Traverse unit adjust

Selects whether or not to use the traverse unit. If robot operates with a traverse unit, select [Yes] to limit the motion of objects of restriction (tool spheres, tool box and robot links) in consideration of arm and traverse unit motions. In this case, correct settings concerning the traverse unit are necessary for the virtual safety fence to function properly. Default setting: No.

Traverse unit axis

Enter the number of the traverse unit axis. The motion amount set for this axis is also taken into consideration of position change of objects of restriction.
Default setting: 0. (Normally set at 7.)

Traverse unit direction

Set the direction to which the traverse unit travels with respect to the robot base coordinates. Default setting: +, X

Buzzer limit distance

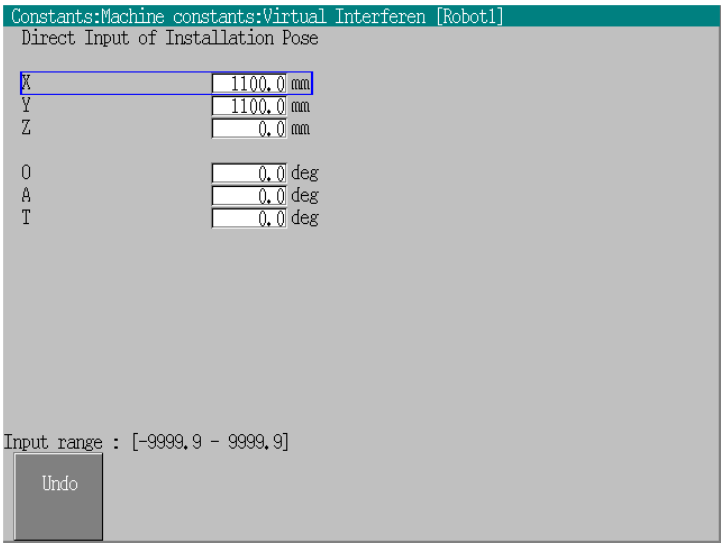
Set the distance from the restricted area. Buzzer beeps when the robot reaches the distance set here.
Default setting: 100 mm.

<Complete>

Records the set data.

17.2.2.5 ROBOT INSTALLATION POSE SETTING

[Direct Input of Installation Pose] screen sets the pose of the each robot's base coordinates with respect to the world coordinates defined per controller. Set the pose as transformation values.

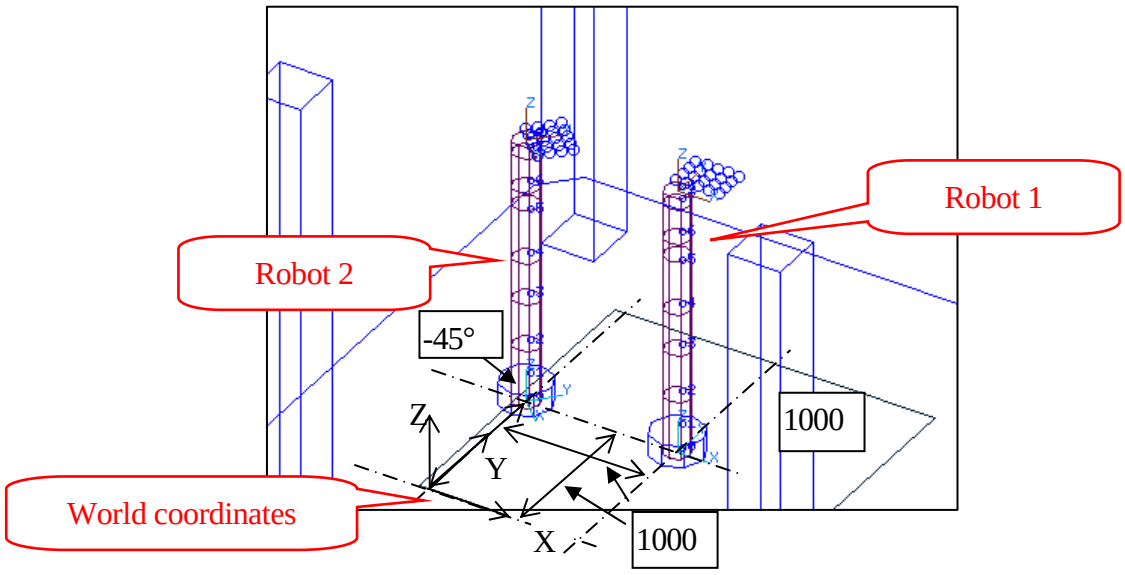


Example

In the diagram below,

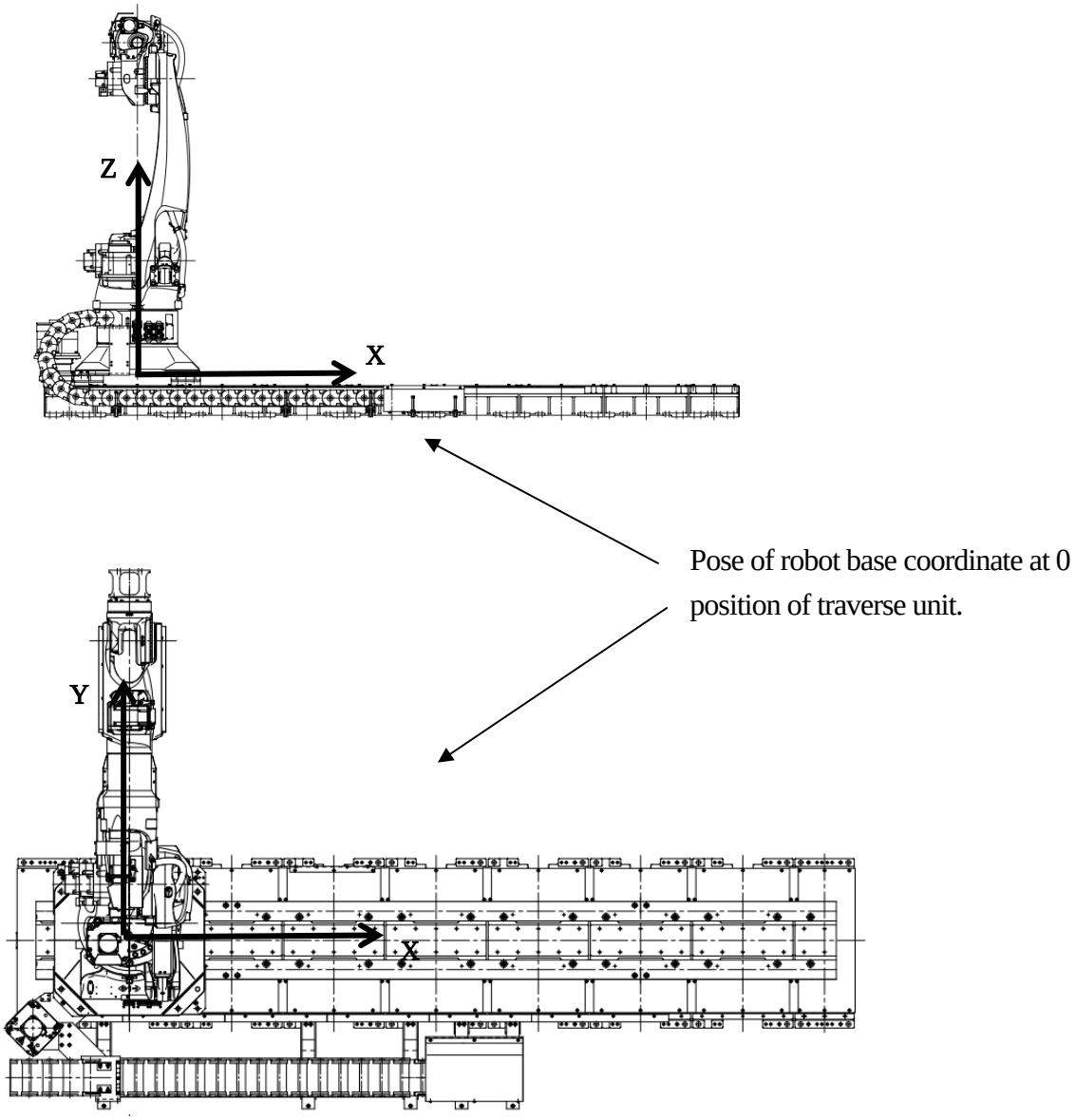
Installation pose for Robot 1 is (X, Y, Z, O, A, T) = (1000, 1000, 0, 0, 0, 0)

Installation pose for Robot 2 is (X, Y, Z, O, A, T) = (0, 1000, 0,-45, 0, 0)



For applications using traverse unit

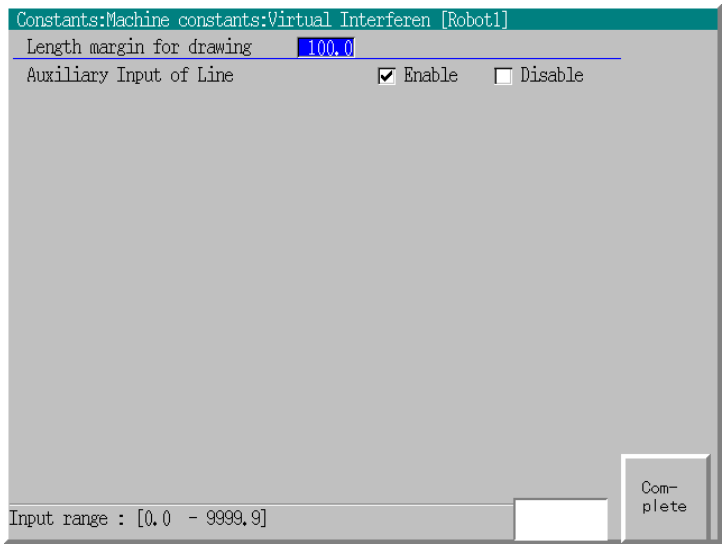
When using traverse unit, the robot installation pose is set at the robot base coordinates with the traverse unit at 0 position.



17.2.3 GRAPHICS/ INPUT SETTING

Selecting [6. Graphic/Input Setting] from the main menu shown in 17.3 displays the following screen.

[Length margin for drawing] sets the size of the graphic display and [Auxiliary Input of Line] enables/disables the restricting line input aid function.



Length margin for drawing
Sets the length (width) of one grid in the graphic display screen. Unit is in mm.

Auxiliary Input of Line (Restricting line input aid function)
Enables/ disables the line input aid function described in 17.2.1 Setting restricted area/ partial restriction area. When [Enable] is selected, the values input for X1 and Y1 in Line 1 are reflected to X2, Y2 in Line 4. Similarly X1 and Y1 values in Lines 2-4 are reflected to X2 and Y2 values in Lines 1-3. This function works when setting the restricted area and partial restriction areas.

17.3 NULLIFYING VSF FUNCTION

When the robot comes to a stop outside of the virtual safety fence, Master power can be turned back ON in neither repeat mode nor teach mode. Follow the procedures below and jog the robot back into motion area.

Recovery Procedure
1. Master can be turned ON when the virtual safety fence is graphically displayed in teach mode. Try error reset if Master cannot be turned ON under this condition.

2. Turn ON Master and manually jog the robot back inside the virtual safety fence.

3. Close the graphic display screen and virtual safety fence function will be enabled.

With the graphic screen displayed, VSF function is nullified even when no error occurs. Note that interference is not checked while graphic screen is displayed.

17.4 SAVING/ LOADING VIRTUAL SAFETY FENCE DATA

To save the virtual safety fence data, save all robot data. When the VSF function is enabled, the virtual safety fence data will be included in the robot data.

To load the virtual safety fence data, select VSF (virtual safety fence) data as the data type to load. Enter the password in the password input box that appears. Virtual safety fence data is not automatically included as robot data when loading data.

17.5 SETTING FOR MULTI-ARM CONTROLLER OPERATION

Following settings are necessary for multi-arm controller operation controlling more than two robots.

1. Restricted area setting
   Follow the procedures explained in 17.2.1 Setting Restricted Area and Partial Restriction Area. World coordinates origin for restricted area setting is recommended to be set so calibration jigs can be used properly.

2. Robot installation pose setting
   Follow the procedures explained in 17.2.2.5 Robot Installation Pose Setting and record the installation pose for all robots used.

3. Robot link setting (For each robot)
   Follow the procedures explained in 17.2.2.3 Robot Link Setting. Normally, default settings need not be changed.

4. Tool data setting (For each robot)
   Follow the procedures explained in 17.2.2.1 Setting Tool Sphere and 17.2.2.2 Toolbox Setting.

17.6 ERROR MESSAGES

When the robot interferes with the restricted areas, error or warning occurs and robot stops depending on whether in teach mode or repeat mode.

In teach mode:
When in teach or check mode, warning is given and the robot stops before entering the restricted area. When teaching operation is done very near the restricting lines, the check object of restriction (tool sphere, etc.) may enter the restricted area. In this case, the robot comes to an error stop.

In repeat mode (auto or manual):
In automatic or manual repeating operation, the robot comes to an error stop before the check object of restriction enters the restricted area. The error stops the robot (cycle OFF) if the check object of restriction is already in the restricted area. In multi-arm controller operation, only the robot that causes an error stops. Other robots do not stop together. All robots may stop due to signal transmission from process controller or ladder diagram setting.

The following errors are displayed if the command value of the robot will enter the restricted area.

Error message	***** Command value almost exceeds virtual safety fence. (*1,*2)
Explanation	Tool sphere/box defined for the tool or the link for the robot model is about to enter the restricted area. *1:Sphere1-20, Link 1-7,Tool box *2:Restricting line1-8, Z upper limit, Z lower limit

Error message	***** Command value almost enters restricted area. (*1,*2 *3)
Explanation	Tool sphere for the tool or the link for the robot model is about to enter the partial restriction area. *1:Sphere1-20, Link 1-7 *2:Partial restriction area1-8 *3:Restricting line1-4, Z upper limit, Z lower limit

Error message	***** Command value almost enters restricted area. (*1,*2)
Explanation	Tool box for the tool is about to enter the partial restriction area. *1:Tool box *2:Partial restriction area1-8

The following errors are displayed if the current value of the robot enters the restricted area.

Error message	***** Current value exceeded virtual safety fence. (*1,*2)
Explanation	Tool sphere/box defined for the tool or the link for the robot model entered the restricted area. *1:Sphere1-20, Link 1-7,Tool box *2:Restricting line1-8, Z upper limit, Z lower limit

Error message	***** Current value entered restricted area. (*1,*2 *3)
Explanation	Tool sphere for the tool or the link for the robot model entered the partial restriction area. *1:Sphere1-20, Link 1-7 *2:Partial restriction area1-8 *3:Restricting line1-4, Z upper limit, Z lower limit

Error message	***** Current value entered restricted area. (*1,*2)
Explanation	Tool box for the tool entered the partial restriction area. *1:Tool box *2:Partial restriction area1-8

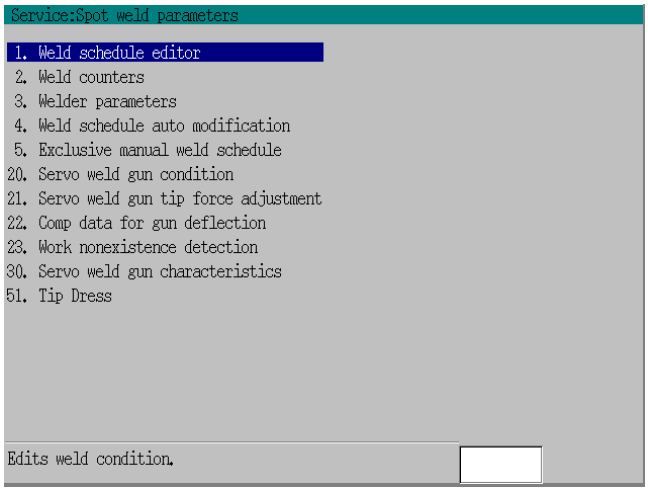
A. SPOT WELDING

This section describes information specific to welding applications. Spot welding can be performed using either a pneumatic gun or a servo weld gun. Carefully read the explanations given below, unless specifically noted the functions described here apply to both types of weld guns. Features and functions unique to the air gun or the servo weld gun are indicated accordingly.

A1.0 REQUIRED SETTINGS FOR SPOT WELDING

In order for the robot to perform spot welding, various data must be set for the weld gun in the Spot service, Constants and auxiliary function screens. Each of the data settings is described in detail below.

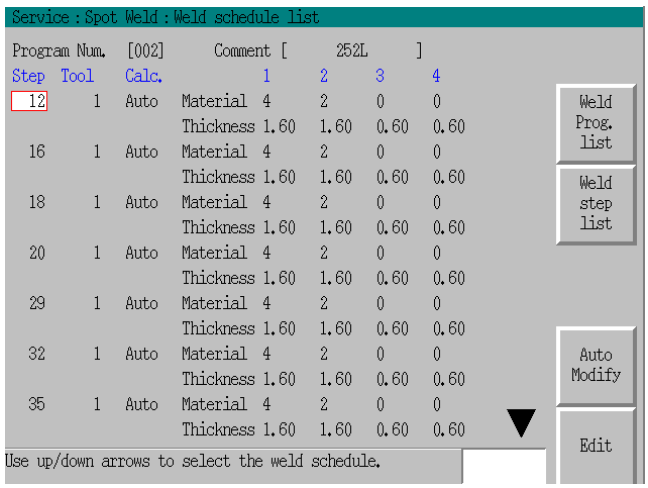
A1.1 SETTING UP SPOT PARAMETERS



Press <Spot service> to display the screen shown on left.

Move cursor to desired function by ↑, ↓ or input its function number by NUMBER (0-9) (E.g.: To display [Weld schedule editor] screen, press 1 then ↵.) and set necessary data on the displayed screen.

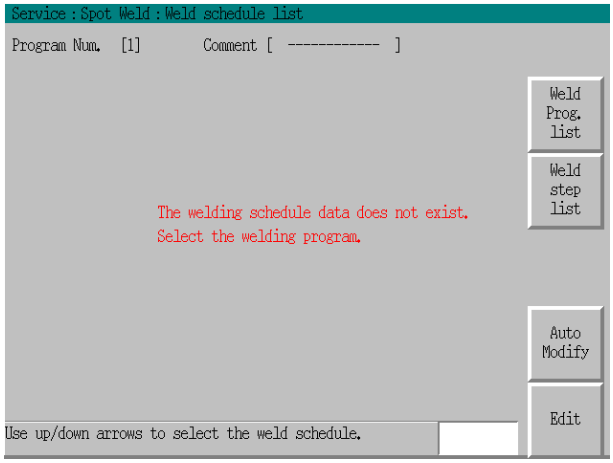
A1.1.1 EDITING WELD SCHEDULE (CONDITION)

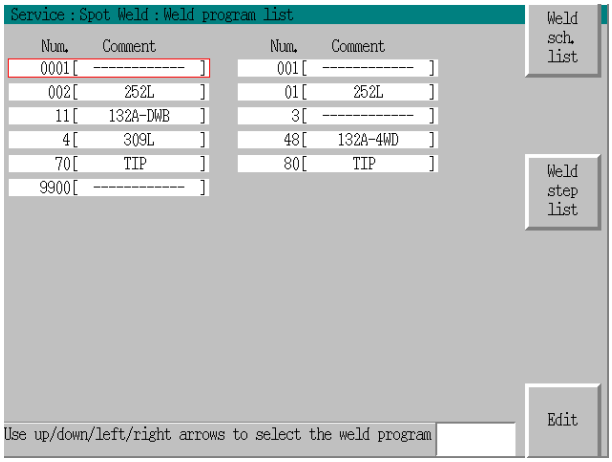


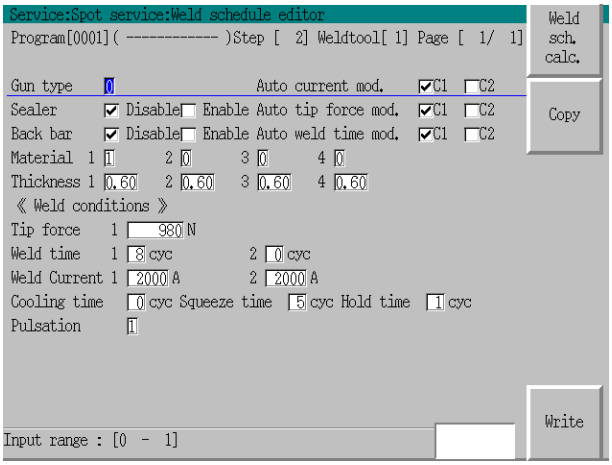
Select [1. Weld schedule editor] in the screen shown above.

When selecting a program that contains weld points, the screen shown on left appears. Press <Edit> to display the weld schedule editor screen.

If a program containing no weld points is selected, the screen below-left appears. Otherwise, Press <Weld program list> to display the screen below-right. Use ↑, ↓, ← and/or → to select a program to edit. Press <Edit> to display weld schedule editor screen.







Weld conditions can be edited on the screen shown left

Each of the on-screen items are defined below.

Control type

Specifies power source used for welding, constant or auto modification (adaptive control).

Gun type (Setting range: 0, 1)

0:direct welding

1:series welding

Sealer

Sets if application contains sealer.

Back bar (Setting range: 0,1)

Sets if welder operates with or without a Back bar.

Material (Setting range: 0- 5)
Sets material specification of each plate, from 1 to 4 overlapping plates.
0:no plate
1:SCP, SHP28 - 35
2:SGA, CSEA, CSEMC28 - 35
3:SCAP, SHP38 - 45
4:SGAC, SEAC38 - 45
5:SCP, SHP60 -

Thickness (Setting range: 0.60 – 3.00)
Sets thickness of each plate, from 1 to 4 over lapping plates.

Auto current mod., Auto tip force mod., Auto weld time mod.
Sets whether to use C1 or C2 set in A1.1.4 Weld Schedule Auto Modify when modifying (by linear-up) weld current, tip force ad weld time depending on the number of weldings.

< Weld sch. calc. >
Pressing this button uses the data familiar to operator that is input in the top half of the screen to search the preinstalled welding database for weld conditions that best match the input data. The search results are automatically input in the<<Weld conditions>>on the bottom half of the screen. These conditions can be manually modified as needed. To save all settings, press <Complete>.

[<<Weld conditions>>] can be input automatically (and edited) per the above method, or they can be input manually.

Tip force (Setting Range: 98 – 9999N)
Sets the tip force of the weld gun.

Weld time (Input Range: 0 – 99 cyc)
Sets the length of time to apply weld current for 1st and 2nd weld.

Weld current (Input Range: 2000 – 25500 A)
Sets amount of weld current at 1st and 2nd weld.

Cooling time (Setting Range: 0 – 99 cyc)
Sets cooling time before 2nd weld.

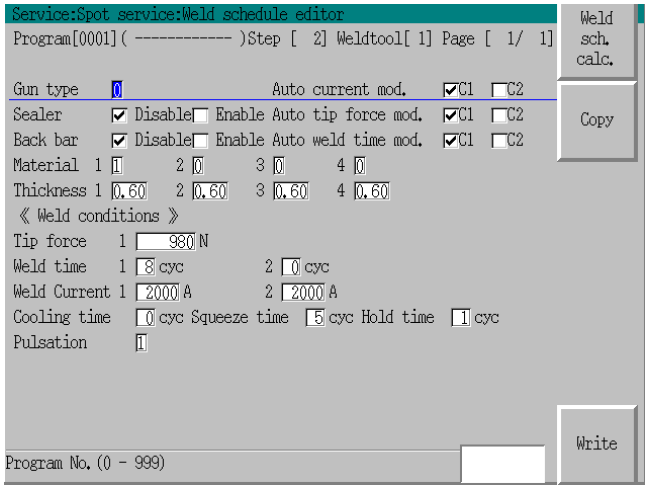
Squeeze time (Setting Range: 0 – 99 cyc)
Sets length of time between start of pressurization and first current application.

Hold time (Setting Range: 0 – 99 cyc)
Sets length of time between end of current application and gun opening.

Pulsation (Setting Range: 1 – 9)
Sets how many times the set current is pulsed (applied) to the weld point.

<Auto Modify >
Sets the weld condition automatically for individual step based on weld condition data that are familiar to the operator.

< Copy >



Pressing < Copy > displays the input box at the bottom of the screen.

Input the program number whose step data is to be copied by NUMBER (0-9) and press ↵.

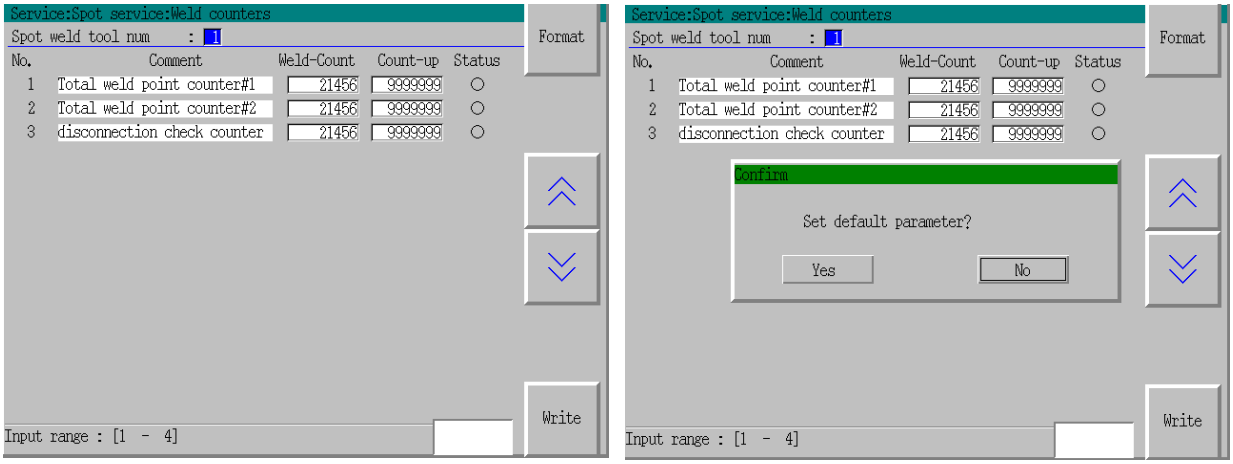
Then input the step number containing the desired weld conditions by NUMBER and press ↵. Requested weld condition is copied and displayed in the weld schedule editor screen.

< Complete >
Press < Complete > to save* the weld schedule data shown on screen to memory.

NOTE* Note that to save the weld schedule data to memory, < Complete > must be pressed, not REC.

A1.1.2 WELD COUNTERS

Select [2. Welding counters] from Spot service menu to display the screen shown below left.
Shows/set weld-counts for weld point and disconnection check counters.



Spot weld tool number (Setting range: 1 - 4)
Sets the identification number of the weld gun.

Weld-Count (Setting range: 0 - 99999999)
Counts up every welding operation. Direct input of the weld count value is also available.

Count-up (Setting range: 0 – 99999999)
When weld counter value exceeds this preset value, status indicator below changes from ○ to ● for an alarm.

Status ○: Weld-count ≦ Count-up setting
Status ●: Weld-count ＞ Count-up setting

Disconnection check counter (Input range: 0 – 99999999)
When the Weld-count reaches the preset Count-up value, the disconnection check signal turns ON. Set interlock panel to receive this signal and to activate a disconnection check program upon its input. Then, set the program completion signal to be sent from interlock panel to robot so that the disconnection check signal turns OFF and Weld-count for this counter returns to 0.

<Initialize>
Press <Initialize> to display the confirmation pop-up screen above right. Select [Yes] to reset all the counters to zero.

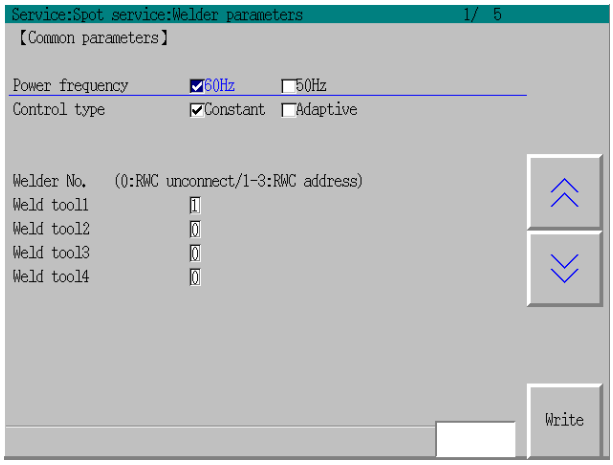
Press <⩒ ⩓> to display the setting screen for each weld tool number.

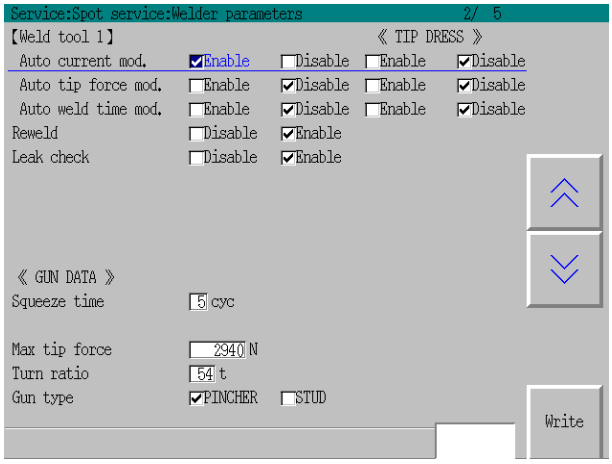
<Complete>

Press <Complete> to store the weld counter data to memory.

A1.1.3 WELDER PARAMETERS

Select [3. Welder parameters] from Spot service menu to display the screen shown below. Set parameter data for the welder through these screens.





Power frequency

Sets the power frequency used by the welder.

Control type

Sets the control type used by the welder.

Weld tool 1-4 (Setting range: 0-6)

Sets the RWC numbers for each tool(weld gun).

0: RWC unconnected

1-6: RWC addresses

Auto current modif., Auto tip force modif., Auto weld time modif.

Select [Enable] to make the auto modification (adaptive control) function take effect on current, tip force and weld time of each weld and tip dress.

Reweld

Select [Enable] to execute automatic rewelding when a current drop occurs.

Leak check

Select [Enable] to activate leak check function for the welder.

Squeeze time (Setting range: 0-99 cyc)
Value set here is referred and set automatically in the weld conditions when pressing <Auto Modify>. Actual squeeze time length is set per A1.1.1.

Gun Cylinder Area (Setting range: 0-999 cm^2)
Set if a pneumatic gun is used. (displayed only for air gun application.)

Max tip force (Setting range: 10-9999N)
Sets the maximum tip force of the gun.

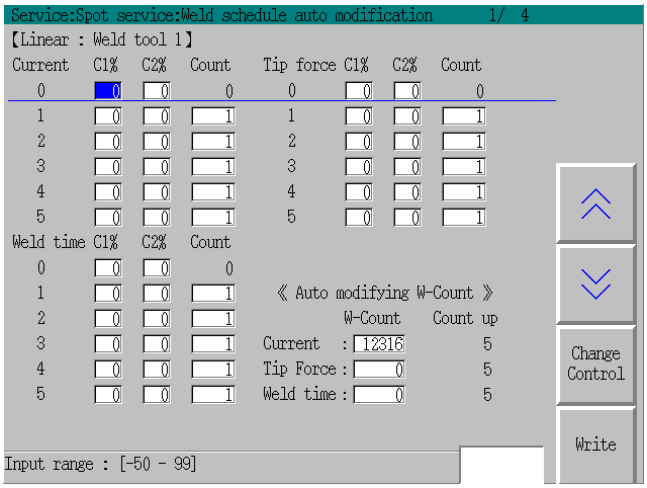
Turn ratio (Setting range: 0-999 t)
Sets the turn ratio of the transformer.

Gun type
Pincher: Select if a standard weld gun is used.
Stud: Select if a stud weld gun is used.

Press < > to display the setting screens for other weld tool numbers.

<Complete>
Press <Complete> to store the welder parameter data set for each tool number to memory.

A.1.1.4 WELD SCHEDULE AUTO MODIFY



Select [4. Weld schedule auto modification] from Spot service menu to display the screen shown on left. Sets how the weld schedule is auto modified according to the number of weldings.

Select either C1 or C2 when using this function. Refer to A1.1.1 for more details.

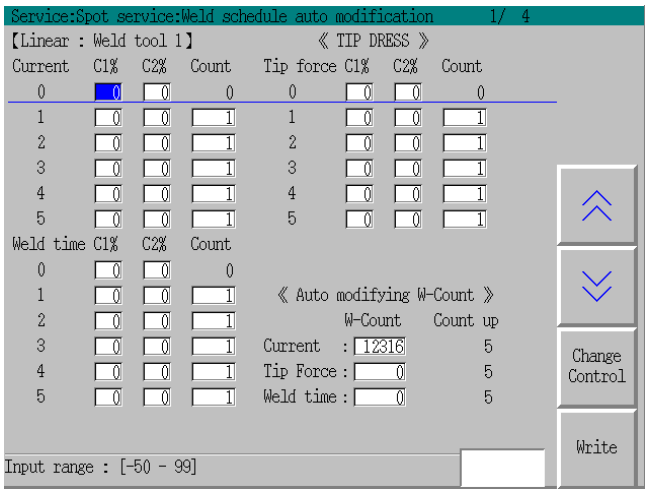
C1/C2 for Current/Tip force/Weld time (Setting range: -50-99 %)
Specify the current, tip force, and weld time to five specific points as the percentage to the standard weld conditions set in A1.1.1, which defines the linear-up characteristics [C1] or [C2]. Modification takes effect from first weld until the weld counter value reaches the number shown in [Count up].

Count (Setting range:0-99999)
Sets the number of welds within each block (1-5).

W-Count («Auto modifying w-count»)
Shows the current cumulative weld counter value (linear up counter values). Counter value returns to zero, if the linear up reset signal is input.

Count up
Shows total count of all the blocks specified in [Count] column for [Current], [Tip force] and [Weld time]. When weld counter value exceeds this total, the weld schedule is no longer modified by this function.

<Change Control>



Every time <Change Control> is pressed, screen switches as follows:
Normal weld→Tip dressing →Normal weld

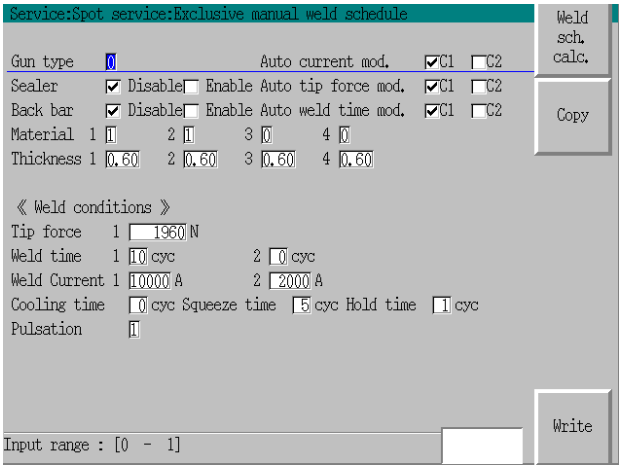
If weld tip dressing equipment is used, set linear-up characteristic data on this screen as you would for normal welds.

Press < ﹀ ﹀ > to display the setting screens for other weld tool numbers.

<Complete>

Press <Complete> to store the weld parameter data to memory.

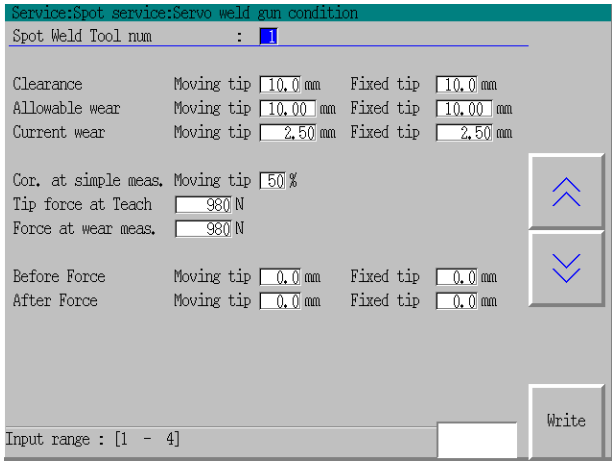
A1.1.5 EXCLUSIVE MANUAL SCHEDULE



Select [5. Exclusive manual schedule] from Spot service menu to display the screen shown on left. Sets the data used when operating the system manually.

Use the procedure and description noted in A1.1.1 to make settings here.

A1.1.6 SERVO WELD GUN CONDITION



Select [20. Servo weld gun condition] from Spot service menu to display the screen shown on left.

Sets the operating parameters for the servo weld gun on this screen.

Spot weld tool number (Setting range:1-4)
Sets the identification number of the servo weld gun.

Clearance (Moving tip, Fixed tip) (Setting range:0.0-max stroke of the gun unit: mm)
Sets the distance that the moving and fixed tips move away from the workpiece after completion of welding. These distances can also be set via the SGCLEARANS AS language command.

Allowable wear (Moving tip, Fixed tip) (Setting range:0.00-100.00 mm)
Sets allowable tip wear. If moving/fixed tip wear exceeds the set value, error arises.

Error code: E5034 Tip wear exceeds limit (Moving side)
E5035 Tip wear exceeds limit (Fixed side)

Setting zero disables this error check function.

Current wear (Moving tip, Fixed tip)
Setting range: |setting value| < [Allowable wear] (set above)
Displays the current wear values last calculated by controller at the moment this screen is displayed. Values reset to zero upon input of “linear up reset” signal, and current values can be displayed by SGCHIP AS language command.

Cor. at simple meas. (Moving tip) (Setting range: 0-100 %)
Specifies the wear ratio of moving tip as a percentage of the total wear of moving and fixed tips that were calculated by the workless wear measurement. In this case moving tip wear is calculated as follows:
1. First calculates the total wear of moving tip and fixed tip based on the gun axis value at workless clamp measurement.
2. Moving tip wear is given by multiplying the total wear by the set wear ratio.
Wear ratio of the fixed tip becomes: 100 % - [Cor. at simple meas. Moving tip] %

Tip force at Teach (Setting range: 294-9799 N)
Sets the tip force applied for welding teach mode when ENABLE + CLAMP or AXIS are pressed.

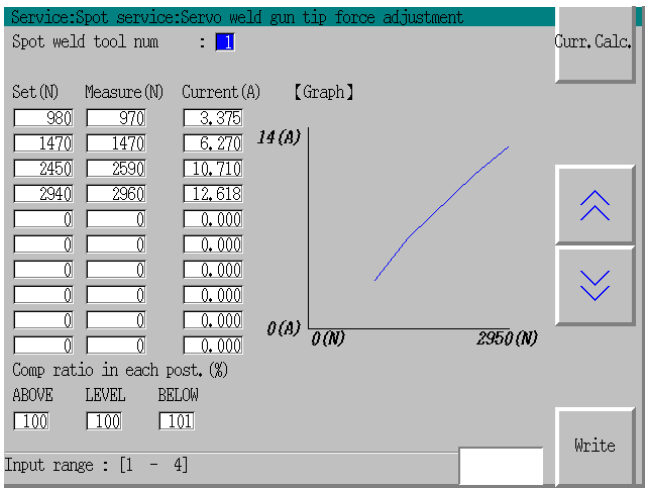
Force at wear meas. (Setting range: 100-max tip force N)
Sets the tip force of the servo weld gun at the tip wear measurement.**

NOTE** We recommend setting the same value used at [Tip force at teach] in order to minimize errors during measurement.

Press < > to display the setting screens for other weld tool numbers.

<Complete>
Press <Complete> to store the parameter data to memory.

A1.1.7 SERVO WELD GUN TIP FORCE ADJUSTMENT



Select [21. Servo weld gun tip force adjustment] from Spot service menu to display the screen shown on left.

Based on data set here, this screen adjusts current output so that the motor can accurately apply the specified tip force value.

Spot weld tool number (Setting range:1-4)
Sets the identification number of the servo weld gun.

Set (N) (Setting range:0-9799 N)
Set the target tip force value to be measured.

[NOTE]

1. Set the tip forces in ascending order. When adding a force between previously set force values, move all subsequent values down one line.

2. Operate in this order: Input [Set] values, measure actual force to each setting and input readings in [Measure], press <Current Calc.> to attain the adjusted Amp values in [Current]. Be careful not to press <Complete> before pressing <Current Calc.>. Finally, press <Complete> to save all settings.

Measure (N) (Setting range: 0-9799 N)
Pressurize gun at each value set in [Set (N)]. Measure* the actual tip force generated at that setting, and set those values in [Measure].

NOTE* Measurement in Repeat mode is recommended under the same pressurizing conditions as in actual production, when measuring contact Kawasaki for measurement procedure.

Current (A) (Setting range: 0.000-100.000 A)
Displays the gun axis motor current required to attain the [Set] tip force.

<Current Calc.>*

Press <Current Calc.> to calculate the gun axis motor current values required to attain the tip forces that were set at [Set (N)].

NOTE* Repeat force measurement and pressing <Current Calc.> until the difference between set and measured force values reduces to the desired threshold.

Graph

Displays a graph of the correlation between [Set (N)] and [Current (A)]. Updates the data every time < Current Calc.> is pressed.

Com ratio in each post. (%) ABOVE/LEVEL/BELOW (Setting range: 50-150 %)

Although the same current is set for each gun posture, the actual tip force of the servo weld gun changes with its posture due to the effect of gravity, friction, etc. To compensate, set an adjusting ratio to magnify/reduce current output so that the set force can be attained. Set adjusting ratio to 100 in standard gun postures and set adjusting ratios in the other postures as follows:

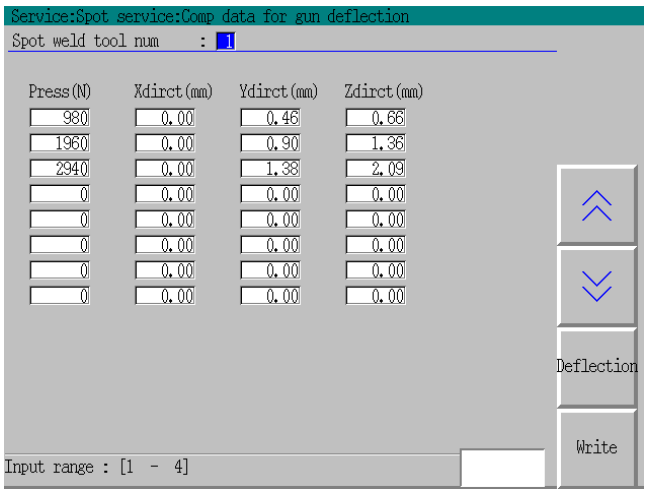
$$\text{Adjusting ratio} = \frac{\text{Actual tip force in the standard posture}}{\text{Actual tip force in the posture}} \times 100$$

Press < > to display the setting screens for other tool numbers.

<Complete>

Press <Complete> to store the input data for the servo weld gun to memory.

A1.1.8 COMPENSATION DATA FOR GUN DEFLECTION



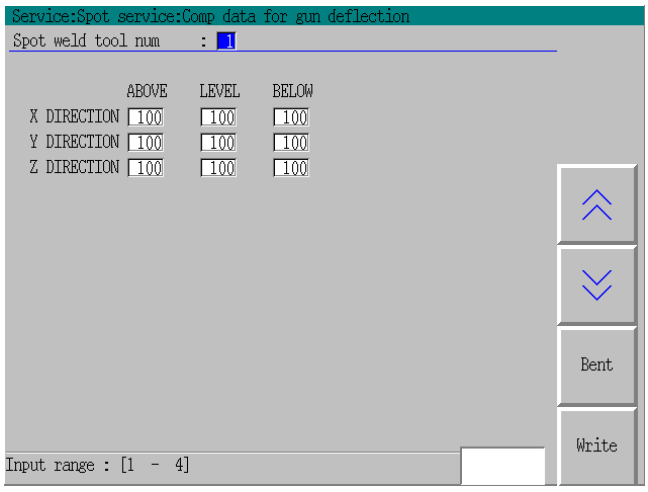
Select [22. Comp data for gun deflection] from Spot service menu to display the screen shown on left.

Set the amount of deflection on the tool X, Y and Z directions of the servo weld gun to be compensated by the controller during gun pressurization.

Press (N) (Setting range: 0-9799 N)
Sets the force value used when measuring the deflection of the servo weld gun.

X direct (mm), Y direct (mm), Z direct (mm) (Setting range: -100.00-100.00 mm)
Sets the deflections along X, Y and Z directions of the servo weld gun tool coordinates at each force value when pressurizing the gun in its standard posture.

<Comp data for gun deflect>



Press <Deflect> to display the screen shown on left.

This adjusts how much compensation is applied to the deflection amounts set on previous screen depending on the posture of the gun.

ABOVE, LEVEL, BELOW (Setting range: 50-150)
Set deflection data in standard posture to 100 on X, Y and Z directions of the gun tool coordinates, then set the deflection data for the other postures as percentage to that in standard posture.

<Deflect adjust>

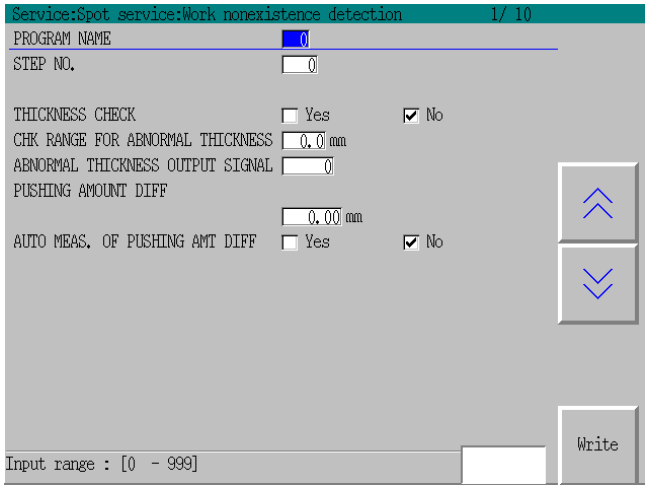
Press <Deflect adjust> to return to the previous screen.

Press < ﹀ ﹀ > to display the setting screens for other weld tools number.

<Complete>

Press <Complete> to store the data settings for gun deflection compensation to memory.

A1.1.9 WORKPIECE DETECTION FUNCTION



Select [23. Work nonexistence function] from Spot service menu to display the screen shown on left.

Sets the parameter data for the Workpiece detection function.

PROGRAM NAME (Setting range: 0-999), **STEP NO.** (Setting range: 0-9999)
Sets the program name and step number.

THICKNESS CHECK

Select [Yes] or [No] to check the thickness of the plate at the input step number.

[NOTE]

Although [Yes] is set, the thickness is not checked unless the “Gun status” information is set to “Normal weld” or “Fast pressurizing” mode.

CHK RANGE FOR ABNORMAL THICKNESS (Setting range: 0.0-9.99)
Sets the allowable range of thickness. Checks if the difference in thickness between repeat and teach modes is within the setting range. If not in range, workpiece may be abnormal or the workpiece itself may be absent.

ABNORMAL THICKNESS OUTPUT SIGNAL (Setting range: 0-max output signal number)
Sets the signal number to be output in the event of abnormal thickness.

· **Setting other than 0**
Displays error message, E5033: Cannot weld because of abnormal thickness, if thickness is abnormal and error signal is output as a 0.3 sec pulse. However the robot does not stop its weld sequence i.e. weld start signal outputs, awaits weld completion signal, etc. (If stopping the robot is necessary, configure system to do so via the interlock panel.)

· **Setting 0**
Displays error message, E5033: Cannot weld because of abnormal thickness, in the event of abnormal thickness and the robot stops the repeat operation at the moment servo weld gun pressurizes and start weld signal is not output.

PUSHING AMOUNT DIFF (Setting range: -300.00-300.00 mm)
Calculates and displays the difference in pushing amounts for gun axis between repeat and teach modes. Difference will not be calculated unless all five steps below are performed.

1) Set the appropriate program name and step number.
2) Select [Yes] to the [Thickness check].
3) Set an acceptable width to the [Check range for abnormal thickness].
4) Select [Yes] to the [Auto measurement of pushing amount difference].
5) In repeat mode, operate robot with a workpiece set. Executing step set at 1) displays the result of auto calculation in [Pushing amount diff].

[NOTE]
Note that changing the tip force and/or deflection compensation data in repeat mode or altering any data taught to the step will affect the calculation result.

AUTO MEAS. OF PUSHING AMT DIFF
Select [Yes] or [No]. Selecting [Yes] measures pushing amount difference automatically when the specified step is executed, but note that [Thickness check] can not be performed simultaneously at this step.

After completion of measurement, this setting returns to [No].

Press < ﹀ ﹀ > to display the setting screens for other steps. This function can be taught in maximum of 10 steps.

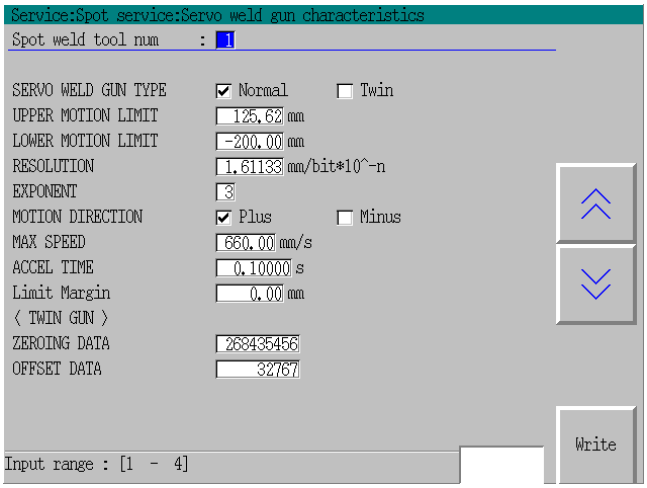
[NOTE]

1.Although [Yes] is selected at [Thickness check], if set program is not found, message “This program does not exist.” displays and data settings will not be stored to memory. This error also happens when selecting a program that first requires reading from a PC card.
2.Thickness check does not execute unless these conditions are true:
(1) The specified step is a weld point step.
(2) Normal weld or Fast pressurizing is selected as the Gun status information for the weld point.
(3) [Yes] is selected for [Thickness check].
3.Reset the step number to undergo thickness check if any alternation in the program causes addition/deletion of steps. The data does not update automatically through this screen.
4.Thickness check functions only in repeat mode, not in check mode.
5.Setting thickness check lengthens the cycle time required to process the weld point.

<Complete>

Press <Complete> to store the data settings for this workpiece detection function to memory.

A1.1.10 SERVO WELD GUN CHARACTERISTICS



Select [30. Servo weld gun characteristics] from Spot service menu to display the screen shown on left.

Sets the mechanical parameter data for the servo weld gun.

For details on TWIN GUN, see A6.5.

Spot weld tool num (Setting range: 1-4)
Sets the number of the weld gun.

SERVO WELD GUN TYPE
Select [Normal] or [Twin] according to the type of the gun.

NOTE* If a twin gun is used, set data to [Zeroing data] and [Offset data] in the <Twin gun> area in the screen above.

UPPER MOTION LIMIT (Setting range: -2000.00-2000.00 mm)
Mount servo weld gun with reference new tips and drive gun axis from the closing point to opening end and set value as follows.

Upper motion limit = stroke length to the mechanical stopper-5 mm

[NOTE]

This upper motion limit is also used as the base zeroing data for gun axis. If this data is ever changed, perform the functions below.

1. Disconnect then connect the servo weld gun axis (calibration).
2. Tip wear measurement.
3. Confirmation and adjustment of taught weld points.

LOWER MOTION LIMIT
Set the amount calculated as: -(Allowable tip wear + α). α:margin (100 and over)

RESOLUTION (Setting range: 0.01000-99.90000), **EXPONENT** (Setting range: 1-7)
Set the moving distance per 1 encoder bit. Unit: 10^{-n} mm/bit (n = resolution exponent)

MOTION DIRECTION
Sets closing direction for servo weld gun as either [Plus] or [Minus] on the tool Z axis when pressing AXIS + button.

MAX SPEED (Setting range: 0.00-1000.00 mm/sec)
Sets the maximum speed of the gun axis.

ACCEL TIME (Setting range: 0.01000-100.00000 sec)
Sets the length of time for the axis to accelerate from zero to maximum speed.

ZEROING DATA (Setting range: 0-268435456), **OFFSET DATA** (Setting range: 0-65535)
If a twin gun is used, set zeroing and offset data for each gun individually.

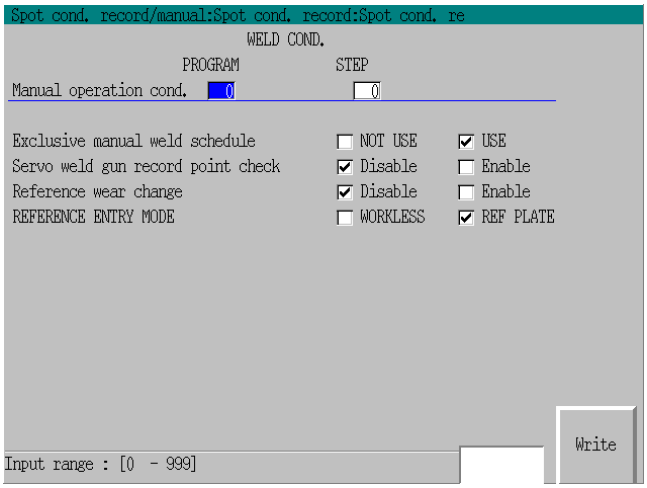
[NOTE]

Some data input in the servo weld gun characteristic screen might not take effect even though the data has been stored in memory.
If data is changed, be sure to perform disconnection/connection of the gun axis (see A6.1) even when gun is not actually changed..

Press < ﹀ ﹀ > to display the setting screens for other weld tools number.

<Complete>
Press <Complete> to store the weld gun characteristics to the currently selected tool number.

A1.2 SPOT CONDITION RECORD



Press <Spot Condition> to display this screen.

Sets the weld conditions used during manual operation, tip wear measurement, etc.

If multi-robot controller is used, set the robot number prior to inputting data.

Manual Operation Condition

Specify the program and step number taught with the desired weld conditions.

Exclusive manual weld schedule

Selects if the conditions set in A1.1.5 Exclusive manual schedule are to be used during manual operation.

[Not use]: Uses the weld conditions taught in the program step specified above in [Manual operation condition] when executing a manual weld.

[Use]: Conditions set in A1.1.5 Exclusive manual schedule are used during welding. (Any step number set in [Manual operation condition] is ignored.)

Servo weld gun record point check

Select [Enable] to check the state of the fixed tip of the servo weld gun at the weld points (Zero touch teach). See figure on next page.

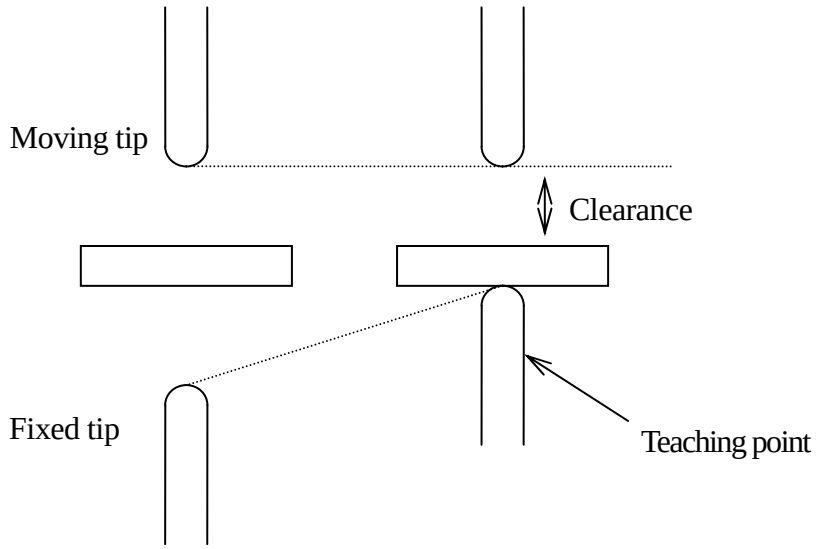
This function is effective only in check mode and regular closing of the gun/pressurization is carried out in repeat mode irrespective of this setting.

Selecting [Enable] stops the moving tip of servo weld gun at the clearance position set in A1.1.5 and welding is not carried out. Meanwhile, the fixed tip moves to the teaching point so that its taught position can be checked. Select [Disable] to carry out the regular welding operation.

Moreover, as soon as the fixed tip reaches to the teaching point, the robot outputs a welding initiation signal and awaits the weld completion signal.

In check once mode, even after the weld completion signal is input, the fixed tip stays at the teaching position until CHECK GO is pressed. Press CHECK GO to move it to its clearance position.

In continuous check mode, after weld completion signal is input, the fixed tip automatically moves to its clearance position and proceeds to the next step without waiting.



Reference wear change

Zeros the displayed tip wear. Once [Enable] is selected, zeroing is executed at the next tip wear measurement. Wear displayed thereafter are calculated based on this zero setting and displayed at [Current wear] in the screen shown in A1.1.6.

This setting returns to [Disable] automatically, once the displayed tip wear is zeroed.

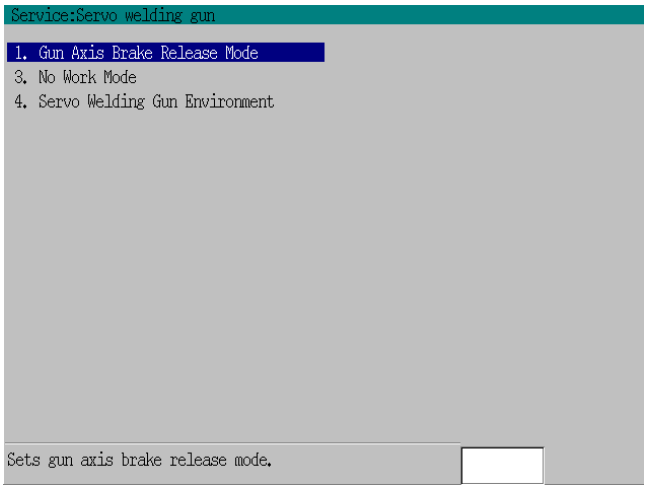
NOTE* The standard used to compensate for tip loss does not change when zeroing the displayed tip wear via this screen.

REFERENCE ENTRY MODE

Select the method used to measure the tip wear.

[Workless]: Measurement taken by pressing tips together without pressing a reference plate.
[Ref plate]: Measurement taken by workless clamping and pressing a reference plate.

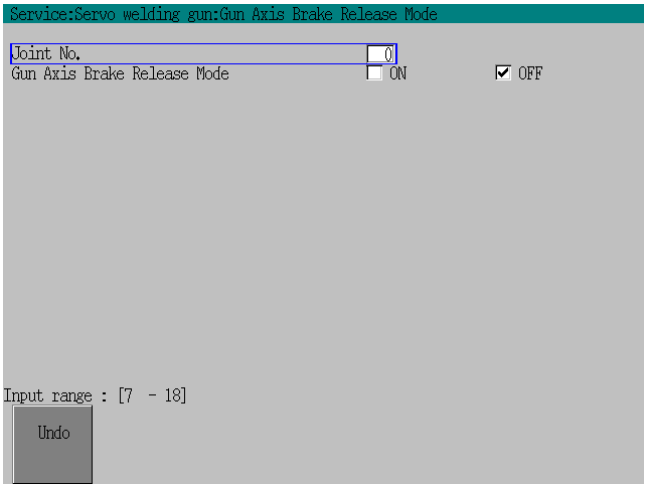
A1.3 SERVO WELD GUN



Select [17. Servo welding gun] from Service menu to display the screen shown on left.

This section describes how to set data in the items shown on left after selecting the robot number by pressing <Teach> below right.

A1.3.1 GUN AXIS BRAKE RELEASE MODE



Select [1. Gun axis brake release mode] to display the screen shown on left.

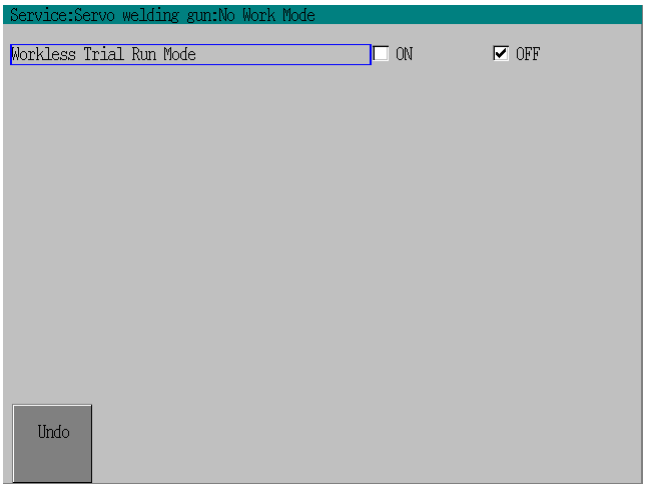
Joint No. (Setting range: 7-10)
Sets the number of the gun axis whose brake is to be released.

Gun Axis Brake Release Mode
As a safety measure to prevent crashes, the gun axis brake remains locked after disconnecting the axis in the control system. In order to unlock and release the gun brake, select [ON] for [Gun axis brake release] in screen above and push the brake release switch. (Brake release takes effect without this setting if gun is connected in the control system.)

[NOTE]

1.Setting returns to [OFF] automatically at MOTOR POWER ON.
2.Brake of gun axis can not be released if the gun is not mounted to the robot.

A1.3.2 NO WORKPIECE MODE



Select [3. No work mode] from the menu in [17. Servo welding gun] to display the screen shown on left.

Workless Trial Run Mode

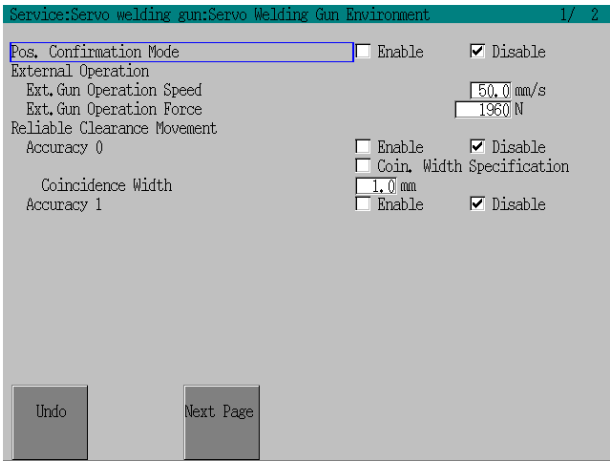
When running a robot without any workpiece, such as for test run, durability run, etc., the tips may impact each other at above a certain speed in weld points for thick plates and cause damage to the tips, etc. In this case, set ON for [Workless trial run mode] in the screen above to make the pressurization smooth.

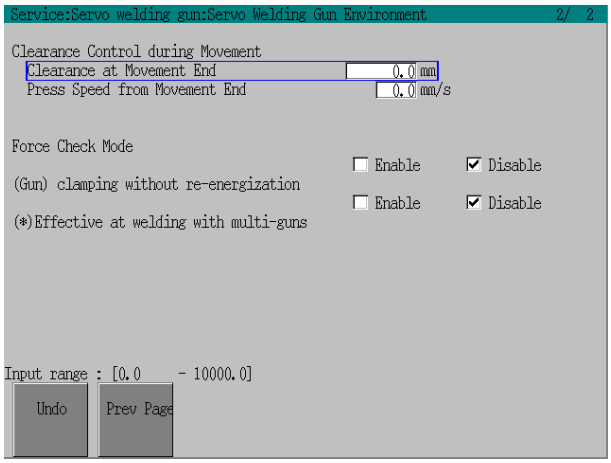
[NOTE]

Select [OFF] for this setting when operating with workpiece. If workpiece is pressurized with setting [ON], gun will pressurize as though workpiece has thickness of 0 and work may incur impact forces and welding may fail.

A1.3.3 SERVO WELD GUN ENVIRONMENT

Select [4. Servo welding gun environment] from the menu in [17.Servo welding gun] to display the screen shown below. Press <Next page> to show the screen below-right.





Pos. Confirmation Mode

Functions exactly the same as A1.2 [Servo weld gun record point check], refer to that section for details. Enable/Disable are selectable from both screens.

Ext. Gun Operation Speed (Setting range: 0.0-999.9 mm/s)

Sets speed to open/close gun axis when using an external signal. However the maximum speed is limited to 250mm/s in teach mode. Even if 350 mm/s is set, gun axis speed in teach mode becomes 250 mm/s.

Ext. Gun Operation Force (Setting range: 0.294-9.799 kN)

Sets the tip force value when using an external signal to initiate pressurization of the gun.

[NOTE]

When a low tip force and high operational speed are applied, closing motion of the gun might not function smoothly. If this happens, raise the tip force or lower the speed.

Clearance at Movement End (Setting range: 0.0-10000.0 mm)

Generally when welding at a weld point, both the tips contact the workpiece first at the same time and then the robot pressurizes the workpiece using the moving tip. But, if movement to the next point needs to be carried out with clearance at the end of the motion, set a clearance here. Moving tip moves from the clearance set in A1.1.6 to this set clearance during point to point

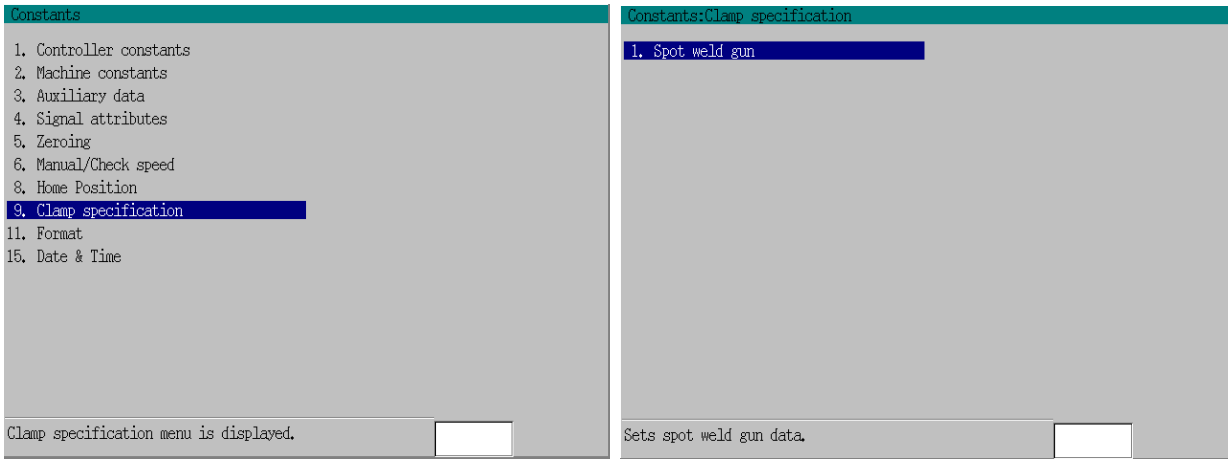
movement. And then closes and pressurizes.

This setting may be required to avoid interference between moving tip and workpiece.

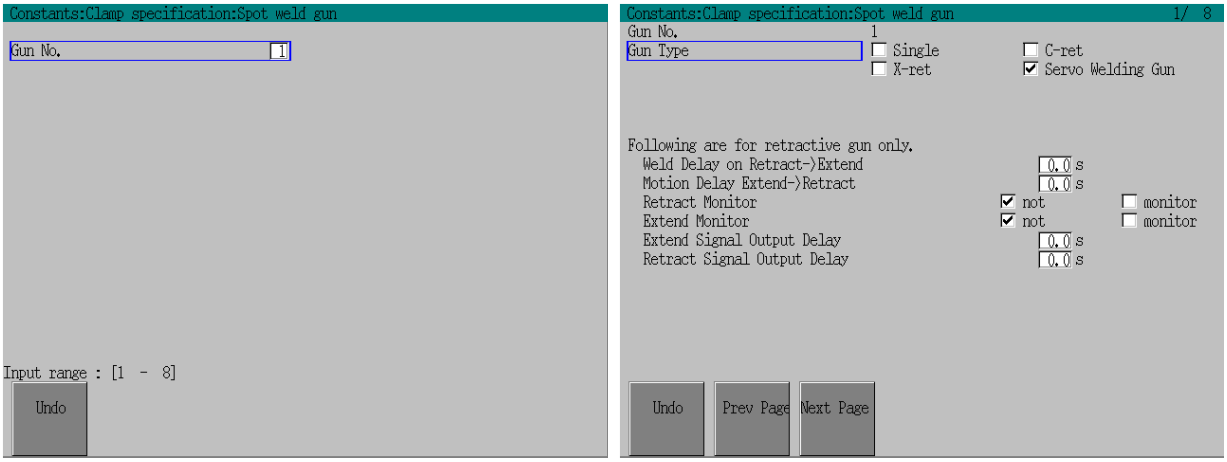
Press Speed from Movement End (Setting range: 0.0-999.9 mm/s)
Sets the closing speed of the gun axis when [Clearance at movement end] is set.

A1.4 CLAMP SPECIFICATION

Press <Constants> to display the screen below left and select [9. Clamp specification] to display the screen shown below right. Various parameter data for the spot weld gun are set here.



Then, press ↵ and set the gun number in the screen shown below left and press ↵ to display the screen shown below right.



Gun Type

Specifies the gun type. If gun is pneumatic retractable type, select [X-ret] or [C-ret]. However, if [Servo weld gun] is selected, various settings must be made in Aux.: [10. Spot weld]-[21 Servo weld gun], and [29.Wear measurement parameters].

Weld Delay on Retract → Extend (Setting range: 0.0-9.9 s)

Sets the time to switch a two stroke gun from retract to extended at welding and delays output of weld instruction signal until gun closes to extended pose.

Motion Delay Extend→Retract (Setting range: 0.0-9.9 s)
Sets the time to switch a two stroke gun from extended to retracted condition.

Retract Monitor
Select [monitor] to always monitor for input of retract detected signal during robot operation. If the signal is not input, error occurs and robot stops. Selects [not] to disable the retract monitor.

Extend Monitor
Select [monitor] to always monitor for input of extend detected signal during robot operation. If the signal is not input, error occurs and robot stops. Select [not] to disable the extended monitor.

Extend Signal Output Delay (Setting range: 0.0-9.9 s)
Delays output of extend detected signal, when two stroke gun with stopper function has switched from retract to extended condition.

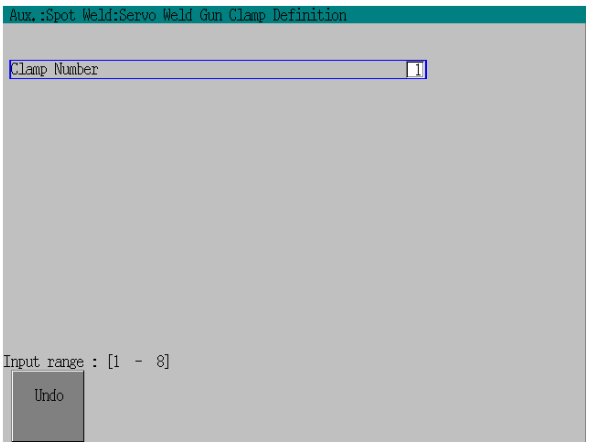
Retract Signal Output Delay (Setting range: 0.0-9.9 s)
Delays output of retract detected signal, when two stroke gun with stopper function has switched from extended to retracted condition.

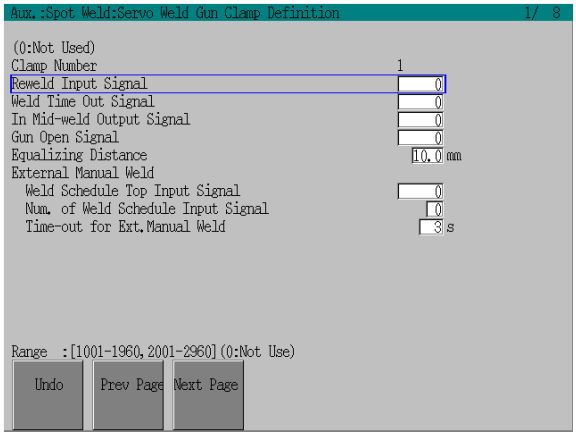
A1.5 SPOT WELD CONDITION BY AUXILIARY FUNCTION

Some parameters of the spot weld gun must be set in Auxiliary function screens. This section describes each of these function screens. Select the robot number first before making any settings.

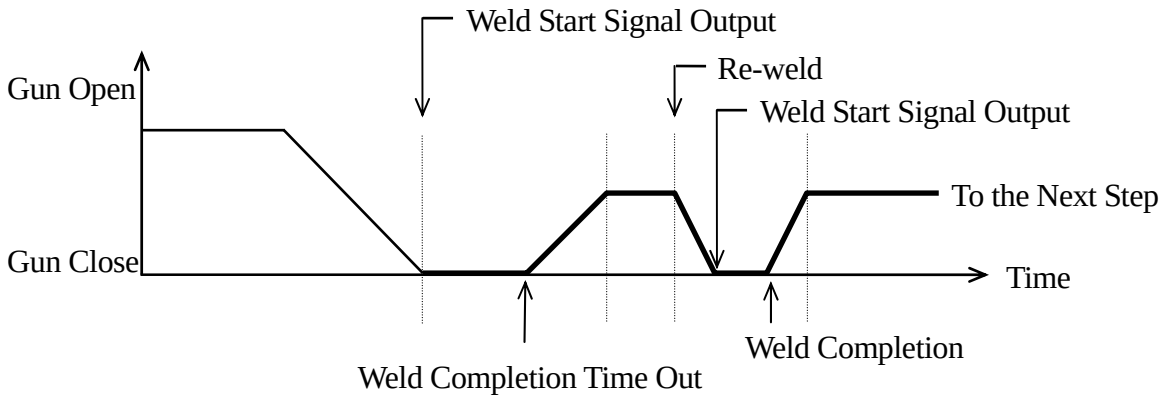
A1.5.1 REWELD INPUT SIGNAL

Enter the clamp number in screen below left, displayed by selecting Aux. function- [10. Spot weld]-[1. Servo weld gun clamp definition]. Press ↵ to display the setting screen for the various signals, including re-weld input signal shown below right.





Reweld Input Signal (Setting range:0, 1001-maximum input signal number)
During a welding, when weld completion signal is not input within the fixed time, the re-weld signal switches ON and robot automatically attempts a re-welding of the currently displayed point/step.



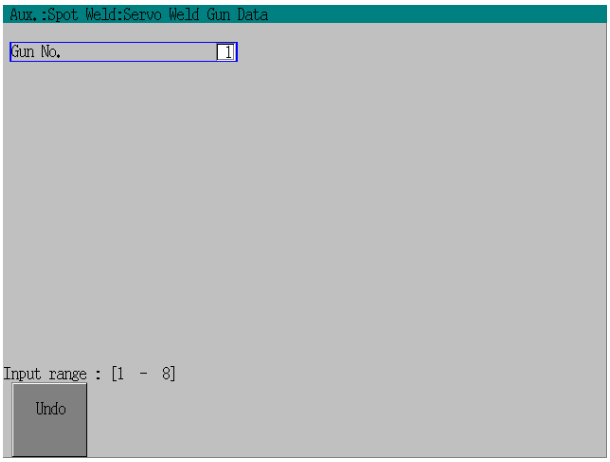
[**NOTE**]

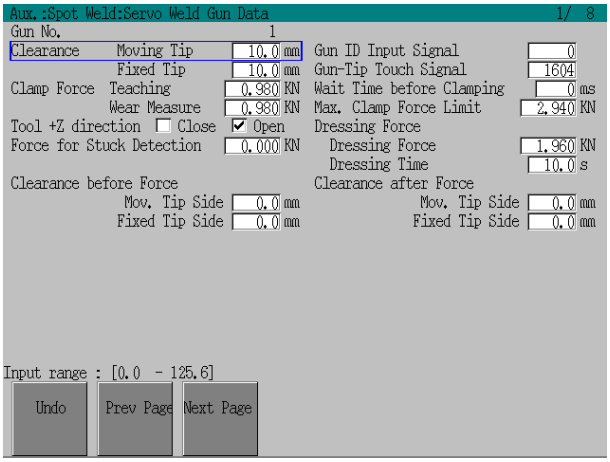
Reweld input signal is detected at the rising edge.

Reweld does not perform, if 0 (zero) is set.

A1.5.2 SERVO WELD GUN

Enter the gun number in below left screen, displayed by selecting Auxiliary function- [10. Spot weld]-[21. Servo weld gun]. Press ↵ to display the setting screen for Servo weld gun shown below right.





Tool +Z direction
Select [Open] to assign the +Z tool coordinate as the direction for opening the gun.

Force for Stuck Detection (Setting range: 0.000-9.799 kN)
The servo weld gun initiates opening motion when a weld completion signal is input. If the force required to open the gun exceeds the force threshold value set here, a stuck tip is detected and error, E5019: Gun tip stuck., is output.

Stuck detection does not perform if 0 (zero) is set.

Gun ID Input Signal (Setting range: 0, 1001-maximum input signal number)
Sets an identification input signal for each gun. Checks if specified gun number matches the actual gun being changed and verifies if identification number of gun mounted to robot matches the gun numbers taught in every step in repeat mode.

Gun ID check does not perform if 0 (zero) is set.

Gun-Tip Touch Signal (Setting range: 0,1001- maximum input signal number)
Sets a signal number to notify robot when fixed tip contacts the workpiece. The teach pendant buzzer sounds when signal is input to the robot.*

NOTE* The buzzer sounds only if DEADMAN is switched ON in teach mode.

Gun-tip touch check does not perform if 0 (zero) is set. However this signal is used for the

workpiece displacement detection.

Wait Time before Clamping (Setting range: 0-9999 ms)
Sets a wait time before initiating pressurization after reaching the taught welding point. The smaller setting, the faster pressurization starts and cycle time shortens, but doing so may make weld gun vibrate more. Consider the effect on cycle time and set the data accordingly.

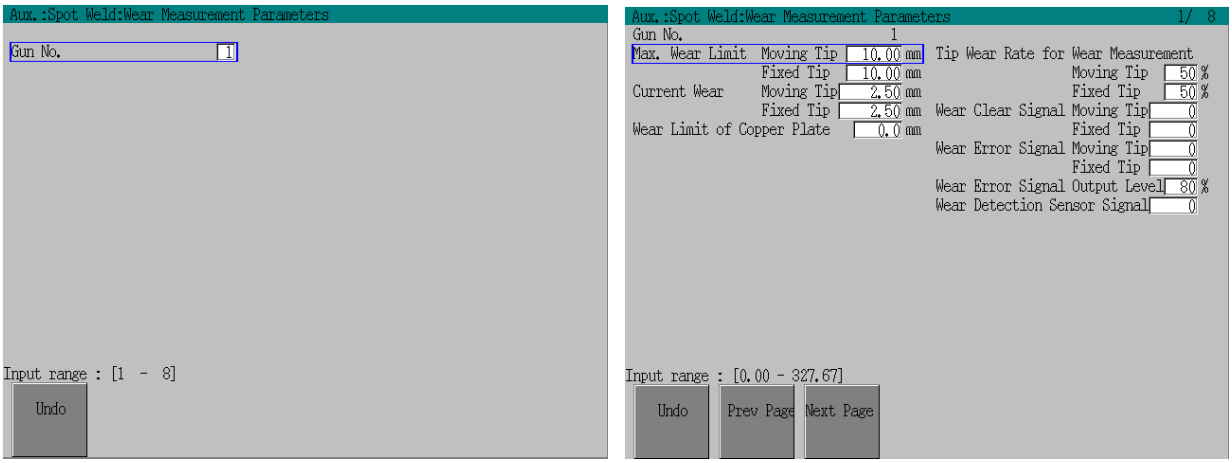
Max. Tip Force Limit (Setting range: 0.000-9.799 kN)
Sets the maximum tip force limit of the servo weld gun.

Setting a force in excess of this value, automatically sets this force limit in the step data. Also, inputting an over-limit value when setting the tip force used for teaching and wear measurement returns an error, and no value will be set.

Other settings
Some items set in this screen can also be set in Spot service screens. (For details on these items see pertinent section.) Settings/data entries made in screens accessed from Spot service menu are reflected in this screen, and vice versa.

A1.5.3 WEAR MEASUREMENT PARAMETERS

Enter the gun number in below left screen, displayed by selecting Aux. function- [10. Spot weld]-[29. Wear measurement parameters]. Press ↵ to display the setting screen for servo weld gun shown below right.



Wear Limit of Copper Plate (Setting range:0.0-999.9 mm)
Sets the wear limit if a copper plate is used for welding.

The wear of copper plate is zero when teaching the weld points. Accumulated wear is

calculated each time gun pressurize plate in repeat mode. If current wear exceeds the limit set here, this error outputs, E5030: Copper plate wear exceeds limit. step=XX, but the robot does not error stop.

Monitoring of the wear limit of copper plate is not performed if 0 (zero) is set.

Wear Clear Signal (Moving Tip, Fixed Tip) (Setting range: 0, 1001-Max input signal number)
Sets the number of the input signals that resets (to zero) the current wear of tip. If input to robot, this signal resets the current wear.

Reset of tip current wear does not take place if 0 (zero) is set.

Wear Error Signal(Moving Tip, Fixed Tip) (Setting range: 0-Max output signal number)
Sets a signal number to output when current tip wear exceeds its allowable wear which was set per A1.1.6.

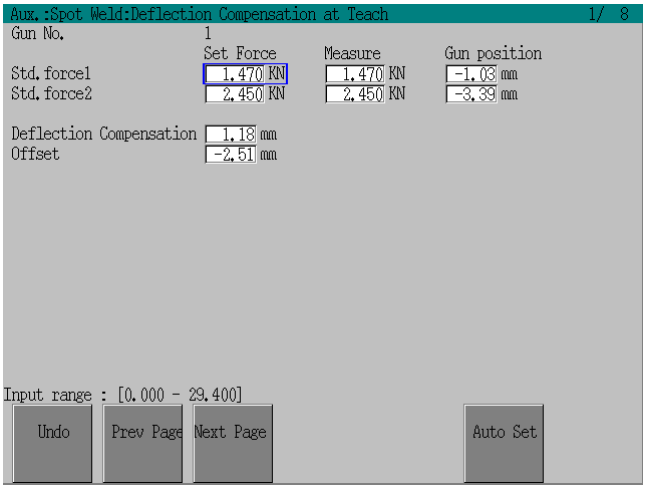
Wear Detection Sensor Signal (Setting range: -1960 - -1001, 0, 1001-1960)
Assigns the number of the signal input from the tip point detection sensor when measuring tip wear via sensor. Set 0 (zero) if the sensor signal is not used.

If assigned with:
a positive signal number, sensor signal inputs when switching OFF to ON.
a negative signal number, sensor signal inputs when switching ON to OFF.

The gun number changes by pressing <Prev Page> or <Next Page>

Other Settings
Some items set in this screen can also be set in Spot service screens. (For details on these items see pertinent section.) Settings/data entries made in other screens accessed from Spot service menu are reflected in this screen, and vice versa.

A1.5.4 DEFLECTION COMPENSATION AT TEACH



Select [28. Deflection compensation at Teach] from the menu shown in Aux. function- [10.Spot weld] to display the screen left. Set the deflection caused when applying force of 0.49 kN.

For example, when pressurizing gun axis at 0.49 kN force and the gun axis value is –1.0 mm, and at 0.98kN force gun axis value is –1.076 mm, the compensation value is calculated as: |(-1.760-(-1.0))| / (0.98-0.49) =0.76 mm/0.49 kN. Thus 0.76 should be input in this case.

If pressurizing at 1.96 kN force in this case, compensation value is 0.76 mm×1.96 kN/0.49 kN＝3.04 mm.

A2.0 MANUAL OPERATION OF SERVO WELD GUN

To operate the servo weld gun manually by axis, set the data required for the gun and connect the gun to controller via the teach pendant. For information on gun connection operation see A6.1 Gun change.

As described in Chapter 2, the gun can be operated manually by using either AXIS or CLAMP.

When operating by AXIS, the opening distance is freely adjustable as with arm axis, however, operating by CLAMP limits the movement. Gun can only move from current position to the weld position then back to the position where it started closing.

A2.1 MANUAL OPERATION BY AXIS

Press AUX to light the LED next to the button, then press JT7 / JT8 while holding down on ENABLE to open/close the gun axis to the desired distance. Set the pressurizing force in [20 Servo weld gun condition] screen in Spot service menu.

[NOTE]

1. When multi servo weld guns are used in the 6-axis robot system, JT7 is assigned to X/JT7 , and joints JT8 and after to Y/JT8 and Z/JT9 and so on. However, this assignment may change if additional axes other than servo weld gun are connected such as traverse axis.
2. The closing speed of the gun is limited to maximum of 80 mm/s.

A2.2 MANUAL OPERATION BY CLAMP

Operating by CLAMP limits the motion. Gun closes from its current position and pressurizes the weld point and then returns to its original position.

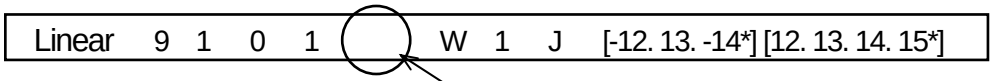
CLAMP key is also used to turn ON/OFF the clamp instruction. The auxiliary data for clamp changes as follows each time CLAMP is pressed:

1(ON)→0(OFF)→1(ON). (Pressing CLAMP key alone does not drive the gun.)

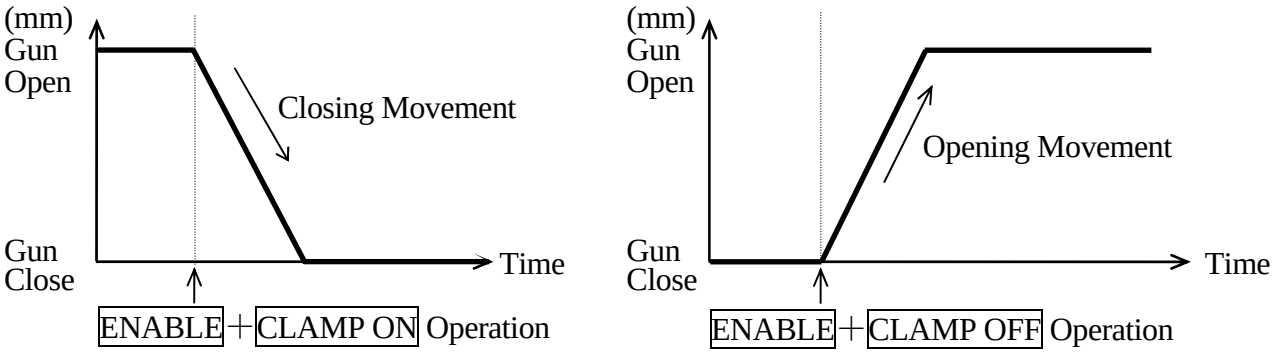
To actually move the gun axis, press DEADMAN + ENABLE + CLAMP. (This key combination is required as a safety feature designed to prevent accidental operation of the clamp.)

To close gun axis from current position, pressurize at weld point, press ENABLE + CLAMP ON* and to return back to closing motion start position, press ENABLE + CLAMP OFF*. The clamp data also changes ON→OFF then OFF→ON by the operations.

NOTE* Pressing CLAMP when clamp data shows OFF is expressed as CLAMP ON and CLAMP OFF, when the data shows ON (1).



Displays 1 for CLAMP ON.
Displays blank for CLAMP OFF.



[NOTE]

1. Prior to operating CLAMP, set the tool number of the gun attached to the robot.
2. The closing speed is limited to a max. of 80 mm/s.
3. Gun axis does not operate if DEADMAN is OFF. Press and hold to switch it ON then press ENABLE + CLAMP.

While clamp is in ON/OFF (close/open) motion, the gun stops immediately when DEADMAN is switched OFF. In this case, motion does not resume even when DEADMAN is turned ON again. Gun axis also stops moving immediately during clamp ON/OFF motion when:

1. Pressing EMERGENCY STOP on the operation panel,
2. Switching TEACH/MAN/AUTO to MAN or AUTO,
3. Inputting an external emergency stop signal,
4. An error occurs.

Even if EMERGENCY STOP is released and the motor power and DEADMAN are turned ON, the gun axis will not resume motion unless ENABLE + CLAMP ON are pressed again. During CLAMP ON motion, if the AXIS key is pressed so that gun axis is driven in reverse past its closing position, releasing AXIS and then pressing ENABLE + CLAMP OFF will not return gun to its original closing start position. However, if the AXIS key is pressed during CLAMP ON motion but gun tip remains within the closing distance when AXIS is released, pressing ENABLE + CLAMP OFF will return gun to its original closing start position.

A3.0 TEACHING IN SERVO WELD GUN APPLICATION

Read and understand all the instructions described here for the servo weld gun application before teaching spot welding operations. Understanding how the robot system can/must be used for welding is critical for operating the robot successfully. Also, pay special attention to all the precautions noted in each section.

A3.1 INSTRUCTIONS SPECIFIC TO THE SERVO WELD GUN APPLICATION

Teach instructions by pressing <Gun Status> and inputting one of the gun status numbers listed in table below. The taught instruction is displayed as one character in two different places, under the [CLAMP] column on the teaching screen and on the <Gun Status> button itself, e.g. displays “R” when weld gun is in Disconnection status, etc.

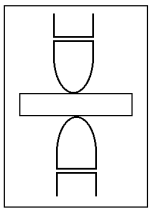
Instruction	Input Number	Display	Instruction	Input Number	Display
Gun Disconnection	0	R	Leak Check	5	L
Normal Weld	1	W	Knock Mode	6	F
Workless Clamp Measurement	2	K	Tip Dress	7	H
Reference Plate Measurement	3	P	Copper Plate Mode	10	C
Gun Connection	4	A	Workpiece Deviation Measurement	11	M

A3.1.1 GUN DISCONNECTION INSTRUCTION

When a step taught this instruction [0] is executed, the gun axis is disconnected from controller in the control system (gun remains physically attached to robot). Also, with instruction [0] already set as [Gun Stat.], pressing ENABLE + <Gun Status R> enables gun disconnection manually.

A3.1.2 NORMAL WELD INSTRUCTION

When a step taught [1] is executed, the following welding sequence is executed: gun pressurizes – weld start signal outputs- gun energizes-weld completion signal received – gun opens to set clearance dist. Thus, as long as gun and workpiece/jig suffer no interference, only the closed position of the gun need be taught at desired points, this economizes teach time as there is no need for teaching each and every gun open position. Drive fixed tip until it makes light contact with workpiece, press ENABLE + CLAMP ON to teach. Ensure gun axis and workpiece are perpendicular as shown below.



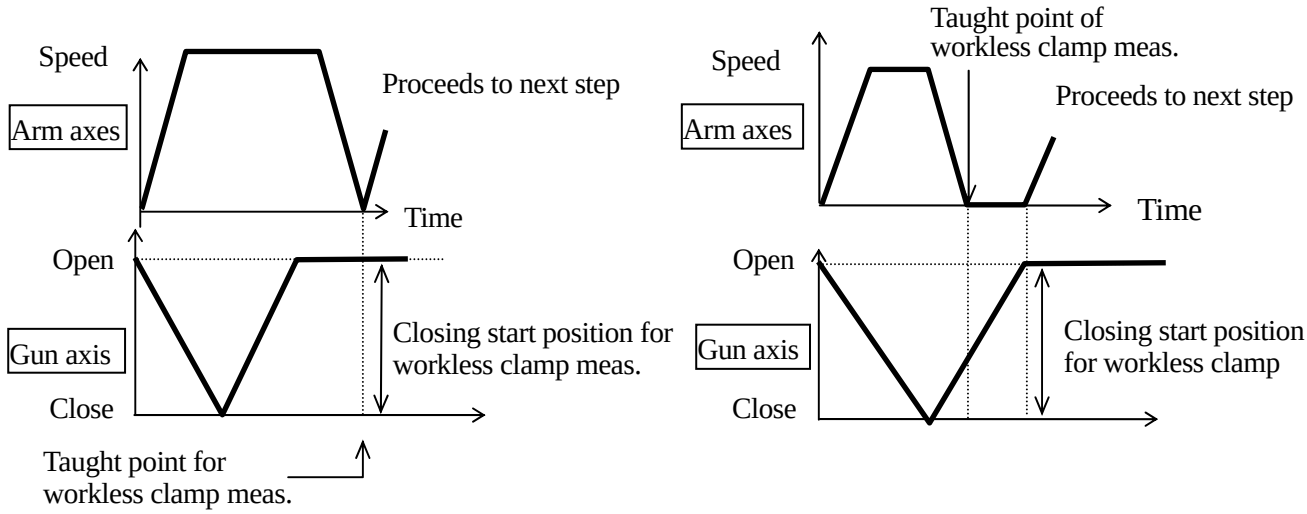
When pressurizing, robot compensates for any deflection of the gun, but ensure workpiece and tip should contact properly and that the workpiece is not deformed by excessive force.
Teach this instruction even at a transitional points where clamp is OFF.

A3.1.3 WEAR MEASUREMENT BY WORKLESS CLAMP INSTRUCTION

Teach this instruction [2] pressing the moving tip against the fixed tip with the tip force value set in Spot service – [20. Servo weld gun condition] – [Force at wear measurement]. Condition of the tips at this time becomes the standard (zero tip wear) used for measuring tip wear thereafter.

When a step taught [2] is executed, robot measures the wear on fixed/moving tips in sequence: gun closes – pressurizes – opens to its closing start position. The difference between the gun axis position at the time of teaching and at this measurement is calculated as the sum wear for moving and fixed tips. If a moving tip wear correction rate is input in Spot service – [20. Servo weld gun condition] – [Cor. at simple meas. Moving tip], the wear of the moving tip is calculated as: sum wear × moving tip wear correction rate. Fixed tip wear is calculated as: sum wear – moving tip wear.

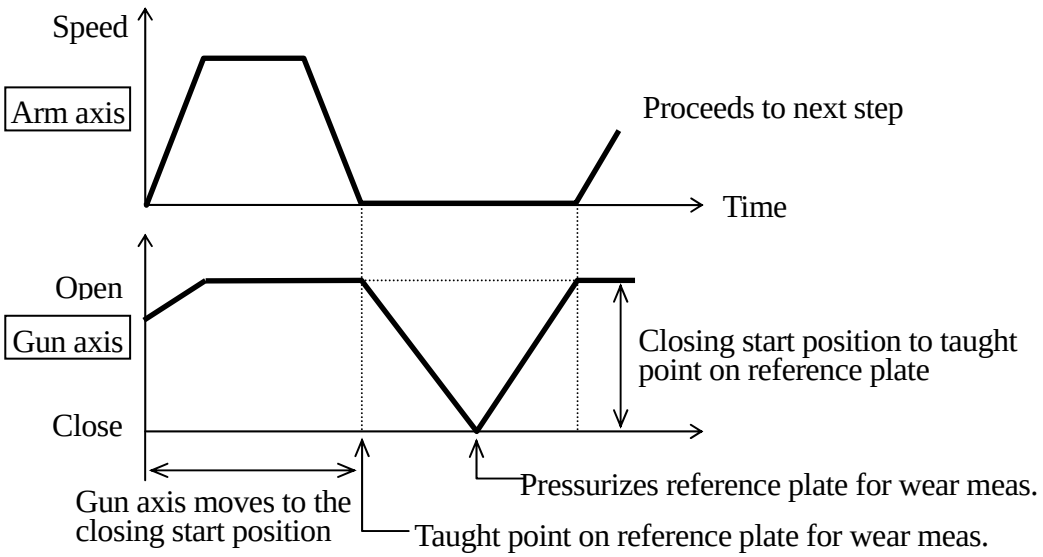
Workless clamp measurement is executed as robot moves to its taught point. However, this clamping does not synchronize with the motion of the arm axes, and its aspect varies depending on time needed to complete motion of gun and arm axes as shown in the figures below.



A3.1.4 WEAR MEASUREMENT BY REFERENCE PLATE INSTRUCTION

Teach this instruction [3] pressing the moving tip against a reference plate at the force value set in Spot service – [20. Servo weld gun condition] – [Tip force at Teach]. Pressing REC with the gun pressurized stores the current condition of the tip at this time as the standard (zero moving tip wear) used for measuring moving tip wear thereafter.

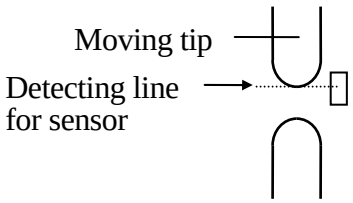
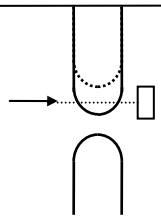
When a step taught [3] is executed, robot moves to the measuring point taught on the reference plate, arm reaches axis coincidence, then: gun closes – pressurizes (at the force set for wear measurement) – opens to the closing start position. The difference between the gun axis position at time of teaching and at this measurement is calculated as the moving tip wear. Calculates fixed tip wear from: sum wear result in workless clamp measurement – moving tip wear calculated here.



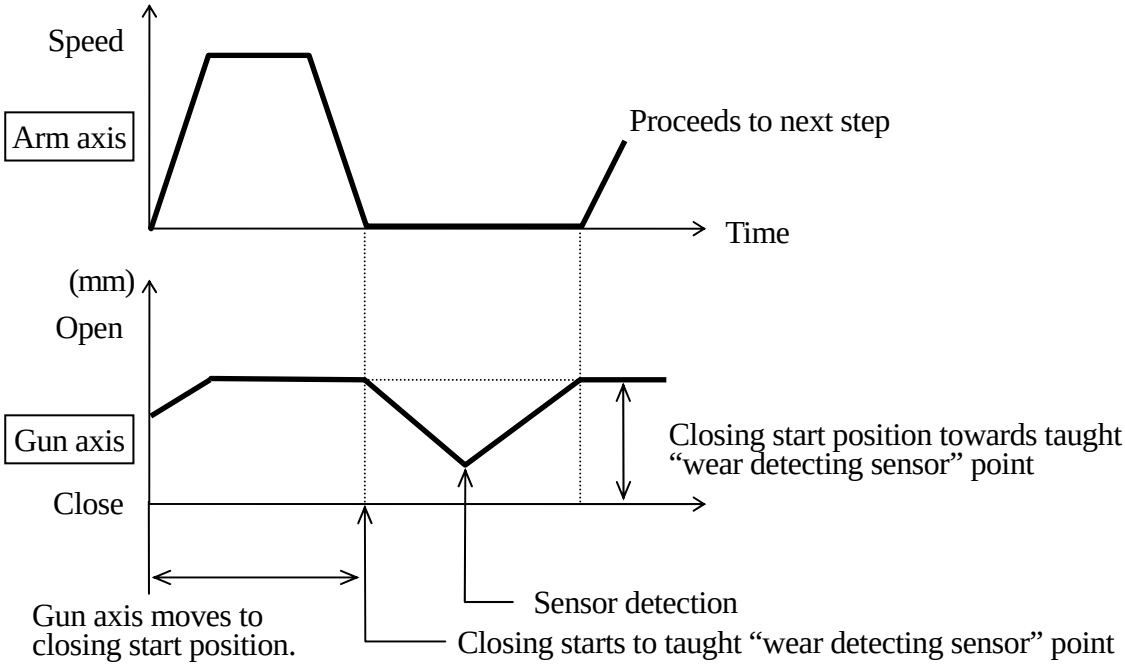
Moving tip wear measurement by wear detection sensor

Teaching [3] can also be used to measure the moving tip wear via a sensor instead of a reference plate. In order to calculate moving tip wear by a detection sensor, assign a signal number to be input to the robot when detection occurs in Aux.-[10. Spot weld]-[29. Wear measurement parameters]-[Wear detection sensor signal]. When signal is 0, wear measurement by reference plate is executed.

Move the gun axis and stop it at the moment moving tip crosses the detecting line of the sensor used for instructions [3] as then press REC. The current tip condition becomes the standard (Moving tip wear zero) value for measuring moving tip wear thereafter.

ABLE to teach the condition	UNABLE to teach the condition
	
End of moving tip is tangent with sensor line.	End of moving tip is either above or below the sensor line.

When a step taught this instruction [3] is executed using a wear sensor, robot moves to the taught point, arm axes coincide, then gun closes – signal is received indicating moving tip arrived at detecting line (shown above) – gun opens to closing start position. (See figure below.) Calculates moving tip wear from the difference in gun axis positions when tip crosses detecting line between teach and repeat modes. Calculates fixed tip wear from:
sum wear result in workless clamp measurement – moving tip wear calculated here.



A3.1.5 GUN CONNECTION INSTRUCTION

When a step taught this instruction [4] is executed, establishes connection between the gun axis and the controller in the control system. Also, with this instruction [4] already set as [Gun Stat.], pressing ENABLE + <Gun Status A> enables gun connection manually.

A3.1.6 LEAK CHECK INSTRUCTION

When step taught [5] is executed with clamp ON, the leak check operation is executed in the order below.

1. Outputs the leak check signal, a general purpose signal, when robot starts moving to the taught point.

2. Robot reaches axis coincidence at taught point and begins welding sequence. Robot follows regular weld sequence but the servo weld gun does not pressurize.

3. Leak check signal turns OFF, upon input of weld completion signal or when:
   - Cycle operation is turned OFF
   - Robot starts moving to a point other than the leak check point. (E.g., if robot starts processing next step before finishing the leak check point process.)

4. Regarding the Servo welding conditions, robot does not check the validity of set conditions when outputting settings to the welder, and error is not displayed even if no data are set.

Reference: Leak check point processing in robot

- Teach Clamp ON and OX39 as the leak check signal.
- When executing the point, outputs OX39 and executes the welding sequence after axis coincidence. Servo weld gun does not pressurize during leak check.
- Leak check signal (OX39) is processed in the same timing as a general purpose signal, turns ON upon starting motion to the taught point, and turns OFF when proceeding to a step where OX39 is not taught.

A3.1.7 FAST PRESSURIZING INSTRUCTION

Servo weld gun can change its pressurization mode from smooth operation with minimum impact to some appropriate impact similar to the effect produced by an air gun.

Teaching [6], fast pressurizing, is useful when welding workpieces where the base metal is thick or the overlapping quality is poor. In these cases by applying force like an air gun, the weld strength can be improved and overall cycle time can be shortened.

When teaching, select the mode appropriate for each welding point and your desired welding conditions.

A3.1.8 COPPER PLATE MODE INSTRUCTION

Teach [10] copper plate mode when welding points with a copper plate. Automatically detects the wear of the copper plate when executing a step taught this mode. If the wear exceeds the limit set in Aux. – [29. Wear measurement parameters] – [Wear limit of copper plate], error occurs: "E5030: Copper plate wear exceeds limit. step=xx".

The wear is calculated from the difference between the taught pressurizing condition and the condition detected when pressurizing thereafter in this mode.

A3.1.9 MEASUREMENT FOR WORKPIECE DEVIATION

Teaching [11] enables the robot to detect how much the workpiece is deviating from its taught workpiece placement position. Pressing ENABLE + CLAMP ON with the fixed tip only just touching the workpiece in the same way as a regular welding point, then teach by pressurizing the workpiece. This condition becomes the standard for zero workpiece placement deviation.

When executing this instruction, the workpiece deviation is measured in the order given below:

1. The moving and fixed tips move to the opening clearance position set in Spot service - [20. Servo weld gun condition]-[Clearance].

2. Fixed tip moves at a constant speed towards the moving tip until the tip contact signal is input. Once the signal is input, the amount of workpiece deviation is calculated as the difference between the taught position and the detected position, considering the wear on the fixed tip.

3. The fixed tip moves back to its initial clearance position at constant speed.

4. Robot proceeds to next step after axes coincide.

If switching RUN/HOLD or restarting from Emergency Stop during measurement, the fixed tip immediately moves back to the clearance position and restarts this detection sequence.

The measured deviation can be readout using SGWORKGAP of AS language.

[NOTE]

1. Detect the tip contact signal via fixed tip. The deviation can not be detected by the moving tip.
2. In order to detect the workpiece position, the fixed tip can move a maximum length of “set length for moving tip clearance distance” + “set length for fixed tip clearance distance”, hereafter “Distance A”.
   If tip contact signal is not input to robot while moving Distance A, the robot stops after moving Distance A and returns detection value of “-9999” indicating workpiece not detected. Then fixed tip returns to the clearance position and robot proceeds to next step.
   Error does not occur at this time, so if the workpiece position could not be detected, check if the value is “-9999” using program, etc. and stop the robot externally if necessary.
3. If Gun-tip touch signal is not set in Aux.- [10. Spot weld] – [21. Servo weld gun], an error occurs and robot will not be able to detect the workpiece position.

A3.2 TEACHING FLOW FOR SPOT WELD OPERATIONS USING SERVO WELD GUN

The flow for teaching spot weld operations when using a servo weld gun is shown in the figures below. Pay attention to the following when teaching.

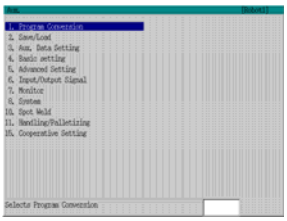
1. For the welding application to accurately calculate plate thickness, compensate for deflection, determine welding point and pressurizing motion, the condition where gun has 0 wear must be taught to the robot. Then the robot automatically adjusts for tip loss that occurs gradually during welding and the accumulated wear amount is updated based on the 0setting. Wear must be measured before teaching/editing position data at a weld point.

2. At each step, press REC to store the set pose and auxiliary data including the gun status data, a setting unique to the servo weld gun application. To store weld conditions, press <Complete> on each of the Weld schedule editor screens. (Refer to A1.1.1)

Teach Operation Flow Chart for Servo Weld Gun

1. Setting various data
   Refer to A1. Various settings for spot weld for details.

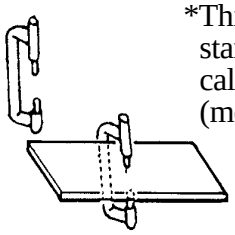
·Set Servo weld gun conditions, tool data and so on.



2. Teaching of Tip wear measurement point.
   For details refer to A3.1.3 Wear meas. by workless clamp, A3.1.4 Wear meas. by ref. plate.

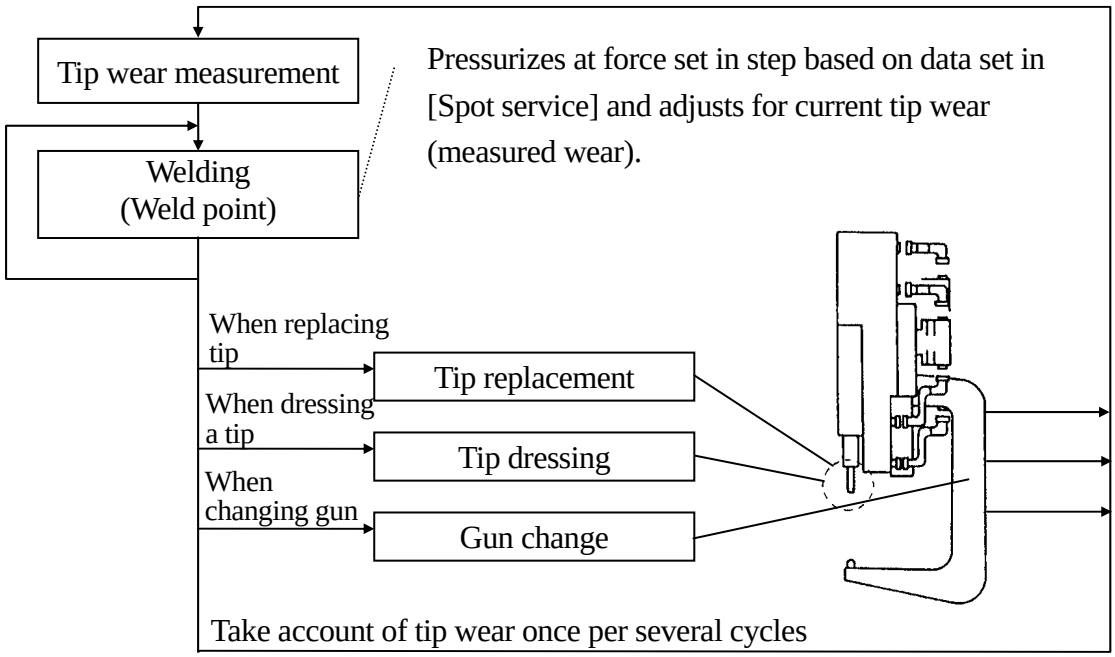
·Teach Tip wear measurement program (point).

*This data becomes the standard for tip wear calculations (measurements) thereafter.



Reference plate

7. Repeat operation
   Refer to chapters 6 and A6 for details.

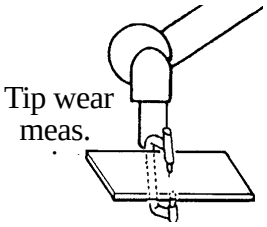


*Example of repeat operation of the program taught in 4. Teaching.
This flow chart of repeat operations will vary with each application/system.

3. Tip wear measurement

For details refer to A3.1.3 Wear mea. by workless clamp, A3.1.4 Wear mea. by reference plate.

Execute the program (taught points) taught in 2. in check/repeat mode.



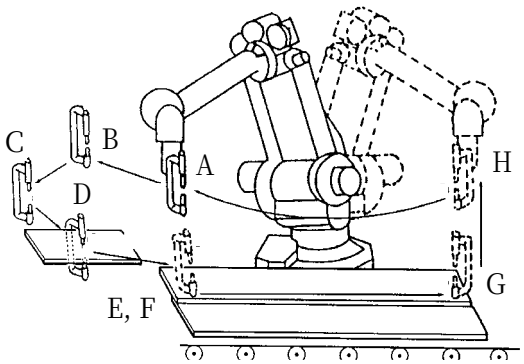
* Calculates data for workpiece thickness, etc. considering the tip wear measured here.

4. Teaching

Refer to A3.4 An example for teaching operation for details.

·Teach the points to be welded or for tip dressing, etc.

·Execute measurement at least once every several cycles and whenever is replaced or dressed, gun is changed or any time current tip wear changes.



When adding/editing teaching

When change in teaching required

Tip replacement

New tip required

5. Set/check the force of weld points with that welding conditions

For details refer to A1.1.1 Editing weld schedule, 3.3.1.3 Servo weld gun manual operation.

·Set the welding conditions.

·Use the manual weld function if necessary.

6. Confirmation of teaching program.

Refer to chapter 5 and A5 for details.

·Execute the program taught in 4 in check mode.

A3.3 TEACHING AND EXECUTING TIP WEAR MEASUREMENT

Selects one of the three methods available below for measuring tip wear, then teach wear measurement steps so the force value applied to the measuring point is the same at teaching and in repeat mode. (Refer to A3.1.3 and/or A3.1.4 for details.) Then, calculate current wear by executing the wear measurement step at the following times: before teaching weld points, after tip/gun replacement, before executing the welding program, etc.

Display the calculated tip wear value in Spot service - [20. Servo weld gun condition] - [Current wear]. Or current wear can be substituted in the variable parameter of SGCHIP of AS language.

Wear measurement methods:
1. Workless clamp meas.
2. Workless clamp meas. + Reference plate meas.
3. Workless clamp meas. + Detection sensor meas.

Pay attention to the following points depending on the wear measurement methods selected:

1. After tip replacement, initialize the wear value of the new tip by either of the methods below:
   (1) If the wear of the tip under control tip length is known, input the amount directly to Spot service – [20. Servo weld gun condition] – [Current wear]
   (2) If the wear is unknown, measure the wear via Workless clamp meas. + Reference plate meas., or Workless clamp meas. + Detection sensor meas. Thereafter, wear measurement by only workless clamp meas. is acceptable if the wear ratio of tips is accurate.

2. Turn Clamp ON to execute a step taught either [2] Workless clamp measurement or [3] Reference plate measurement. If Clamp ON is not taught to these steps, error results when attempting to execute wear measurement.

3. If the gun has an equalizer, execute wear measurement by Workless clamp meas. + Detection sensor meas. because accurate wear value cannot be obtained for moving tip by Reference plate meas.

4. Execute wear measurement in order of: Workless clamp meas. then Reference plate meas. or Detection sensor meas.
   (1) Execute Workless clamp meas. prior to the step taught Reference plate meas. or Detection sensor meas., otherwise an error occurs.

(2) Note that when executing just the Workless clamp meas. again and again, the wear is calculated from the measurement data of the last Workless clamp meas. step and the data of the last executed Reference plate meas. or Detection sensor meas. step.

5. In order to minimize errors in tip wear measurement, in repeat mode execute the wear measurement step at the same tip force value that was used when teaching the wear measuring step.

6. If the tip wear measurement point requires re-teaching due to deviation of the reference plate, broken gun or gun replacement, teach and measure the tip wear again and re-teach all other teaching points as well.

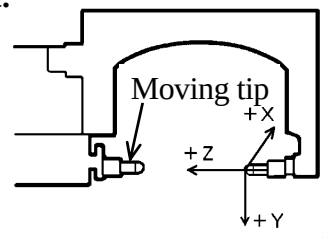
7. Always measure the tip wear immediately after gun replacement, when the new gun is connected to the robot.

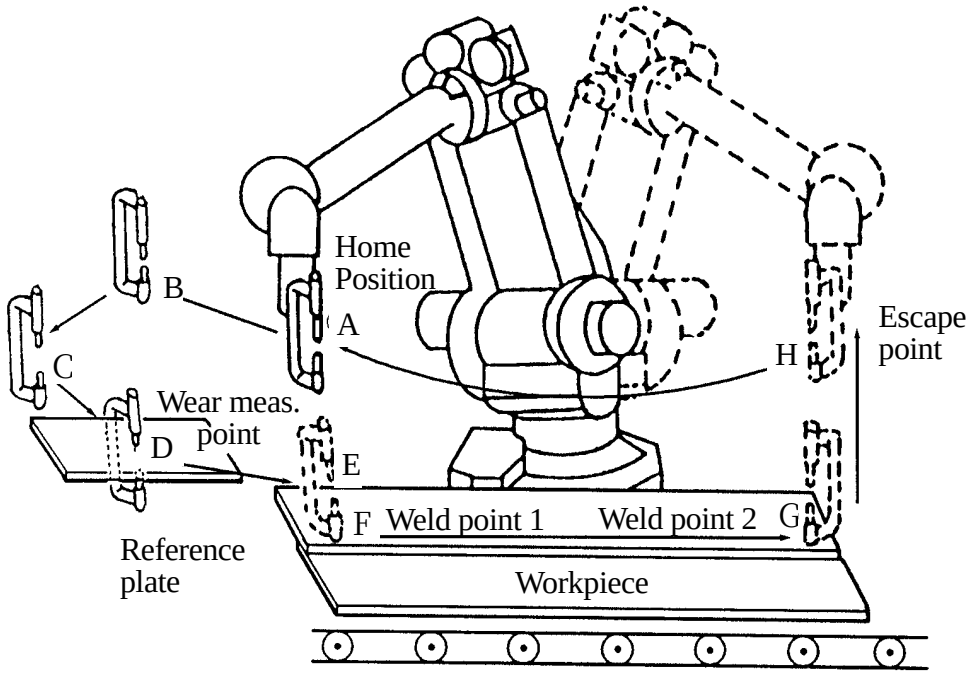
A3.4 EXAMPLES OF TEACH OPERATION

This section describes how to teach operations to the servo weld gun using the examples on the following pages.

⚠ CAUTION

1. **Set the correct tool number of the servo weld gun prior to teaching and repeat operations. Incorrect setting of the tool number may cause the pressurizing process to malfunction.**
2. **In order for tip wear measurement and deflection compensation to function properly, set the operating direction of moving tip along tool Z axis.**
3. **As shown in the figure, set the moving tip opening direction of the servo weld gun in Aux. – [10. Spot weld] – [21. Servo weld gun] – [Tool Z + direction].**
4. **Set the tool Y direction parallel to gun axis and yoke plane.**
5. **Measure the tip wear for all guns prior to teaching and editing operation.**





Example of Teaching

Teaching point	Contents
A	Home position (Set an appropriate opening distance for the gun in preparation for Workless clamp measurement step
B	Move gun to a point that permits wear measurement by workless clamping, and teach the Workless clamp meas. step with clamp (CL1) ON.
C	Move gun near the next tip wear measurement point, and adjust the opening distance of the gun axis.
D	Move gun to the tip wear measurement point on the reference plate, and teach the Reference plate measurement step with clamp (CL1) ON.
E	Move gun to an escape point near weld point 1, and adjust it to an opening distance that does not interfere with the workpiece.
F	Turn clamp (CL1) ON, and teach while pressurizing.
G	Turn clamp (CL1) ON, and teach while pressurizing.
H	Move gun to an escape point near weld point 2 with clamp (CL1) OFF.

Example of auxiliary data in this application

Teaching point	Step	Intp	Spd	Acc	Tmr	Tol	Gr	Clamp		
								ON/OFF	Gun status	Gun No.
A	1	Joint	9	3	0	1	1	OFF	Normal weld	1
B	2	Joint	9	1	0	1	1	ON	Workless clamping meas.	1
C	3	Joint	9	3	0	1	1	OFF	Normal weld	1
D	4	Linear	9	1	0	1	1	ON	Reference plate meas.	1
E	5	Joint	9	3	0	1	1	OFF	Normal weld	1
F	6	Linear	9	1	0	1	1	ON	Normal weld	1
G	7	Linear	9	1	0	1	1	ON	Normal weld	1
H	8	Joint	9	3	0	1	1	OFF	Normal weld	1

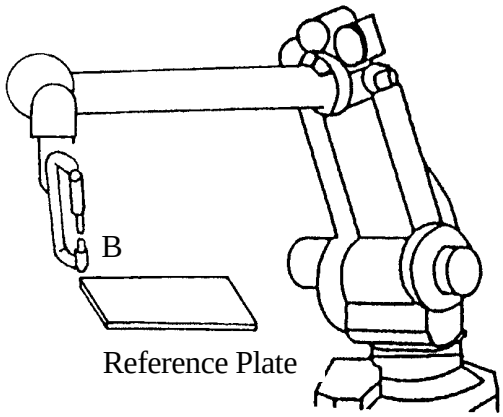
[NOTE]

1. The table above is given only as an example, set auxiliary data appropriate for your specification/system.
2. Set the tool number that corresponds to the servo weld gun.
3. Pose data is omitted in the above example.
4. Gun status is classified as below.

0: Gun Disconnection R
1: Normal Weld W
2: Workless Clamp Meas. K
3: Reference Plate Meas. P
4: Gun Connection A
5: Leak Check L
6: Knock Mode F
7: Tip Dress H
10: Copper Plate Mode C
11: Workpiece Deviation Meas. M

Teaching "Wear Measurement via Workless Clamping"

This is teaching point B in the table above.



Teaching procedure

1. Press DEADMAN + AXIS to move the gun tip to Teaching point B, the Workless clamp measurement position.

2. Press ENABLE + CLAMP ON. Set the pressurizing force at this time in Spot service – [20. Servo weld gun condition] – [Tip force at Teach].

3. Press <Gun Status> → 2* → ↵ → NUMBER** → ↵ to set the Gun status.

   NOTE * Set [2] for Workless clamp measurement.
   NOTE ** Set the gun number, 1 for normal spec, 1-4 for gun change spec.

4. Set other auxiliary data such as interpolation, speed, accuracy, timer and tool.

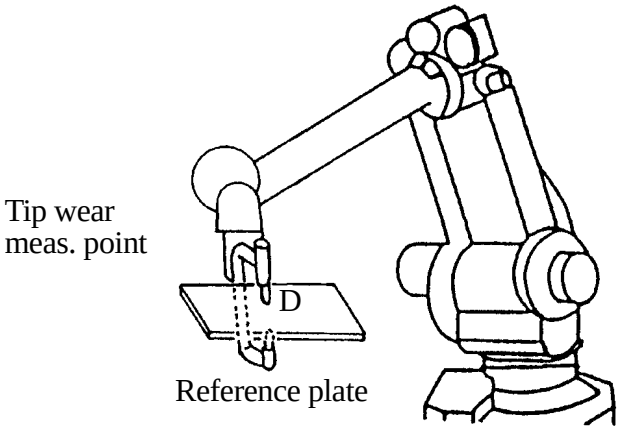
5. Press REC to teach the pose and auxiliary data of teaching point B.

[NOTE]

1. Teach gun status as [2] Workless clamp meas. with clamp ON in teaching point B.
2. In teaching point A, set an appropriate opening distance for the moving tip of the servo weld gun in preparation for the workless clamping in teaching point B.

Teaching Wear Measurement via Reference Plate

This is teaching point D.



Teaching procedure

1. Press DEADMAN + AXIS to move the gun tip to the tip wear measurement by reference plate point D.

[NOTE]

To minimize measuring errors, teach by pressing the moving tip against the reference plate without allowing the fixed tip to touch the plate.

2. Press ENABLE + CLAMP ON to press the moving tip against the reference plate. Set the pressurizing force in Spot service – [20. Servo weld gun condition] – [Tip force at Teach].

3. Press <Gun Status> → 3* → ↵ → NUMBER** → ↵ to set gun status.

NOTE * Set [3] for Reference plate measurement.

NOTE ** Set gun number, 1 for normal spec., 1-4 for gun changer spec.

4. Set other auxiliary data such as interpolation, speed, accuracy, timer and tool.

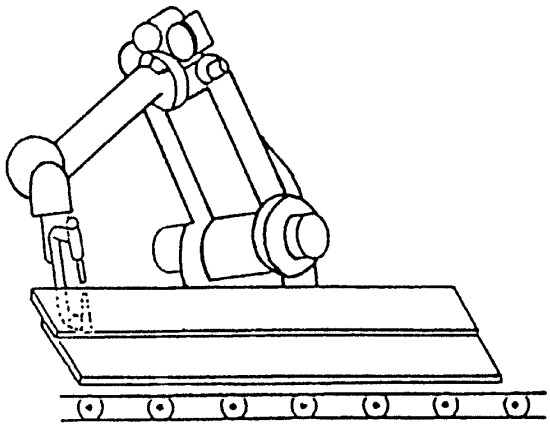
5. Press REC to teach the pose and auxiliary data of teaching point D.

[NOTE]

1. Teach gun status as [3] Reference plate meas. with clamp ON in teaching point D.
2. In teaching point C, set an appropriate opening distance for the moving tip of the gun in preparation for the reference plate pressurizing in teaching point D.

Teaching a Non-Weld Point

This is equivalent to teaching points A, C, E, H and teaches the gun with an opening clearance position.



Teaching procedure

1. Press DEADMAN + AXIS to move the gun tip to teaching point A (or C, E, H).

2. Press AUX + JT7+ or JT7- to adjust the state of gun opening.*

NOTE* Operational key for axis might differ if robot specification includes traverse axis.

3. Press <Gun Status> → 1** → ↵ → NUMBER*** → ↵ to set Gun Status data.

NOTE ** Set [1] for normal weld point.

NOTE *** Set gun number, 1 for normal spec., 1-4 for gun changer spec.

4. Set other auxiliary data such as interpolation, speed, accuracy, timer and tool.

5. Press REC to teach the pose and auxiliary data of teaching point A (or C, E, H).

[NOTE]

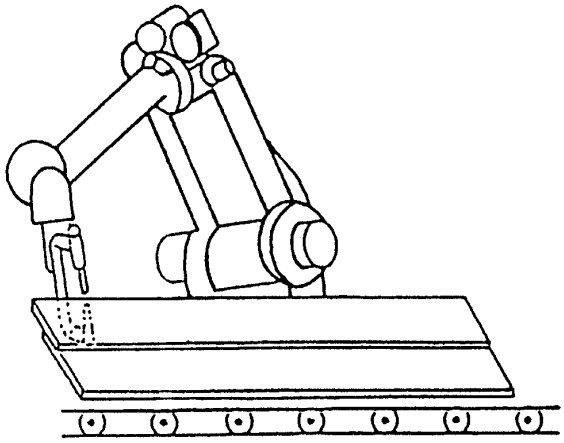
In teaching points A and C, set an appropriate opening distance for the moving tip in preparation for the wear measurement by Workless clamp meas. and Reference plate meas..

Teaching a Weld Point

This is equivalent to teaching points F and G.

⚠ CAUTION

1. **When teaching/re-teaching weld points, always execute tip wear measurement prior to teaching.**
2. **Execute tip wear measurement immediately after tip or gun replacement or a gun change.**
3. **If wear measurement is not executed prior to teaching, the robot cannot compensate correctly for changes in wear and weld quality will deteriorate.**



Teaching procedure

1. Press DEADMAN + AXIS to drive the servo weld gun to the appropriate opening distance at each weld point, then move the fixed tip to welding point 1 and 2 so tip makes light contact with the workpiece.

[NOTE]

Drive robot so fixed tip only touches the workpiece without applying force against the workpiece.

2. Press ENABLE + CLAMP ON to pressurize the servo weld gun.

[NOTE]

Ensure the gun pressurize the workpiece without any deflection while pressurizing.

3. Press <Gun Status> → [1*] → [↵] → [NUMBER**] → [↵] to set gun status.

   NOTE * Set [1] for Normal weld point.

   NOTE ** Set gun number, 1 for normal spec., 1-4 for gun changer spec.

4. Set other auxiliary data such as interpolation, speed, accuracy, timer and tool.

   [NOTE]

   Teach F linear, Fxx, etc. as the interpolation mode, if a stationary gun is used.

5. Press [REC] to teach the pose and auxiliary data of teaching point F (or G).

6. Press [ENABLE] + [CLAMP OFF] to turn clamp OFF and to open the gun.

7. Move the fixed tip away from the workpiece. Teach an escape point if something interferes with motion path of the gun to the next weld point, otherwise move the gun to next welding point.

A4.0 CHECK OPERATION

This section describes the check operations that are unique to the servo weld gun application.

A4.1 CHECK OPERATIONS IN THE SERVO WELD GUN APPLICATION

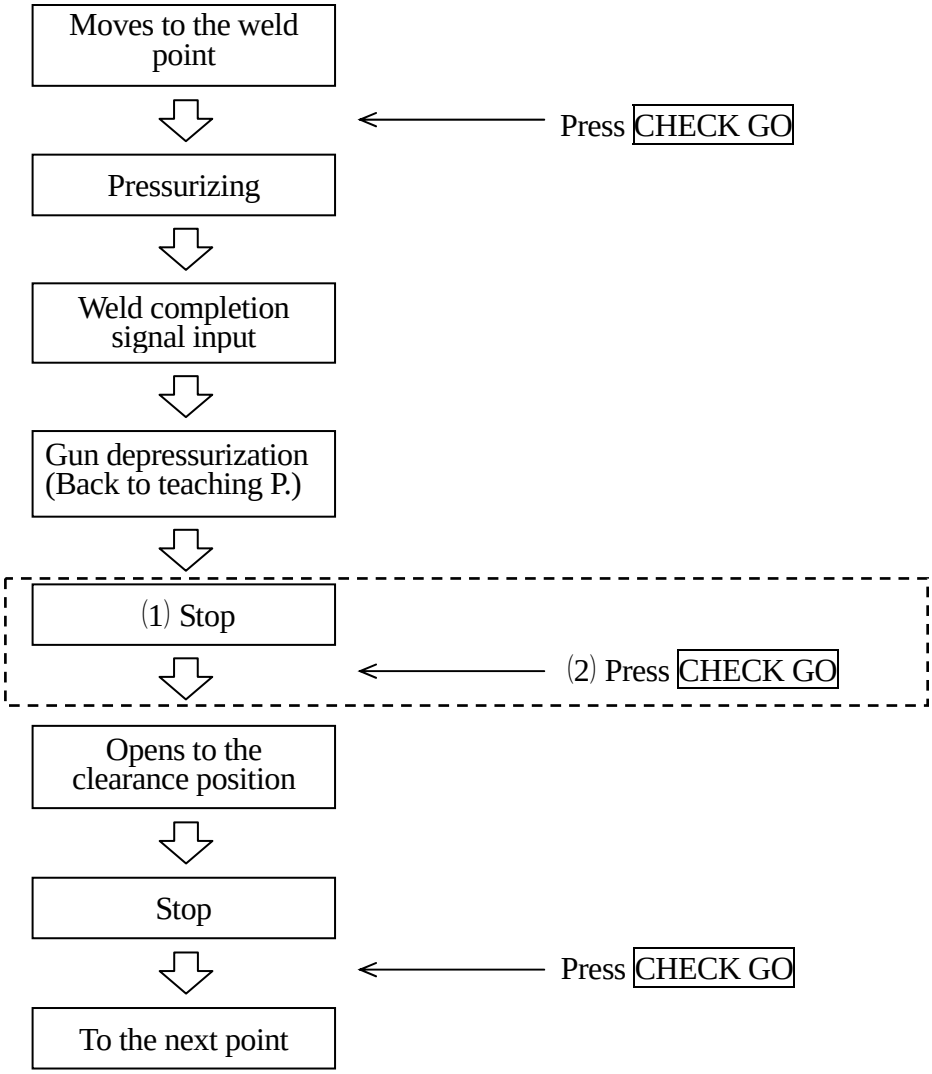
If the [SG. Check] system switch is set OFF in Aux. – [5. Advanced setting] – [2. System switch], check once mode is executed in the same way as normal playback motion: robot moves to weld point – gun closes – gun opens from workpiece by set clearance distance – robot stops.

However, the robot can be stopped at the weld point if [SG. Check] is set to ON. See the following figure.

[NOTE]

This function is ignored in check back mode. In check back mode gun always opens automatically to the clearance distance regardless of the setting of ON/OFF.

Motion with [SG.CHECK] ON



When completing a weld, the moving and fixed tips stop at the taught position for the welding point where both tips make contact with the workpiece (Zero touch position). See (1) in flow chart.

Press CHECK GO to open the gun axis to the clearance position. See (2) in flow chart.

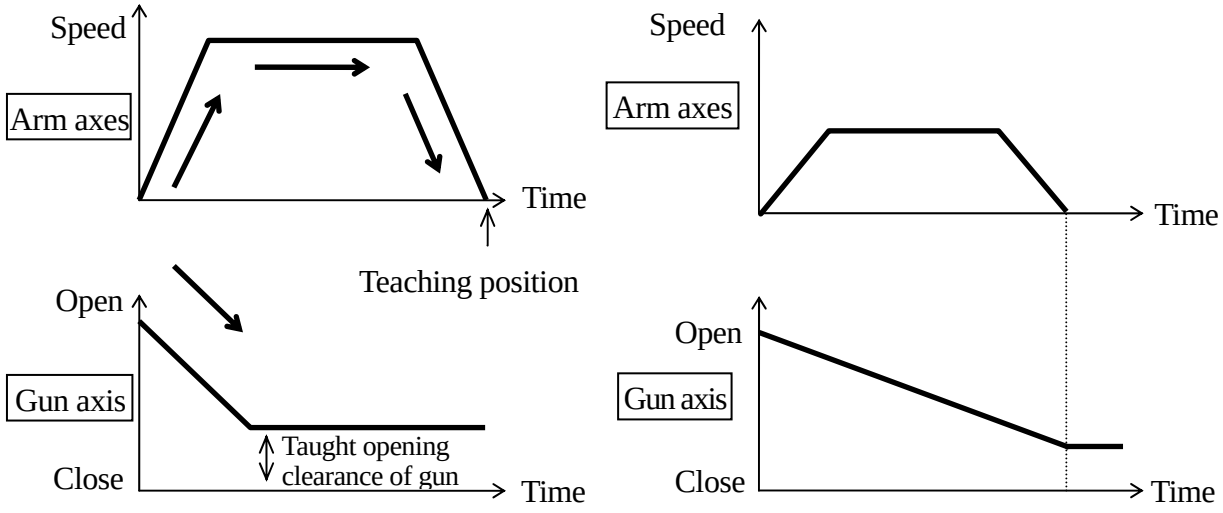
The step enclosed by ⋮ is skipped, if SG CHECK is turned OFF.

A5.0 REPEAT OPERATION IN SERVO WELD GUN APPLICATION

This section describes how the arm axes and servo weld gun axis move during playback of taught points. Note that during workless clamping measurement, axes do not follow the same motion pattern described here. Refer to A3.1.3 for details on playback motion during workless clamping measurement.

A5.1 MOTION AT A NON-WELDING STEP

When executing this step, the robot starts its motion to the taught point. However the motion aspect of arm and gun axes vary depending on the time length needed to complete motion from one taught point to the next. When motion time length of the arm axes is longer than the gun axis, gun axis completes motion earlier than arm axes as shown in left figure below. When motion time length of arm axis is shorter than gun axis, arm and gun axes start and complete motion simultaneously, as shown right.

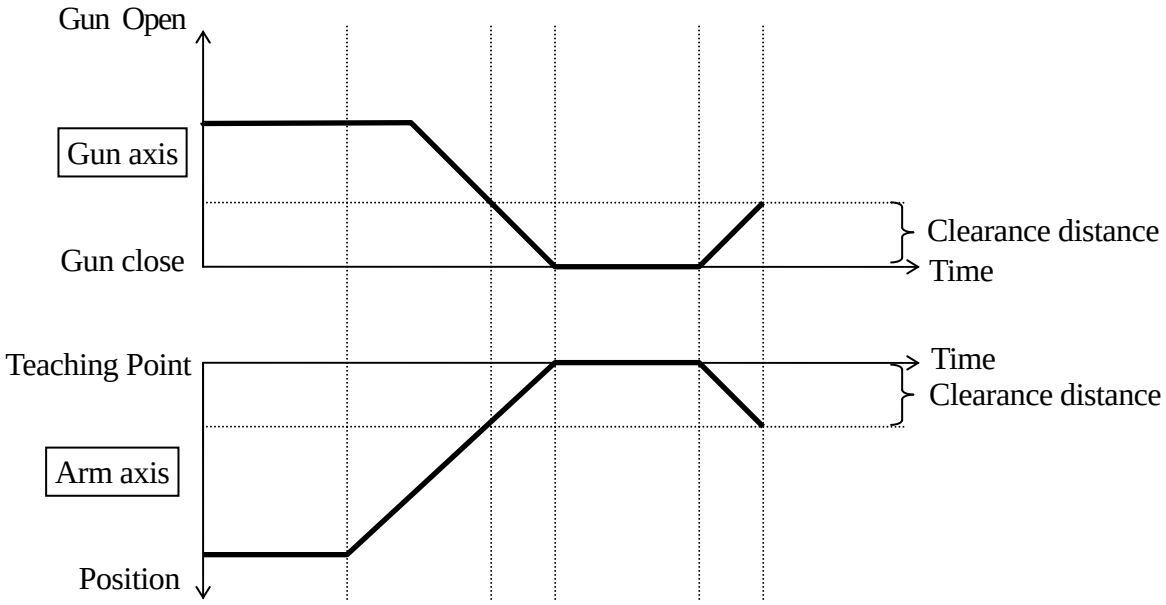


A5.2 MOTION AT A WELDING STEP

When executing this step, the robot performs the welding sequence: closing/pressurizing – welding – opening to the set clearance distance.

When reaching the set force value during pressurization, the weld initiation signal is output. The weld completion signal is input after the welding, and gun and arm axes execute opening motion to the preset clearance distance set in A1.1.6. Then, robot proceeds to the next step.

During motion to the weld point, the motion time length for the arm and gun axes is the same.



[NOTE]

1. Clearance position differs from the weld position taught in each step, thus be aware of the pose of the servo weld gun whenever making changes in the taught programs. When re-teaching the clamp ON position in each step, drive axes so fixed tip touches the workpiece, then with moving tip at clearance position, press ENABLE + CLAMP ON to close the gun and pressurize the weld point.
2. When teaching linear interpolation, the tool coordinates origin moves along a linear path; however, the gun axis ignores this setting and executes joint interpolation.

A6.0 VARIOUS FUNCTIONS IN SERVO WELD GUN APPLICATION

This section describes the various functions available in the servo weld gun application.

A6.1 GUN CHANGE

On systems equipped with a tool changer, follow the procedure below to teach gun change operation to the servo weld gun.

Turn MODE SELECT switch to TEACH and MANUAL/AUTO selector switch to MAN. then switch DEADMAN ON.

1. Disconnecting operation

   (1) <Gun Status> → 0* → ↵ → NUMBER** → ↵

   NOTE* Set [0] for gun disconnection.
   NOTE** Set the gun number, 1 for normal spec., 1-4 for gun change spec.

   (2) Press ENABLE + <Gun Status R> (Executes gun disconnection in control system.)

   (3) Teach a disconnection output signal and dismount the gun.

2. Connecting operation

   (1) Teach a connection output signal and mount a replacement gun.

   (2) Press <Gun Status> → 4* → ↵ → NUMBER** → ↵

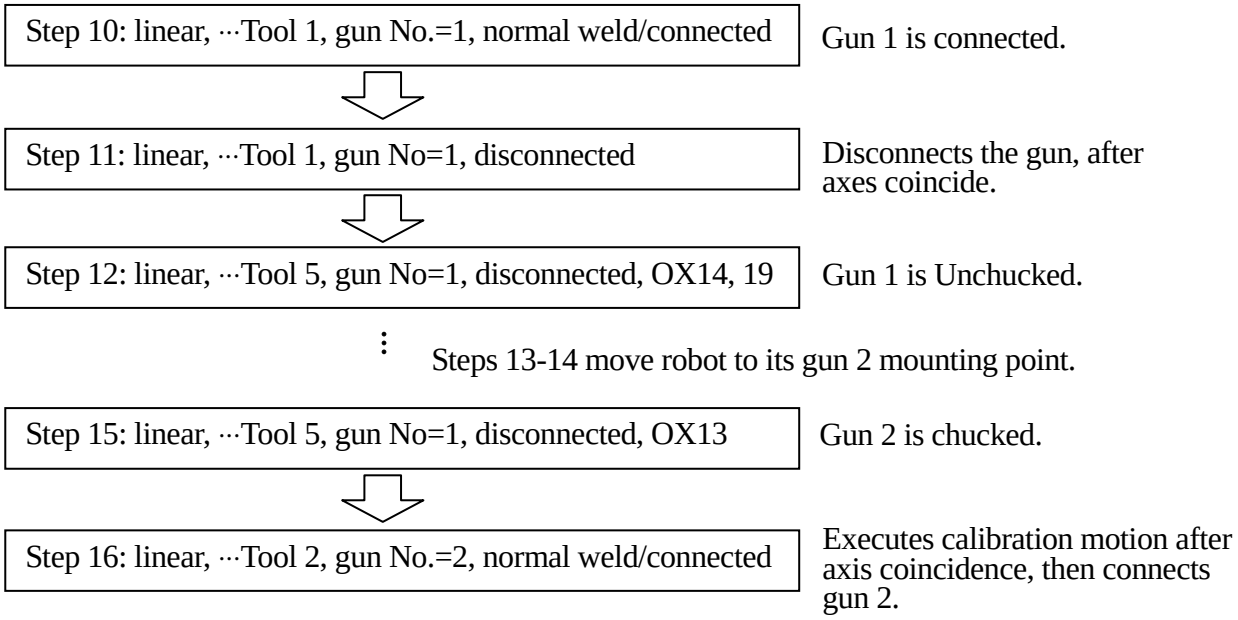
   NOTE* Set [4] for gun connection.
   NOTE** Set the gun number, 1 for normal spec., 1-4 for gun change spec.

   (3) Switch ON the motor power and DEADMAN switch on teach pendant and press ENABLE + <Gun Status A> to execute connection in the control system and automatic calibration of the gun.

The flow chart below shows an example gun change from Gun1 to Gun 2. This example assumes that the settings in the list below were already set before the gun change operation.

OX13	Chuck execution signal to tool changer
OX14	Unchuck execution signal to tool changer
OX19	Selecting signal for gun 1
Tool 1-4	Tool transformation value, when selecting gun 1-4
Tool 5	Tool transformation value, when disconnecting a gun
Gun No.=1	Gun 1
Gun No.=2	Gun 2

Operational Description



[NOTE]

1. When loading data from USB flash memory, disconnect gun axis if the current gun number or gun axis zeroing data in the robot differs from the data saved in USB flash memory. Then, execute the gun connecting operation.
2. When mounting new reference tips, set the value in Spot service – [30. Servo weld gun characteristics] – [Upper motion limit] 5 mm shorter than the stroke distance from closing point to opening end (mechanical end).
3. When calibration completes, software motion limit is set to the same value in Spot service – [30. Servo weld gun characteristics] – [Upper motion limit].
4. Gun axis moves at constant speed while calibration is in motion and is not affected by the set monitor speed.
5. During calibration, operations are processed according to the list below.

Processing during calibration

HOLD/RUN operation	Switching HOLD/RUN to RUN resumes the calibration that was started before HOLD was engaged.
At Emergency Stop	Calibration motion cancels and gun axis becomes disconnected state.
When changing modes	
At CONTROLLER POWER OFF	
In error occurrence	

A6.2 ZEROING OF SERVO WELD GUN

When the servo weld gun is disconnected then connected manually in the control system, the zeroing data is automatically calculated for the axis. The zeroing data is the mechanical end position value for gun axis and is calculated under the condition that the gun axis value is zero when gun with tips of zero wear closes.

1. Press <Gun Status> → 0 → ↵ → NUMBER* → ↵ in teach mode.

   NOTE* Set the gun number. Set 1 for normal spec, 1-4 for gun change spec.

2. Press ENABLE + <Gun Status R>. (Disconnects gun. Unchuck is not necessary.)

3. Press <Gun Status> → 4 → ↵ → NUMBER* → ↵.

4. Switch ON the motor power and DEADMAN switch on teach pendant and press ENABLE + <Gun Status A>.

5. Calibration motion starts. When it terminates, zeroing data is automatically stored.

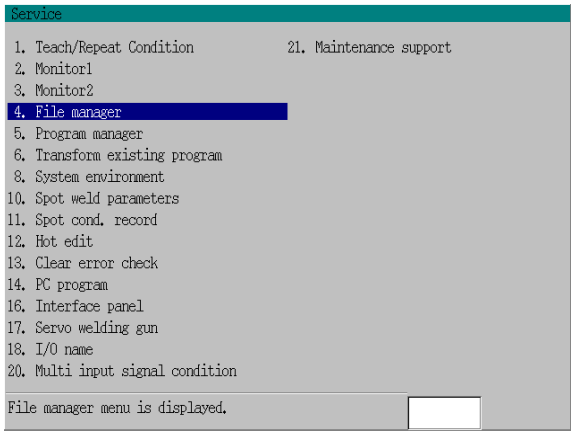
[NOTE]

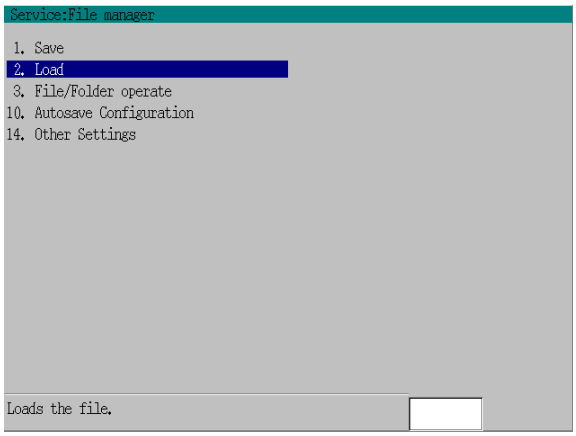
1. Be sure to operate with DEADMAN turned ON. Otherwise, the gun connection cannot be processed.
2. Gun axis connection cannot be processed when Emergency Stop or error occurs. However, disconnection can be processed at all times.
3. If the gun ID input signal is set in Aux. – [10. Spot weld] – [21. Servo weld gun], the set tool number is compared with the actual gun number to be mounted to the robot when connecting a servo weld gun. If different, error; "E5007: Servo weld gun not connected or wrong gun connected." occurs.
4. Calibration is not executed with optional twin gun application.
5. Zeroing data is calculated based on the calibration executed when connecting servo weld gun and the data set in <Spot service> – [30. Servo weld gun characteristics] – [Upper motion limit]. Set these data correctly to attain correct zeroing data.
6. Zeroing is not required when changing the tip.

A6.3 PROGRAM LOADING

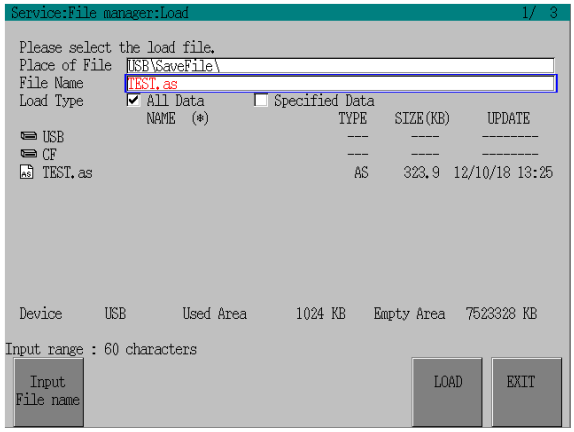
Loads the data stored in files on the USB flash memory into controller memory. Insert USB flash memory into the loading slot.

1. Select [4. File manager] from the menu displayed when pressing ENABLE + <Service> as shown below left, then the screen below right appears.





2. Select [2. Load] to display the file list and select the file to load from the list.



3. Specify the file name and press <Load>.

⚠ CAUTION

1. In the servo weld gun specification, the identification number of the connected gun is automatically checked when a file is loaded. If the data stored in the file differs from the gun currently mounted on the robot, the following warning message is displayed and confirmation of the data is required.

Data within the file is as follows: Confirm! (Enter the return.)
Connecting gun number Axis-Gun [7-1]
****
WARNING
****
Gun number does not coincide with that of gun connected.

1. **Skip (No-zeroing data is loaded.)**
5. **Skip gun axis data (Only the zeroing data of gun axis is not loaded.)**
9. **Compulsory load (Forces the data to be loaded.)**

Select from among the options.

Normally in this situation input 5 or 9, once data finishes loading, disconnect the gun manually in the control system and reconnect.

2. Even if above message did not appear as a safety precaution, disconnect gun once in the control system and reconnect it.
3. After gun is connected, operate the gun in teach mode and confirm that gun functions normally throughout its motion range.
4. Zeroing data of the gun axis is calculated automatically at calibration when gun is connected in the control system, thus each calibration may affect the data. If calibration is executed even once after zeroing data has been saved, the saved zeroing data and the zeroing data currently in the robot may differ. And if the saved zeroing data is used in this situation, the gun axis may malfunction.

A6.4 STATIONARY GUN (OPTION)

The interpolation modes that can be taught differ depending on the mounting position of the spot weld gun, whether it is on the robot or in a fixed position on the floor, etc.

Stationary gun : Teach interpolation modes FJPOINT, FLIN and FCIR1, etc.
Non-stationary gun : Teach interpolation modes JOINT, LINEAR, CIR1, etc.

⚠ CAUTION

Teaching interpolation modes JOINT, LINEAR, etc. at steps where workpiece is welded via fixed gun, or conversely, teaching FJOINT, FLIN, etc. without using a fixed gun will prevent the following functions from operating correctly: tip wear compensation, deflection compensation, motion to clearance position, etc.
However, at non-pressurizing steps, teach whatever interpolation mode is most appropriate.

A6.5 TWIN GUN (OPTION)

In twin servo weld gun, where a single motor controls two pressurizing system, the closing motion of one gun is performed while the other gun opens. This section describes the differences between the servo weld gun and the twin gun and gives precautions for use.

1. Changing between the twin guns is accomplished via Gun change, the same operation used with the standard servo weld gun. However chuck/unchuck is not required, only the taught tool number needs changing. For instance, when moving gun from a welding position where Gun 1 is to be used to a position where Gun 2 is to be used, teach Gun 1 (tool 1) to the first welding Gun 1 first then Gun 2 (tool 2) to next weld point.

2. A step for disconnecting from one gun to the other is not required. Even if the step is taught, it will be disregarded in repeat mode. Also, as with a standard servo weld gun, accuracy setting is ignored at the gun change point (disconnect → connect). When changing between guns on the twin gun, pay attention to the following cautions.

[NOTE]

1. In repeat and check modes, twin gun cannot be unchucked even if gun is disconnected. Also, if abnormality occurs in the gun axis encoder, robot error stops and operation of all axes is disabled. If twin gun is forcibly unchucked at this time it may cause trouble in the gun axis motor, encoder, amplifier, etc.
2. Unlike repeat and check modes, in teach mode twin gun can be unchucked via the same operation used for standard servo weld gun. Even if twin gun axis malfunctions, unchuck and separation of the gun axis from the robot axes is possible.
3. Unlike a standard gun, in teach, check and repeat modes, calibration is not executed automatically when switching twin guns, instead zeroing data set in the Aux. screen is used. Thus, for each twin gun execute zeroing and set its zeroing data in the controller. Also, if encoders are replaced, redo zeroing and setting of the zeroing data.
4. When one twin gun closes the other gun opens, but if gun change is attempted while one of the guns is nearly closed or is pressurizing, the other gun may be detected as outside the motion range resulting in error. Avoid this by trying gun change when guns are sufficiently open.

3. Operation procedure for pressurizing and welding with each gun is the same as standard gun. Set gun No. 1 for Gun 1 and 2 for Gun 2.

4. Operational procedure for zeroing and setting data of twin gun are as follows.

⚠ WARNING

After changing the motor or encoder, execute zeroing to calibrate the mechanical origin (axis scribe marks) of each axis with the origin of each encoder. If this function is not set properly, home positions will not match and programmed positions may deviate possibly causing damage to robot or surroundings. Therefore, qualify only persons who have completed Kawasaki's maintenance course to operate this function.

(1) Connect Gun 1 and reset its encoder rotation counter.

(2) Align gun 1 to its mechanical origin (scribe marks match position), and again reset encoder rotation counter. In the Aux. function screen, set the gun position data at the scribe marks match position as the value in [JT angle set].

(3) Execute zeroing at the same position as in (2). Set the same data as (2) for JT angle value.

(4) Confirm and note zeroing and offset data of gun 1 (setting and offset values) in A1.1.10 Servo weld gun characteristics.

(5) Change the gun to Gun 2.

(6) Set the offset value noted at (4) in A1.1.10 Servo weld gun characteristics. If the offset values of Gun 1 and 2 differ, an error occurs.

(7) Align gun axis mechanical origin of Gun 2 (scribe marks match position) and then execute the zeroing. In the Aux. function screen, set the gun position data at the scribe marks match position as the value in [JT angle set]. However never reset the encoder rotation counter at this time. If the counter is reset, restart this procedure starting from (1).

(8) Repeat step (4) for gun 2.

(9) Set the zeroing data noted at (4) and (8) in A1.1.10 Servo weld gun characteristics.

[NOTE]

1. Zeroing and setting of its data is required, when replacing the encoder (motor) of the twin gun axis or when switching the gun from unchuck to chuck.
2. For standard servo weld guns, zeroing is automatically calculated at calibration, but twin gun does not execute calibration. Thus, matching of the scribe marks to their match position and zeroing of both guns are required.
3. Zeroing is not required when changing the tip.

A7.0 TIP DRESSING FUNCTION

This function enables tip dresser to operate as an external axis of robot by executing dedicated FN commands.

Following FN command is used to control rotation of the motor for tip dresser.

Dedicated FN command FN309[Axis No., Rotation speed]

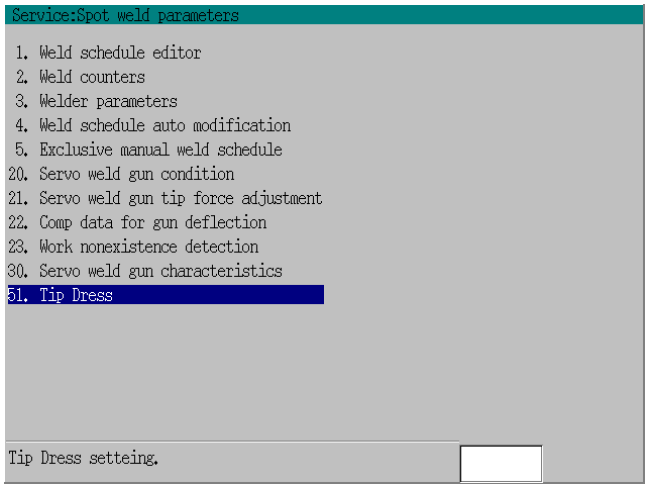
Parameters

Axis No.: Specifies axis number of the endless rotation axis (axis of tip dresser). (Input range: 1 to No. of axes)

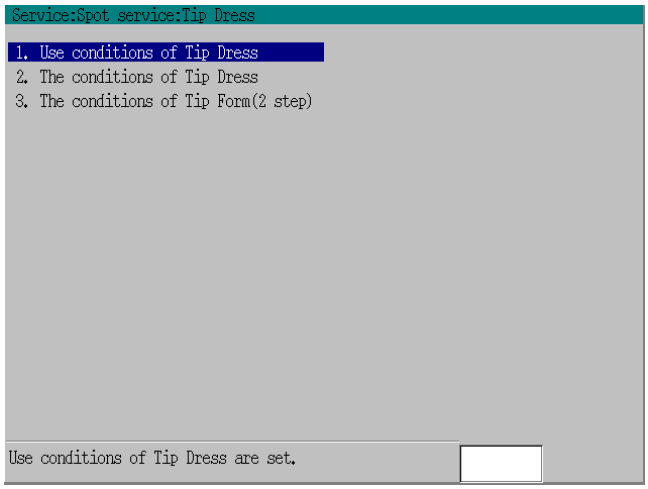
Rotation speed: Specifies rotation speed (rpm). Specifying it with a negative value reverses the motor. (Input range: -1500 rpm to 1500 rpm)

A7.1 TIP DRESSER USAGE CONDITIONS

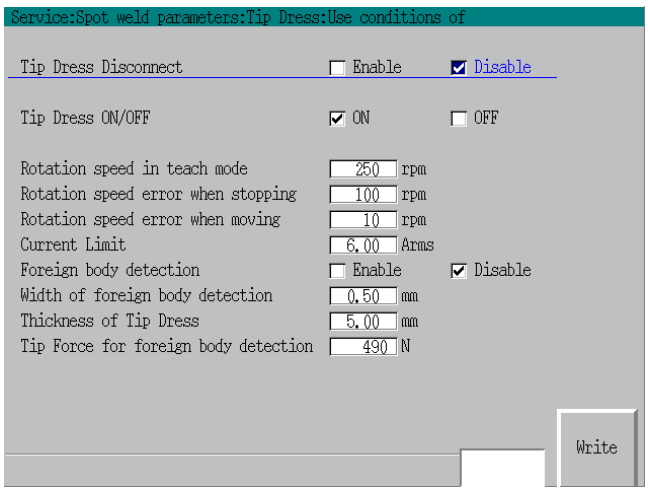
This section describes the procedure for enabling this function.



1. Turn OFF motor power.
2. Press <Spot service> to display the screen on the left.
3. Move the cursor to [51. Tip Dress] by pressing ↑ or ↓, or input a the item number (51). Then press ↵.



4. Move the cursor to [1. Tip dresser Usage Conditions] by pressing ↑ or ↓ or by inputting item number (1) . Then press ↵



5. Set each item of tip dresser on the screen displayed on the left.

Tip Dress Disconnect

Enable: [Enable] is selected when disconnecting tip dresser due to tip dresser motor error, etc.
When Enable is set;

1. Motor/encoder error is not detected.
2. Dedicated output signal, Tip dress disconnect, turns ON.
3. Error is not displayed even if FN309 taught step is executed, and robot moves to the next step immediately.

Disable: Select [Disable] when using this function. Endless rotation axis starts rotating by executing the FN309 command.

Tip Dress ON/OFF

ON: Linear-up table for tip dressing is used when [ON] is selected. Also, dedicated output signal, Tip dress ON, turns ON.

OFF: Linear-up table in general use is used when [OFF] is selected. Also, error is not displayed even if FN309 taught step is executed, and robot moves to the next step immediately. Endless rotation axis does not rotate, either.

Teach mode rotation speed (Displayed only when R314 is input.)

Tip dresser rotates at the speed set here during teaching. (Input range: -1500 ~ 1500 rpm)

Tip dresser rotates when all conditions below are met.

- Master ON in teach mode
- Dedicated input signal, Tip dress teach ON, is ON
- Trigger ON
- Teach lock ON

Rotation speed error when stopping/Rotation speed error when moving (Displayed only when R314 is input.)

Sets the rotation speed to detect velocity deviation error. (Input range: 0 ~ 1500 rpm)

Set 0 for [Rotation speed error when stopping] to disable the error detection function. See A7.2 Setting the rotation speed deviation error for details.

Current Limit (Displayed only when R314 is input.)

Sets the max. current value for tip dresser motor. (Default: 6 Arms, Input range: 0.0 ~ 15.0 Arms)

Foreign Body Detection (Displayed only when R314 is input.)

Foreign body detection function checks if no obstacles have entered the tip dresser and prevents defects in

tip dressing. This setting switches valid/ invalid of the foreign body detection function.

Width of foreign body detection (Displayed only when R314 is input.)
Warning is given and holds robot motion when the measurement result at tip dressing point exceeds the value set here + the thickness of the dresser. When this value is set to 0.0 mm, the foreign body detection is disabled (invalid).

Thickness of Tip Dress (Displayed only when R314 is input.)
Registers the thickness of the tip dresser. This value is used together with the gun axis current position values to measure the thickness of the foreign obstacle.

Tip Force for foreign body detection (Displayed only when R314 is input.)
The measurement for foreign body detection is executed by reading the encoder value when the clamp torque of the servo weld gun exceeds the value set here.

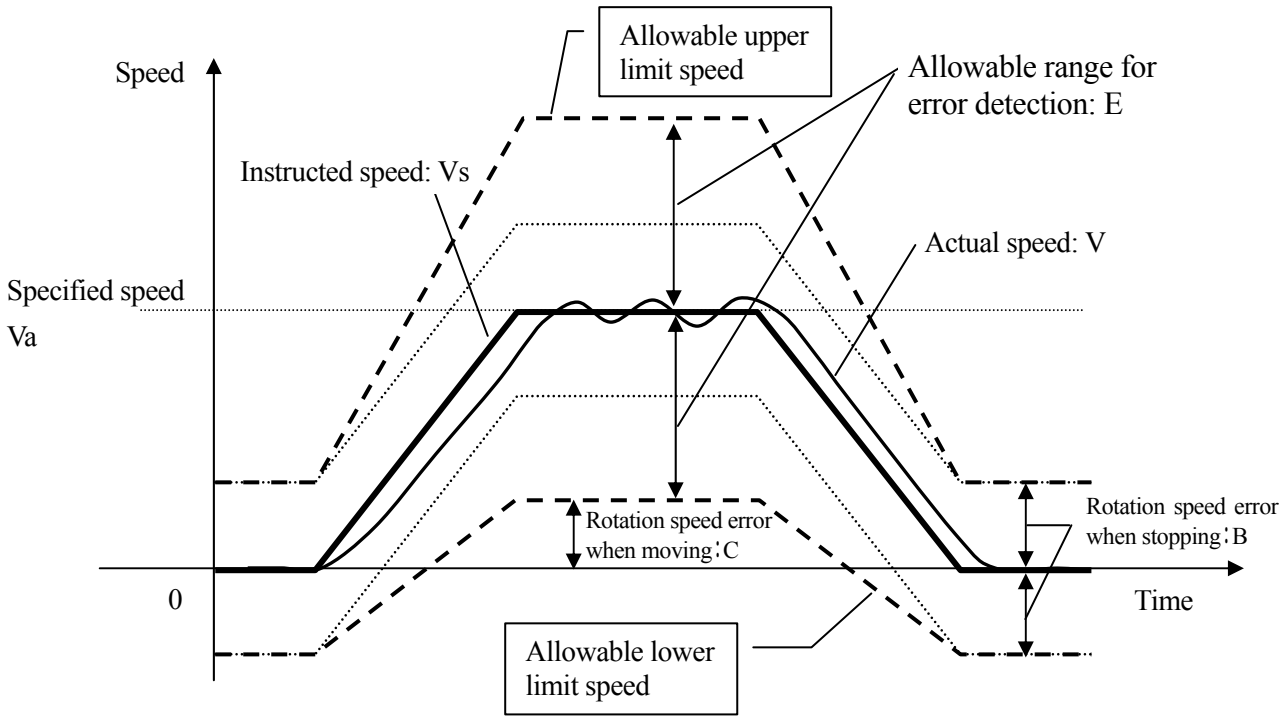
A7.2 SETTING ROTATION SPEED ERROR

Velocity deviation error is detected if actual speed of tip dresser exceeds the allowable range E. The allowable range E is calculated based on the Rotation speed error when stopping B and the Rotation speed error when moving C. See below for B and C.

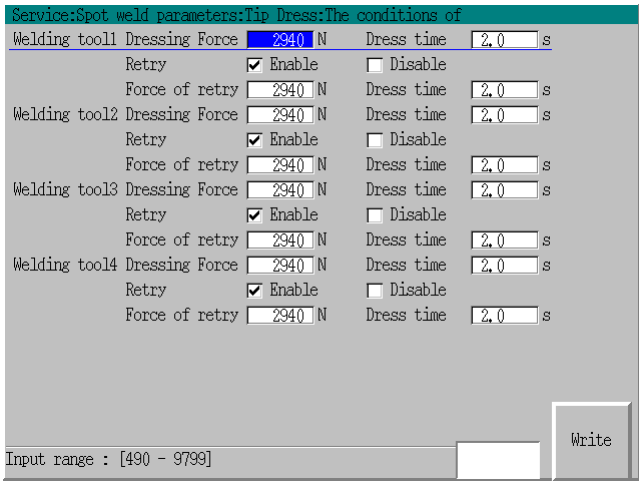
Assuming that;

Actual speed: V
Instructed speed: Vs
Allowable speed: E

E1264 error is detected if $|Vs - V| > E$.
(See error messages in 7.6. "E1264 Velocity deviation error in endless rotation axis. (jt xx)")



A7.3 TIP DRESSER CONDITIONS



Select <Spot Service> - [51. Tip Dress]- [2. Tip Dresser Conditions].

Dress force

Sets the tip force at tip dressing point.

Dress time

Sets the time to pressurize the tip dresser at the tip dressing point. The gun is release when the time set here elapses after the tip force matches the specified force. (Weld complete signal is not necessary)

Retry/ Force of retry/ Dress time

Sets the conditions of retry when abnormalities are detected during tip dressing.

Enable	Tip dressing is repeated at detecting abnormality during tip dressing. (See the list below for abnormalities that are detected.) No abnormality detected at tip dressing point. (No warning display). The gun is moved to the clearance position automatically and re-pressurizes at the force and time set for retry. (Does not output user warning signal). Result after retry ■When abnormality is detected After opening the gun to the clearance position, user warning signal is output and the robot comes to a HOLD. Re-executes the step after error reset and HOLD release. (Normal dressing motion⇒When error is detected: Retry motion/ When no error is detected: Next step) ■When normal Moves to the next step.
Disable	Tip dressing is not repeated at detecting abnormality during tip dressing. When abnormality is detected, After opening the gun to the clearance position, user warning signal is output and the robot comes to a HOLD. Re-executes the step after error reset and HOLD release. (Retries at normal tip force and dressing time.)

*For abnormality that causes retry, see A7.9.

A7.4 CONDITION FOR TIP DRESSER (2STEP)

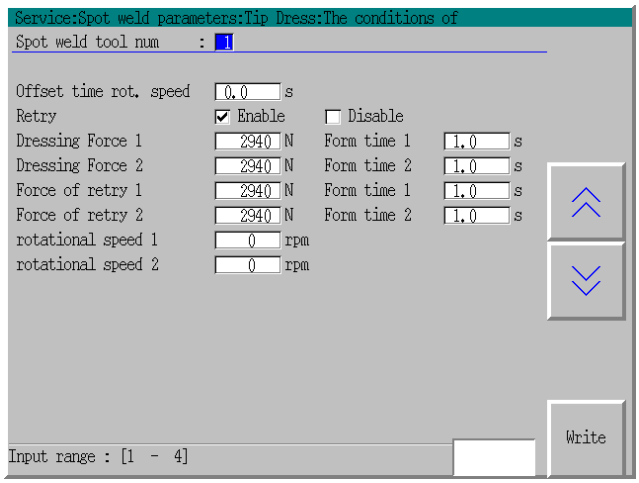
This function changes the tip force and rotation speed during tip dressing.

Exclusive FN Instruction FN312[Axis number, Rotation control]

Parameter

Axis number: Specify the axis number for Endless axis (tip dresser axis) (Input range: 1 to max. number of axis)

Rotation speed: When 1 is specified, rotates at the set rotation speed. When 0 is specified, rotation stops. (Input range: 0,1)



Select <Spot Service> - [51. Tip Dress]- [3. Tip Dresser Conditions (2 Step)].

Spot weld tool number

Specifies the number of spot welding tool to display and set.

Rot. speed adjustment time

Changes to motor rotation speed for the second step before or after the specified time, based on the timing when the tip force changes to that for the second step. Positive value specifies after the set time, and negative value specifies before the set time.

Retry

Sets whether tip dressing is retried when abnormality is detected during tip dressing.

Dress force 1

Sets the tip force for first step of tip dressing.

Dress time 1

Sets the time to pressurize the tip for first step of tip dressing.

Dress force 2

Sets the tip force for second step of tip dressing.

Force of retry 1

Sets the tip force for retying first step of tip dressing.

(Retry) Dress time 1

Sets the time to pressurize the tip for retrying first step of tip dressing.

Force of retry 2

Sets the tip force for retying second step of tip dressing.

(Retry) Dress time 2

Sets the time to pressurize the tip for retrying second step of tip dressing.

Rotational Speed 1

Specifies the rotation speed of tip dresser motor for first step.

Rotational Speed 2

Specifies the rotation speed of tip dresser motor for second step.

A7.5 DEDICATED SIGNALS

Following dedicated signals are added for this function.

Output signals
Tip dress disconnect: This signal is output if [Tip Dress Disconnect] is set to [Enable].
Tip dress ON: This signal is output if [Tip Dress ON/OFF] is set to [ON].

Input signal
Tip dress teach ON: This signal is input when rotating tip dresser at the time of teaching.

A7.6 CAUTIONS

Pay attention to the following when using this function.

1. The current position of endless rotation axis is always displayed as “0 degree”. Also, “0 degree” is recorded at the time of teaching. However, the “0 degree” is not displayed/taught if the endless rotation axis number is the maximum axis number.
2. Software limit of endless rotation axis is not detected. Therefore, error is not displayed even if the taught position of the endless rotation axis is modified to the value except 0 degree.
3. If endless rotation axis is set to the maximum axis number (last axis), it is not displayed on the program edit screen or list nor saved in the save data.
4. Accuracy and axis coincidence of endless rotation axis are not checked.
5. Endless rotation axis continues rotating while waiting for timeout of timer and WX signal.
6. Endless rotation axis continues rotating while subroutine programs such as FN80, FN81 and FN82 are executed.
7. If program is changed by command other than subroutine call, such as EXECUTE, JUMP or RPS, rotating speed is reset to 0 and rotation of the endless rotation axis stops.
8. Endless rotation axis also stops rotating when the step in which END (block teaching command) is taught is executed. In this case, the endless rotation axis does not stop after axis coincidence but stops after starting to the next step.
9. Endless rotation axis does not rotate in teaching/checking even if FN309 taught step is executed.
10. If hold/emergency stop/ mode change/controller power OFF operation is executed while endless rotation axis is rotating, endless rotation axis rotates at the speed before the interruption when robot is restarted.
11. If step is changed after suspension, endless rotation axis does not rotate even if robot is restarted. Also, even if the rotation step is specified by step change operation, the endless rotation axis does not rotate unless FN309 taught step is executed.

A7.7 PROGRAM EXAMPLE

To control a tip dresser as external axis of robot, it is necessary to teach FN309 command between steps which the endless rotation axis starts and stops rotation. To stop the rotation, specify 0 for rotation speed.

```
1.  JOINT SPEED9 ACCU1 TIMER0 CLAMP1 (OFF,0,1,O) OX= WX=
2.  FN309[ 8,250 ]
3.  LINEAR SPEED3 ACCU1 TIMER0 CLAMP1 (OFF,0,1,O) OX= WX=
4.  LINEAR SPEED3 ACCU1 TIMER0 CLAMP1 (ON,0,1,O) OX= WX=
5.  FN80[ 3 ]
6.  JOINT SPEED3 ACCU1 TIMER0 CLAMP1 (ON,0,1,O) OX= WX=10
7.  FN309[ 8,120 ]
8.  JOINT SPEED9 ACCU1 TIMER0 CLAMP1 (OFF,0,1,O) OX= WX=
9.  FN309[ 8,0 ]
10. JOINT SPEED9 ACCU1 TIMER0 CLAMP1 (OFF,0,1,O) OX= WX=
```

Description

1. After axis coincidence in step 1, endless rotation axis starts rotation at the speed of 250 rpm.
2. The endless rotation axis continues rotation while steps 3 and 4 are executed.
3. The endless rotation axis continues rotation while subroutine program in step 5 is executed.
4. After axis coincidence in step 6, the endless rotation axis continues rotation while waiting for WX signal.
5. After receiving the WX signal in step 6, rotation speed of the endless rotation axis changes to 120 rpm.
6. After axis coincidence in step 8, the rotation of the endless rotation axis stops.

A7.8 ERROR MESSAGE

This section describes errors which could occur while executing FN309 function and countermeasures.

1. P2098 The axis is not for endless rotation.

Cause:
The axis specified by FN309 was not endless rotation axis.

Countermeasures:
Specify correct endless rotation axis number.

2. E0106 Value is out of range.

Cause:
Rotation speed specified by FN309 exceeded max. speed of endless rotation axis.

Countermeasures:
Specify rotation speed under the max. speed of the endless rotation axis.

3. E1264 Velocity envelope error in endless rotation axis.(jt xx)

Cause:
The difference between the instructed value and the actual value was larger than the specified value.

Countermeasures:
1. Check if power cables of endless rotation axis are not disconnected. If disconnected, the endless rotation axis does not move although speed command is output and this error occurs.
2. Check if there is no obstacle which slows rotation speed of the endless rotation axis or tip is not pressed more than necessary, etc.
3. Check if encoder line of the endless rotation axis has not broken. If so, this error occurs as encoder value is not updated although the endless rotation axis rotates.

A7.9 USER DEFINED WARNING

If system switch, USER.ABNORMAL, is set to ON, the error related to the axis of tip dresser is handled as user defined warning. In this case, warning is displayed instead of error and the error lamp does not turn on. When warnings below are displayed, refer to details of error handling of the corresponding error.

Warning No.	Error Code	Error Message
W1037	P2098	The axis is not for endless rotation.
W1038	E1029	Encoder rotation data is abnormal.(jt xx)
W1039	E1035	Encoder response error(jt xx).
W1040	E1036	Encoder communication error.(jt xx)
W1041	E1123	Speed error jt xx.
W1042	E1262	Encoder rotation speed exceeded limit (jt xx)
W1043	E1263	Encoder temperature exceeded limit (jt xx)
W1044	E1264	Velocity envelope error in endless rotation axis.(jt xx)
W1045	D1504	Abn. curr feedback XX. (Amp fail, pwr harness disconnect)

F. SEALING

This chapter describes information specific to sealing applications.

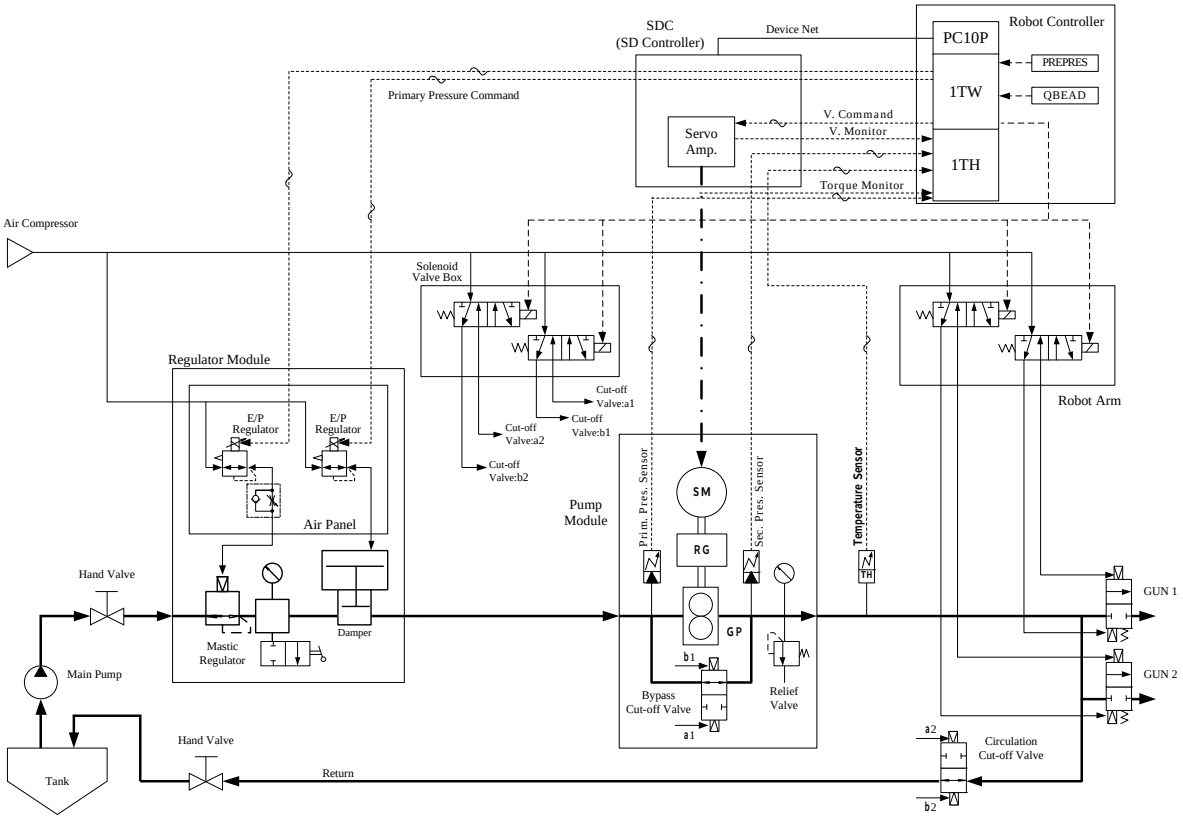
F1.0 SERVO DISPENSER CONTROL

In sealing application, the robot and a servo dispenser are controlled together by the robot controller. A motor driven pump module is installed near the robot arm and functions as a material supplying equipment. The pump is controlled as one of the robot axes, and is driven in cooperation with other robot arm axes. This enables the robot to be used as a flexible, programmable and high-performance sealing machine.

F1.1 COMPONENTS OF THE SERVO DISPENSER

The sealing robot system consists of the following components (see figure below). This manual mainly describes the functions in item 2 below:

1. Robot for sealing (model RS10, etc.)
2. Robot controller with servo dispenser control function
3. Pump module (Gear pump type)
4. Sealing related equipment (Sealing controller, Sealing piping, Sealing gun, etc.)
5. Other optional equipment (Heating system, etc.)



System Configuration for Servo Dispenser

F1.2 SERVO DISPENSER CONTROL FUNCTION

The controller has the following three control modes for the servo dispenser:

1. Dispensing mode

   Applies material from sealing gun upon receiving gun ON signal that sends command value to the gear pump driving motor. The reference value is calculated from the cross-sectional area of bead specified in BEAD instruction and robot's TCP speed or from the flow rate of sealing material specified in QBEAD instruction.

   Use BEAD instruction to specify the bead width and to keep the bead width uniform regardless of changes in robot's TCP speed. The flow rate is adjusted according the specified bead width and the TCP speed. However, note that it is impossible to keep the bead width 100% uniform due to delays in communication in material supplying system or material expansion/contraction. (Setting data in [Output ref. flowrate (R1204)] as described in the following section can compensate some factors.) See F1.6 BEAD command/ instruction for details.

   Use QBEAD instruction to keep the flow rate constant regardless of the TCP speed or the

bead width. Material is applied at the specified flow rate. See F1.6 QBEAD command/ instruction for details.

For easier teaching (programming), Function instructions FN600 and FN601 can also be used instead of BEAD and QBEAD instructions.

2. Pressure readiness mode

Keeps material pressure in the secondary line of the gear pump at pressure specified by PREPRES instruction when the gun is OFF.

For easier teaching, Function instruction FN602 can also be used instead of PREPRES instruction.

3. Circulation mode

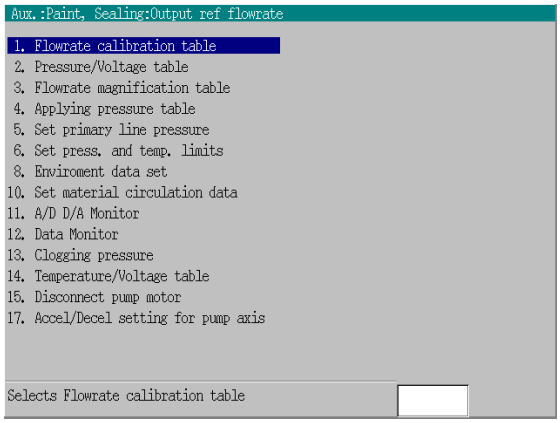
Circulates sealing material for specified time at the specified flow rate, both specified in MATCIRC instruction. Manual circulation is also available via [FUNCTION] – [12. Paint. Sealing] – [4. Output ref. flowrate] - [10. Set Material Circulation Data].

F1.3 DATA SETTINGS FOR THE SERVO DISPENSER

This section explains the necessary settings for the servo dispenser. To open the menu screen shown below, press <STATUS>. From the pull-down menu that appears, select [FUNCTION]. From the menu that appears, select [12. Paint. sealing] and then, select [4. Output ref. flowrate] (R code 1204).

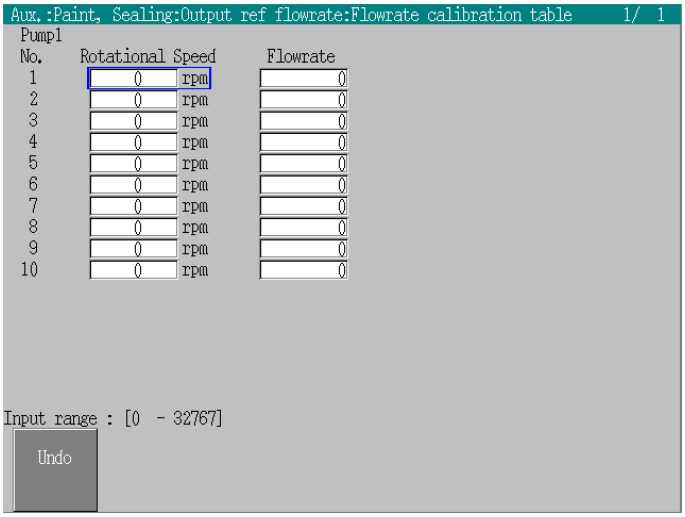
Desired unit can be used in setting data for this auxiliary function but mixed use of different units is not allowed. Keep consistency after determining the unit to use.

When controlling more than two pumps, pump selection screen appears after each item in the menu is selected. Enter the number of the pump to set the data and press ↵.



F1.3.1 FLOW RATE CALIBRATION TABLE

Sets motor revolution speed command to gain each flow rate. In flow rate calibration table that appears when selecting [1 Flowrate Calibration Table], register command voltage for servo motor revolution speed (VCMD) per flow rate.



Input data using number and arrow keys.
Input data range:
Rotation Speed: 0 – 32767
Flow rate: 0 – 32767

Press ↵ to complete.

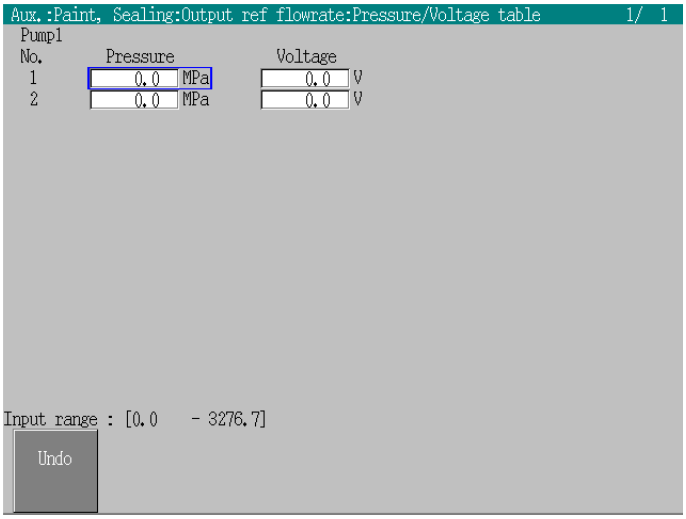
The robot checks if the registered data are set in ascending order. (This check is not executed if the last entry is 0.)

If the data is not set in ascending order, confirmation message appears asking whether or not to register the data. Press <YES> to register the data as they are.

F1.3.2 PRESSURE-VOLTAGE TABLE FOR PRESSURE TRANSDUCER

Specifies pressure-voltage characteristic of pressure transducers used for line pressure detection.

Select [2. Pressure/Voltage Table] from the menu screen for [Output ref. flowrate].



Input data using number and arrow keys.
Input data range:
Pressure: 0 – 32767
Voltage: 0 – 32767

Press ↵ to complete.

The robot checks if the registered data are set in ascending order. (This check is not executed if the last entry is 0.) If the data is not set in ascending order, confirmation message appears asking whether or not to register the data. Press <YES> to register the data as they are.

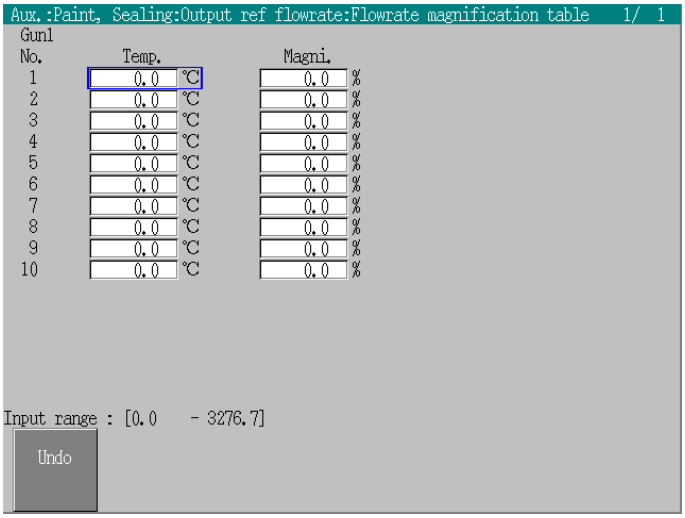
F1.3.3 FLOW RATE MAGNIFICATION TABLE

Specifies the rate of expansion (or contraction) of material flow at each temperature. This enables compensation for temperature characteristic.

Select [3. Flowrate Magnification Table] from the menu screen for [Output ref. flowrate].

The controller supports up to 4 sealing guns. Select from gun 1 - 4.

Pressing ↵ displays the table below.



Input data using number and arrow keys.
Input data range:
Temperature: 0 – 3276.7
Magnification: 0 – 3276.7

Press ↵ to complete.

The robot checks if the temperatures are set in ascending order and the magnifications in descending order. (This check is not executed if the last entry is 0.) If the data is not set in ascending (or descending) order, confirmation message appears asking whether or not to register the data. Press <YES> to register the data as they are.

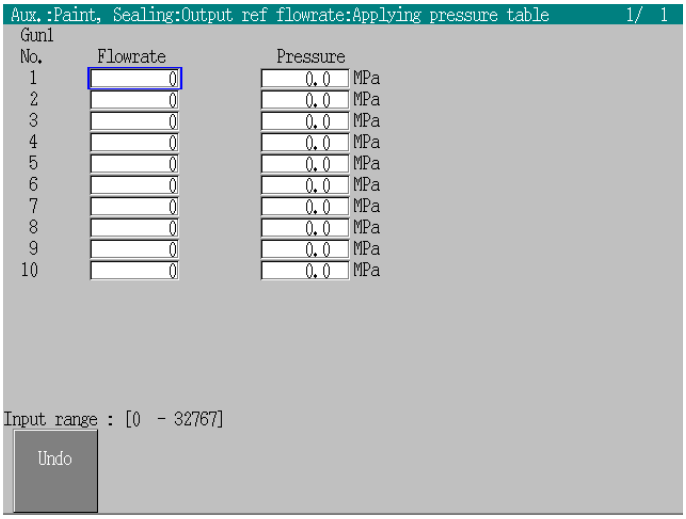
F1.3.4 APPLYING PRESSURE TABLE

Specifies the relation between material flow rate and applying pressure at gear pump outlet in steady state delivery.

Select [4. Applying Pressure Table] from the menu screen for [Output ref. flowrate].

The controller supports up to 4 sealing guns. Select from gun 1 - 4.

Pressing ↵ displays the table below.



Input data using number and arrow keys.
Input data range:
Flow rate: 0 – 32767
Pressure: 0 – 3276.7

Press ↵ to complete.

The robot checks if the registered data are set in ascending order. (This check is not executed if the last entry is 0.)

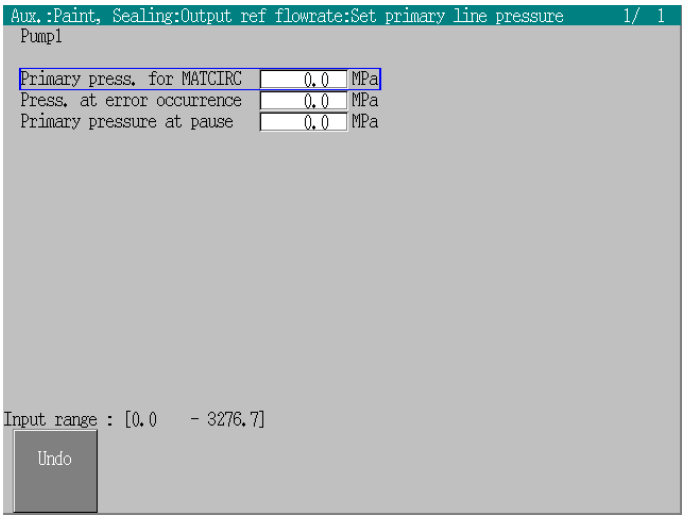
If the data is not set in ascending order, confirmation message appears asking whether or not to register the data. Press <YES> to register the data as they are.

F1.3.5 SET PRIMARY LINE PRESSURE

Specifies the primary line pressure. Primary line pressure can be specified for the following cases:

1. When circulating sealing material with gear pump.
2. When checking for internal leakage of gear pump.
3. When error has occurred.
4. While system is idling.

Select [5. Set Primary Line Pressure] from the menu screen for [Output ref. flowrate].



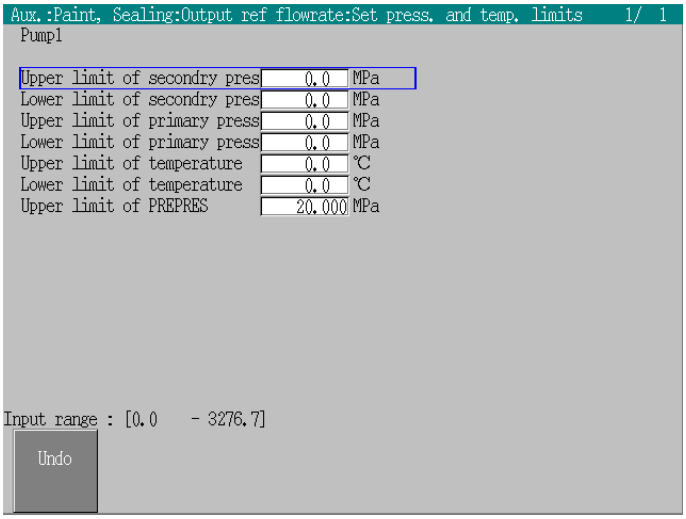
Input data using number and arrow keys.
Input data range: 0 – 3276.7

Press ↵ to complete.

F1.3.6 SET PRESSURE AND TEMPERATURE LIMITS

Specifies limit values for various kinds of checks.

Select [6 Set Press. and Temp. Limits] from the menu screen for [Output ref. flowrate].



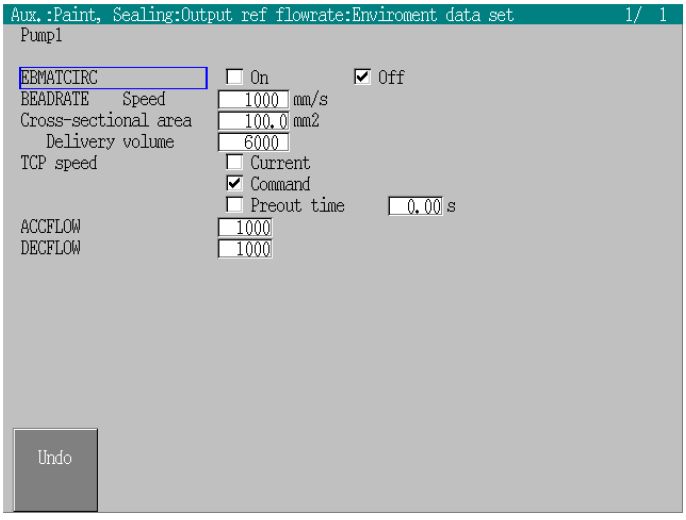
Input data using number and arrow keys.
Input data range:
Pressure: 0 – 3276.7 (Preparation Voltage upper limit 0 – 100000)
Temperature: 0 – 3276.7

Press ↵ to complete.

F1.3.7 ENVIRONMENT DATA SET

Sets various kind of operational conditions.

Select [8. Environment Data Set] from the menu screen for [Output ref. flowrate].



EBMATCIRC specifies the status for Pump1.

EB2MATCIRC specifies the status for Pump2.

EBMATCIRC (EB2MATCIRC)
This is a system switch that enables/ disables MATCIRC instruction. Selecting ON enables MATCIRC instruction and selecting OFF disables it. Default setting is OFF

BEADRATE
Sets conversion factor C for determining flow rate via BEAD instruction. C is calculated by the following formula:

$$C = \frac{\text{Flow rate}}{\text{Cross - sectional area of bead} \times \text{TCP speed}} = \frac{\text{Converted flow rate}}{\text{Flow rate by BEAD}}$$

Setting range
TCP speed: 1.0 - 9000.1 (Default: 1000.0)
Cross-sectional area: 1.0 - 1000.0 (Default: 100.0)
Flow rate: 0.0 - 10000.0 (Default: 1000.0)

The conversion factor is calculated by specifying cross-sectional area of bead and flow rate at TCP speed of 1000. To specify flow rate here, convert the actual flow rate by BEAD using the same unit as in [1. Flowrate Calibration Table].

For example, if 50 is specified for cross-sectional area and 3000 for flow rate, C becomes 0.06. If BEAD 30 instruction is executed with this setting at speed of 400, flow rate becomes 720.

TCP SPEED
Selects by what value the TCP (Tool Center Point) speed is calculated. Select [Current] or [Command].

Current: TCP speed is calculated from current encoder value.
Command: TCP speed is calculated from command value.

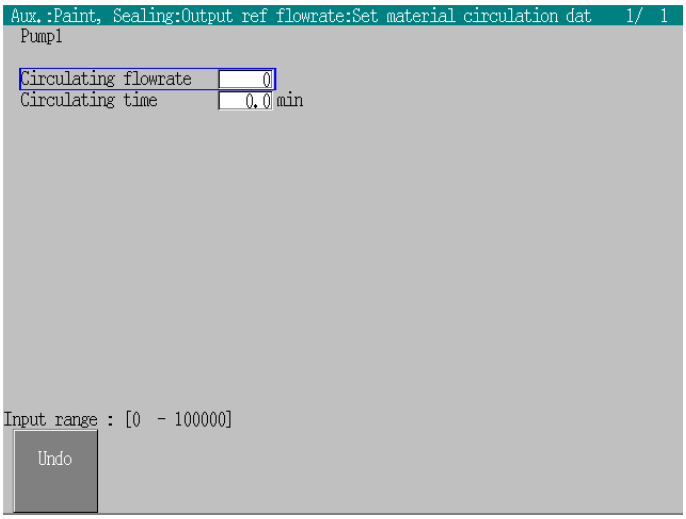
ACCFLOW
Sets the gain for accelerating flow rate in acceleration period. Setting range: 0 - 100000, default: 0

DECFLOW
Sets the gain for decelerating flow rate in deceleration period. Setting range: 0 - 100000, default: 0

F1.3.8 MATERIAL CIRCULATION

Circulates material by driving the gear pump for the specified time at specified flow rate. This setting can also be done via MATCIRC instruction.

Select [10. Set Material Circulation Data] from the menu screen for [Output ref. flowrate].

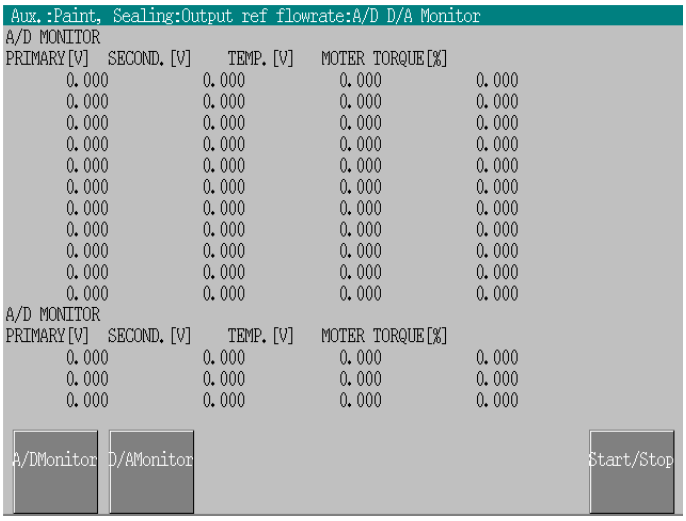


Input circulation data using number and arrow keys.
Input data range:
0 - 100000.0 for [Circulating flowrate],
0 - 60 min. for [Circulating time].
Default is 0 for both.

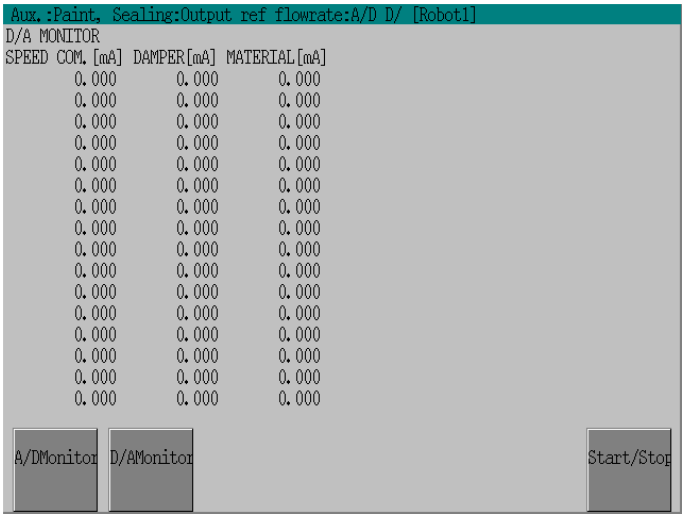
After inputting data, press ↵ to execute material circulation. Command current and air pressure values are displayed.

F1.3.9 A/D AND D/A MONITOR

Monitors in real time the signals that are input and output to/ from the robot.



Signals that are input to the robot are displayed.

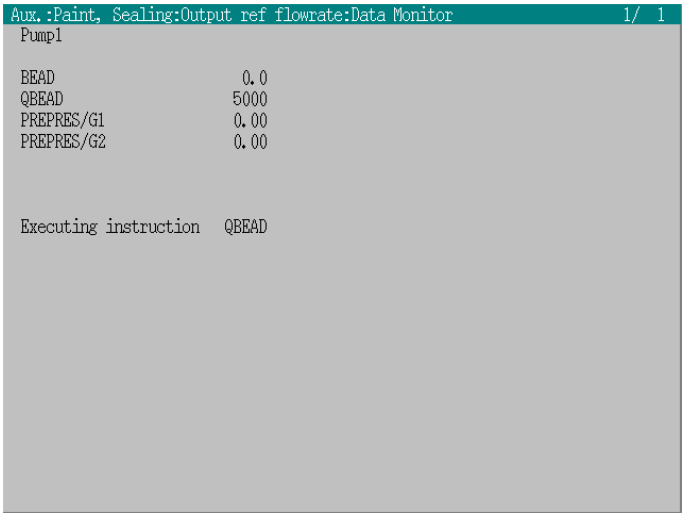


Signals that are output from the robot are displayed.

F1.3.10 DATA MONITOR

Displays data set by BEAD, QBEAD, PREPRES command/instruction.

Select [12 Data Monitor] from the menu screen for [Output ref. flowrate].



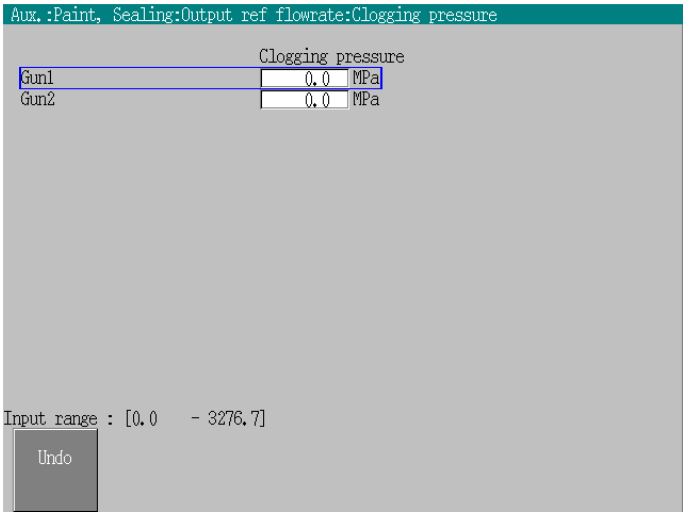
Data set by BEAD, QBEAD and PREPRES instructions are displayed.

Also displays instruction currently being executed (BEAD or QBEAD).

F1.3.11 CLOGGING PRESSURE

For each gun, sets threshold for material pressure to detect clogging of the gun.

Select [13 Clogging Pressure] from the menu screen for [Output ref. flowrate].



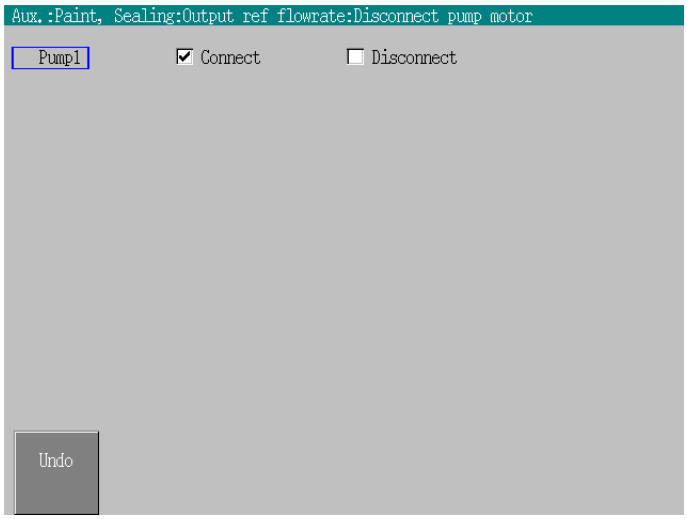
Input the maximum allowable clogging pressure using number and arrow keys.
Input data range: 0 – 3276.7

Press ↵ to complete.

F1.3.12 DISCONNECT PUMP MOTOR

Sets whether the pump axis is connected or disconnected.

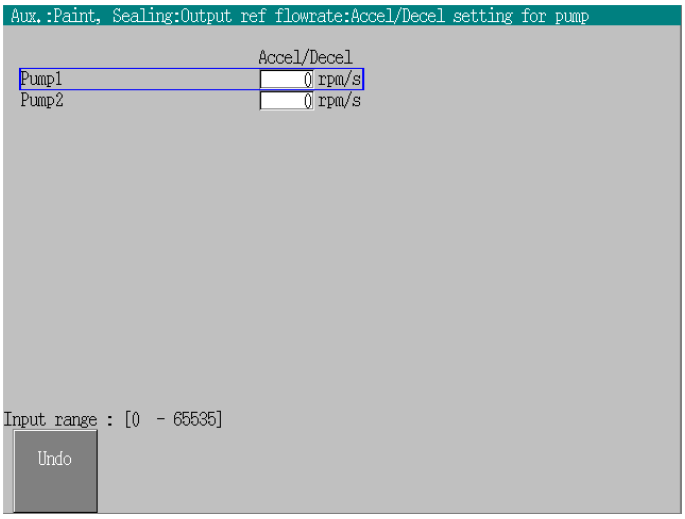
Select [15 Disconnect pump motor] from the menu screen for [Output ref. flowrate].



F1.3.13 ACCELERATION/ DECELERATION SETTING FOR PUMP

Sets the acceleration and deceleration setting for the pump axis.

Select [18 Acceleration/ Deceleration setting for pump] from the menu screen for [Output ref. flowrate].



F1.4 DEDICATED SIGNALS

The following 2 dedicated signals are provided in this servo dispenser control function.

[NOTE]

The following signals must be defined beforehand as dedicated signals.

1. EB-VCMD Effective Signal

   Selects whether voltage output from the robot controller to the servo dispenser is effective or not. Specify output signal number when defining as dedicated signal. ON signal will be output when controller power turns ON and software is loaded.

2. Under-Circulation Signal

   Selects whether under-circulation signal is effective or not for each pump. Specify output signal number for each pump when defining as dedicated signal. This signal turns ON during circulation mode, and OFF when circulation is complete.

   This signal is used as a control signal for switching valves in the circulation line.

F1.5 ERROR SPECIFIC TO THIS FUNCTION

Following error is an error specific to this function. For other errors, refer to the troubleshooting manual.

Error code: E6015
Error message: Signal is not dedicated.

Cause
MATCIRC instruction is entered when the “Under-circulation” is not dedicated.

Countermeasure
Dedicate the signal using the DEFSIG OUTPUT Command etc.

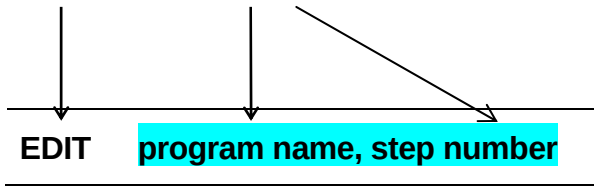
F1.6 AS LANGUAGE

Following commands and instructions are provided for servo dispenser control:

BEAD command/ instruction
QBEAD command/ instruction
PREPRES command/ instruction
MATCIRC command/ instruction
EBMATCIRC switch
EB2MATCIRC switch
MBREAK command

EXAMPLE

Keyword Parameter



Parameters marked with can be omitted.

Always enter a space between the keyword and the parameter.

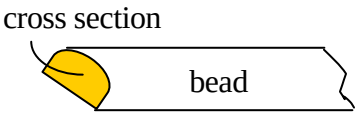
↵ represents the Enter key in the examples.

Monitor Command
Program Instruction

BEAD / P1 robot number: cross section
BEAD / P2 robot number: cross section
FN600 [pump number, cross section]

Function

Sets cross-sectional area of the bead.
Outputs the flow rate to acquire the specified cross-sectional area. The cross-sectional area is kept constant with changes in speed.



If parameters exceed acceptable range, error occurs when this command/ instruction is executed.

Parameter

1. P1 (P2), (pump number for FN instruction)
   Determines which pump is to be used. P1 is for pump1 and P2 for Pump2. Pump1 is automatically selected if neither is specified.

2. Robot number (Monitor command only)
   Sets which robot to use.

3. Cross section
   Sets the cross-sectional area of the bead. Acceptable range: 0 – 2000.

Explanation

Flow rate F can be calculated using the formula below, with A being a cross section:

$$F = A \times V \times C$$

V: moving speed of the TCP (gun tip)
C: conversion factor (BEADRATE) set in [Output ref. flowrate (R1204)] - [8. Environment Data Set].

This command/ instruction is effective until execution of the next BEAD command/ instruction.

Monitor Command
Program Instruction

QBEAD / P1 robot number: flow rate
QBEAD / P2 robot number: flow rate
FN601 [pump number, flow rate]

Function

Sets the material flow rate.

If parameters exceed acceptable range, error occurs when this command/ instruction is executed.

Parameter

1. P1/ P2, (pump number for FN instruction)
   Determines which pump to use. P1 is for Pump1 and P2 for Pump2. Pump1 is automatically selected if neither is specified.

2. Robot number (Monitor command only)
   Sets which robot to use.

3. Flow rate
   Sets the material flow rate. Acceptable range: 0 - 100000.
   Initial set value is 5000.

Monitor Command
Program Instruction

PREPRES / G1 robot number: pressure
PREPRES / G2 robot number: pressure
PREPRES / G3 robot number: pressure
PREPRES / G4 robot number: pressure
FN602 [gun number, pressure]

Function

Specifies the preparatory pressure in the secondary line for the specified gun. The pressure in the gun is kept at the specified value until the gun signal turns ON.
If parameters exceed acceptable range, error occurs when this command/ instruction is executed.

Parameter

1. G1/G2/G3/G4, (gun number for FN instruction)
   Specifies the gun for which preparatory pressure is set.
   G1: for Gun1, G2: for Gun2, G3: for Gun3, G4: for Gun4
   Gun 1 is automatically selected when no number is specified.

2. Robot number (Monitor command only)
   Sets which robot to use.

3. Pressure
   Sets the preparatory pressure in the secondary line. Acceptable range: 0-100000.
   Initial set value is 5.

This command/ instruction goes into effect after controller power is turned ON.

Monitor Command
Program Instruction

MATCIRC / P1 robot number: flow, time
MATCIRC / P2 robot number: flow, time

Function

Sets the flow rate and duration time for material circulation in Circulation Mode.
If parameters exceed acceptable range, error occurs when this command/ instruction is executed.
This can also be set via [Output ref. flowrate(R1204)] – [10 Set Material Circulation Data].

Parameter

1. P1 (P2)
   Sets the number of the pump to be used. P1 is for Pump1 and P2 for Pump2. Pump1 is automatically selected if neither is specified.

2. Robot number (Monitor command only)
   Sets which robot to use.

3. Flow
   Sets circulating flow rate. Acceptable range: 0-100000.

4. Time
   Sets circulating time. Acceptable range: 0-60 (Unit: minute)

Explanation

MATCIRC is effective when:
1. EBMATCIRC/EB2MATCIRC system switch is ON
2. The gun signal is OFF
3. MATCIRC is running.

Circulation is terminated when circulating flow rate is set at 0.

Circulation Mode is canceled when controller power is turned OFF. Circulation will not resume when the controller power is rebooted.

Under-Circulation signal is turned ON when the MATCIRC command/ instruction is executed (while circulation is taking place).

Circulation flow/time remain constant even if the SYSINIT command is used.

MATCIRC is suspended if the gun signal turns ON while MATCIRC is running. Turning OFF gun signal does not restart the execution of MATCIRC.

Example

```
MATCIRC/P2 1000, 10.5
```

This instruction circulates material in Pump2 at flow rate of 1000, and circulation time 10 min. 30 seconds.

System Switch

EBMATCIRC ON/OFF

Or

SWITCH EBMATCIRC=ON/OFF

Function

Toggles the status of the circulation circuit for Pump1. The ON instruction enables the circulation circuit, and OFF disables it.

MATCIRC is ineffective when this command is OFF.

Default setting is OFF.

System Switch

EB2MATCIRC ON/OFF

Or

SWITCH EB2MATCIRC=ON/OFF

Function

Toggles the status of the circulation circuit for Pump2. The ON instruction enables the circulation circuit, and OFF disables it.

MATCIRC is ineffective when this command is OFF.

Default setting is OFF.

Program Instruction

MBREAK

Function

Makes the robot wait until the current operation is finished before beginning the next operation.

Explanation

With rough accuracy setting, commands, such as SIGNAL, tends to be output before reaching the taught point. This instruction is used to make the robot wait the execution of the next instruction, so that the signals are output closer to the taught point.

Example

```
ACCURACY 1000 ALWAYS
LMOVE #A
LMOVE #B
LMOVE #C
MBREAK
SIGNAL 2
```

In this sample program, Signal 2 is output at the midpoint of the decelerating path between points #A and #B, and at the midpoint of the accelerating path between points #B and #C.

F2.0 COLLISION DETECTION

Collision detection is a function that detects collision or interference of the robot arm or tool with the workpiece or jig and decreases damages given to the robot's tool, workpiece, etc. The robot retracts and stops to avoid further damage. This function enables collision detection without the need of a shock sensor; the software detects the collision.

⚠ DANGER

This function cannot completely prevent damage given by collision. Also, the safety of persons around the robot is not guaranteed by this function. All safety procedures must be followed and your own safety and the safety of others in the immediate area should always be ensured.

F2.1 OVERVIEW

In the collision detection function, collisions are sensed by detecting the collision or shock given to the robot arm or tool. These functions are called collision detection and shock detection, respectively.

In collision detection, the current motor current is monitored, and when the peak current exceeds the set threshold, the robot considers it has collided.

In shock detection, changes in the motor current per unit time are monitored, and when the amount of change exceeds the set threshold, the robot considers it has collided. This function detects collision faster than the collision detection described above, and is efficient in lessening the damage given to the robot or tool.

The thresholds for collision detection and for shock detection are set prior to shipment from the factory. Thresholds are set for each joint, and separately for teach/check mode and for repeat mode. The thresholds can be used at the set values, but in cases such as when special care to avoid collision is necessary, change the thresholds to adjust the sensitivity.

The thresholds for repeat mode can be registered under threshold ID numbers from 1 to 9. The threshold ID numbers can be used within programs.

⚠ CAUTION

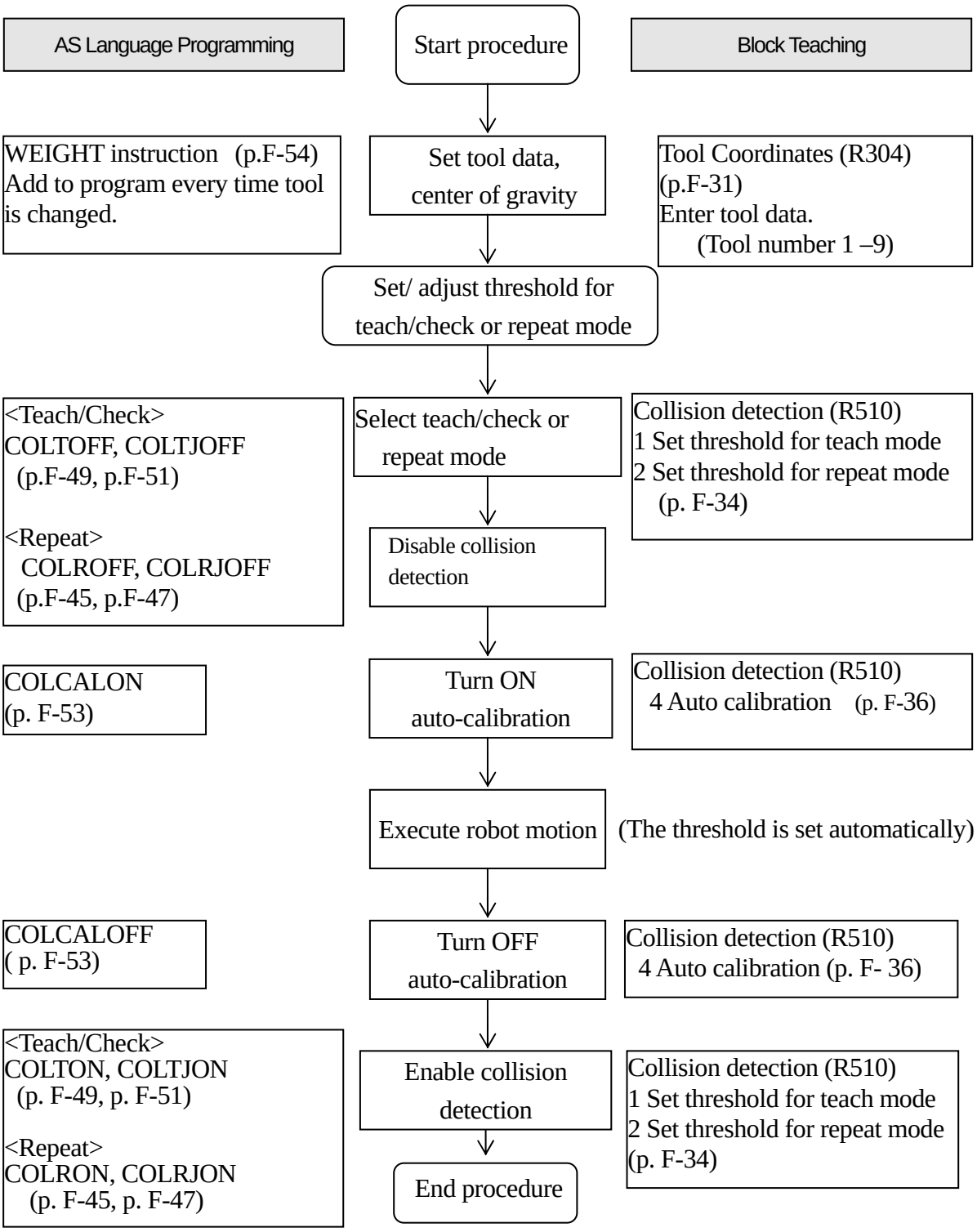
The thresholds for collision detection are set at the level where collision can be correctly detected when the robot moves at maximum speed with the rated load. Therefore, this function can be used as is without having to set the thresholds. In particular motions where damage is to be kept minimal, adjust the sensitivity of this function by changing the thresholds. Also, this function is automatically turned OFF when the moving tip of the weld gun comes in contact with the work piece in spot welding applications.

The threshold is set prior to shipment using the rated load, but by setting the tool data accurately, the sensitivity of the collision detection will be increased.

F2.2 PROCEDURES TO SET COLLISION DETECTION

The following flow charts explain the procedures to use this function in AS language programming and block teaching.

F2.2.1 BASIC PROCEDURE

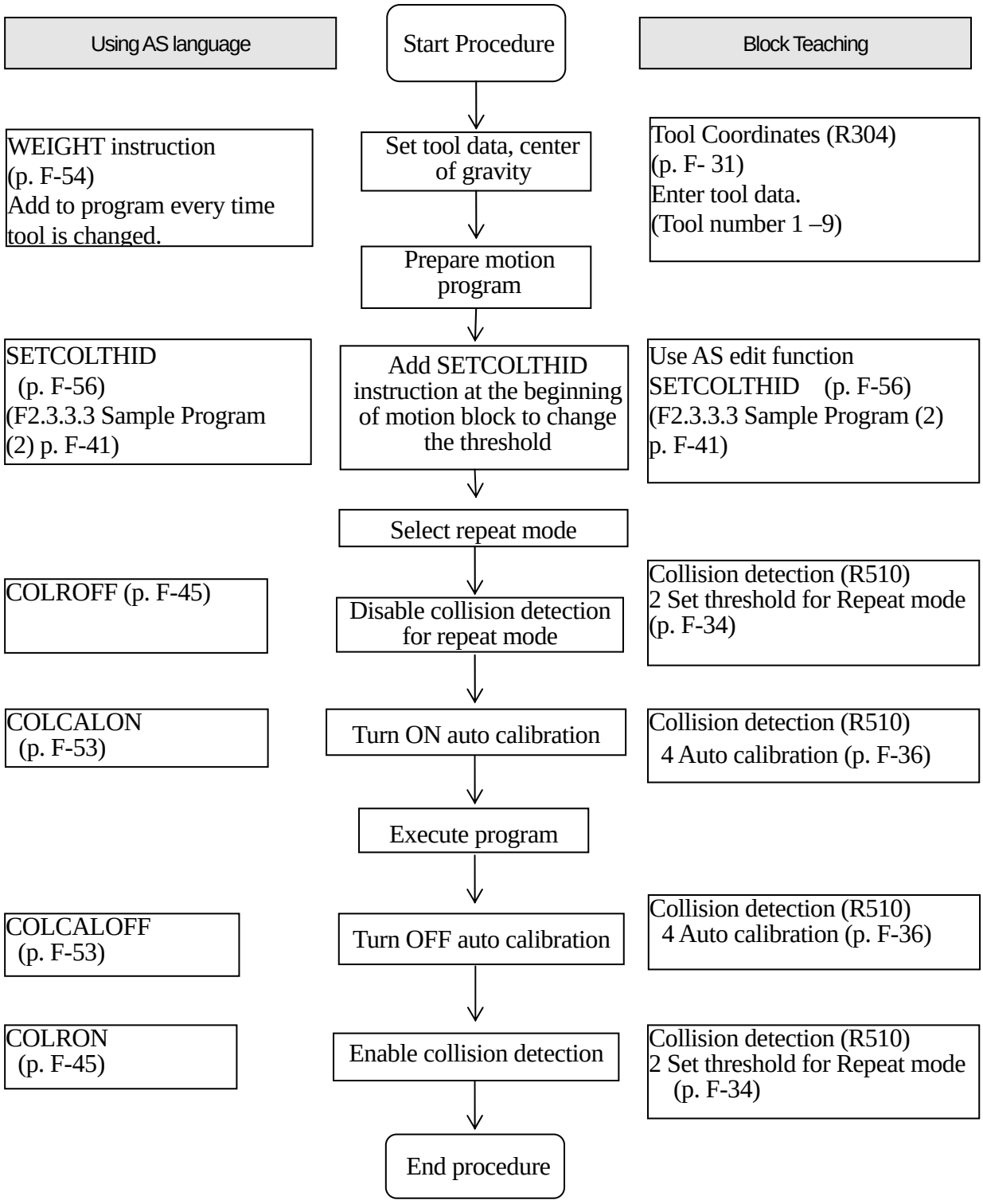


CAUTION

When setting the threshold by auto calibration, make sure the desired motion mode (Teach/ Check, Repeat) is correctly selected to avoid setting of the threshold of the undesired mode. The threshold of the motion mode selected when auto-calibration is executed will be set.

F2.2.2 APPLICATIONS (USING SETCOLTHID INSTRUCTION)

The chart below shows the procedures for auto calibration of thresholds using SETCOLTHID instruction.



F2.2.3 RESTORATION PROCEDURE

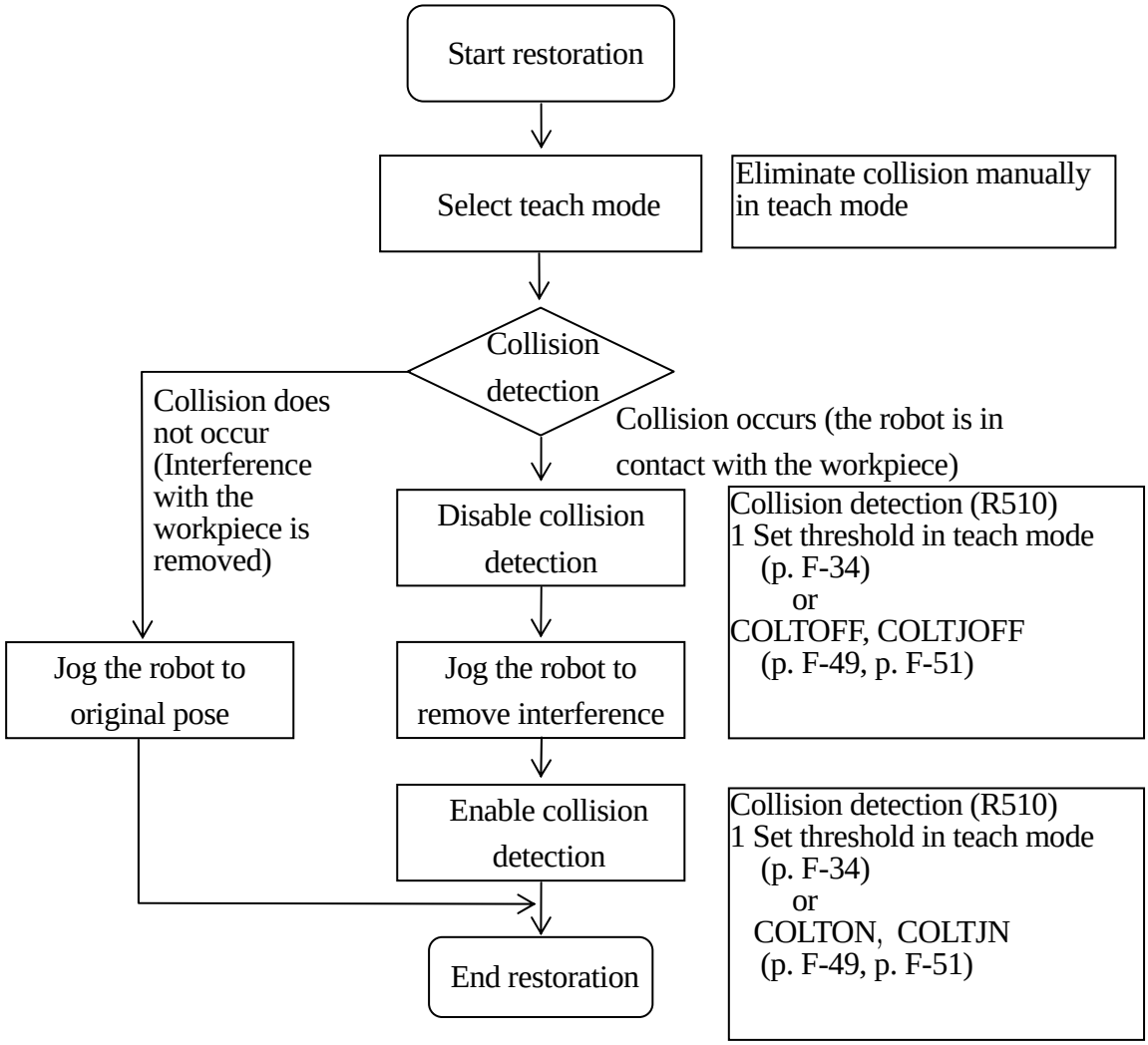
Movement of robot after collision
- When in teach mode: stops immediately
- When in repeat mode: retracts then stops.

(Only when retraction is ON (COLMVON, p. F-52))

When the robot stays in contact with the obstacle after the collision, depending on the residual stress, the collision detection error status may continue.

⇩

To proceed with the restoration procedure,
temporarily disable the collision detection function.



F2.3 SETTING AND USING COLLISION DETECTION

F2.3.1 SETTING TOOL DATA

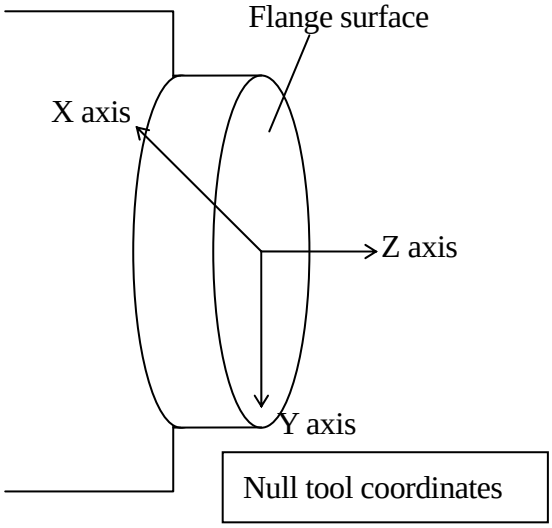
To use the collision detection function, the tool data has to be set accurately to simulate the robot motion.

The tool data can be set using the AS language command (WEIGHT command/ instruction) or by using the Auxiliary Function screen on the teach pendant.

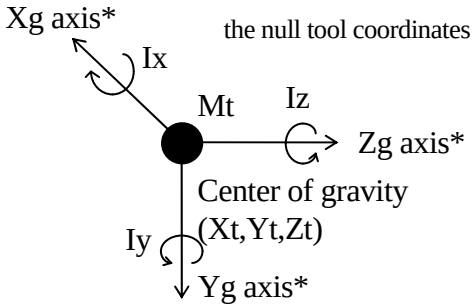
In block teaching, the load data can be set by directly entering the necessary data in Tool Coordinate (R304) or by automatically calculating the tool load (Automatic Load Measurement). In the following example, the tool data is set by directly entering the tool load data via Tool Coordinate (R304). For information on Automatic Load Measurement, refer to the Operation Manual. WEIGHT command/ instruction will be explained in F2.4 AS Language.

Data set in Tool Coordinate (R304) are: dimensions to the tool coordinate origin in the directions of X, Y, and Z measured from the origin of the wrist flange, rotation angle of the tool coordinates, mass and center of gravity of tool, and inertia moment. Data for 9 tools can be registered.

Acceptable range for each data is:
Load mass: 0 to maximum load
Center of gravity: -9999.9 - 10000.0
Inertia moment: 0 - 999.99

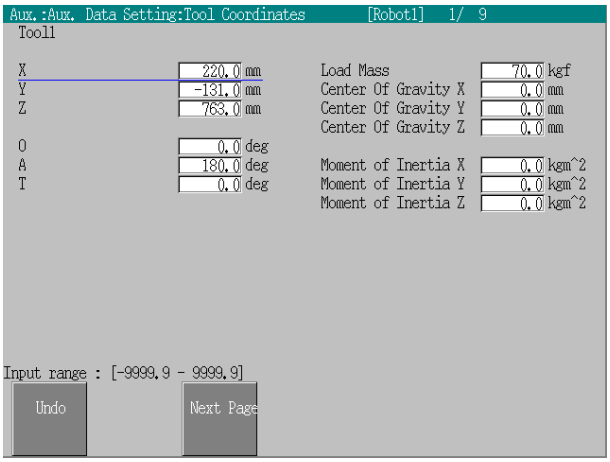


NOTE* Xg, Yg, Zg axes pass through the center of gravity and are parallel to the X, Y, Z axes of the null tool coordinates



Mt: Mass of tool
Xt: Center of gravity X
Yt: Center of gravity Y } Center of gravity of tool
Zt: Center of gravity Z
Ix: Inertia moment around tool Xg axis
Iy: Inertia moment around tool Yg axis
Iz: Inertia moment around tool Zg axis

In the teach pendant screen, press <STATUS>. From the pull-down menu that appears select [FUNCTION]. Next, select [3. Aux. Data Setting] from the menu that appears, and than select [4. Tool coordinates].



Move cursor to each item and input required data by NUMBER (0-9). When using several tools, press <Next Page> to move to the next page and input the tool data. Press ↵ when all data are input. If there is no error, “Setting complete.” is displayed, and the tool setting is completed.

CAUTION

When the input value is out of acceptable range, the message, “Value is out of range” will appear followed by a prompt for entering new values.

CAUTION

This function uses the tool load data to simulate the robot motion by the dynamics model for monitoring collisions and external shock disturbances. Therefore, if this tool data is not set accurately, it may result in false detection or the setting of high detection sensitivity may become impossible. To use this function efficiently, ensure accurate tool load data.

F2.3.2 SETTING THRESHOLDS

F2.3.2.1 RANGE OF THRESHOLD

To utilize the collision detection function in teach/ check or repeat modes, two types of thresholds, for collision detection and shock detection, are set for each joint.

When the thresholds are to be changed within a program or when the threshold is to be used with a particular tool, register the thresholds (for collision detection and shock detection) to the threshold ID numbers 1 to 9.

The thresholds are expressed in percentage with the rated current as 100%. The acceptable range for thresholds for collision detection is 0 to 500, and for shock detection, 0 to 200. They are expressed in integers only.

Set or check the thresholds using the teach pendant or PC. The next section explains how to set the thresholds using the auxiliary functions using the teach pendant. (See F2.4 AS Language Reference for setting thresholds via PC using AS language.)

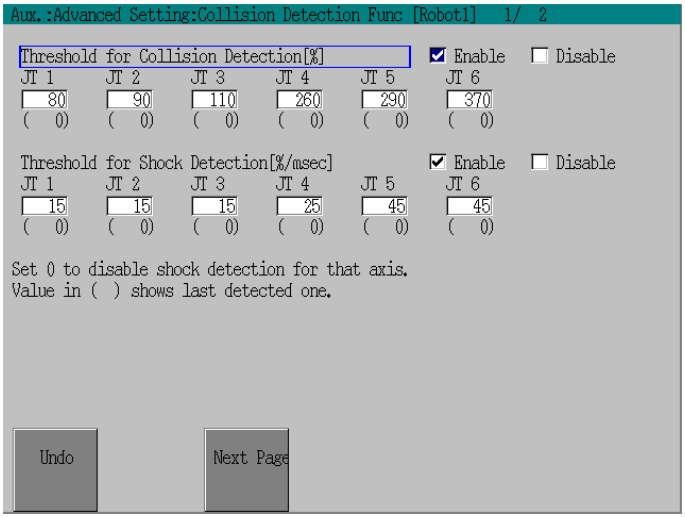
	Collision Detection (R510) settings	AS monitor command/program instruction	Acceptable Range
Teach/ check mode	Threshold for collision detection	COLT	0 - 500
	Collision detection ON/OFF	COLTON/COLTOFF	ON/OFF
	Threshold for shock detection	COLTJ	0 - 200
	Shock detection ON/OFF	COLTJON/COLTJOFF	ON/OFF
Repeat mode	Threshold for collision detection	COLR	0 - 500
	Collision detection ON/OFF	COLRON/COLROFF	ON/OFF
	Threshold for shock detection	COLRJ	0 - 200
	Shock detection ON/OFF	COLRJON/COLRJOFF	ON/OFF
	Threshold ID	SETCOLTHID	1 - 9
	Auto calibration of threshold	COLCALON/COLCALOFF	ON/OFF
	Property for Collision detection (Setting threshold ID for tools)		

F2.3.2.2 SETTING THRESHOLD BY AUXILIARY FUNCTION

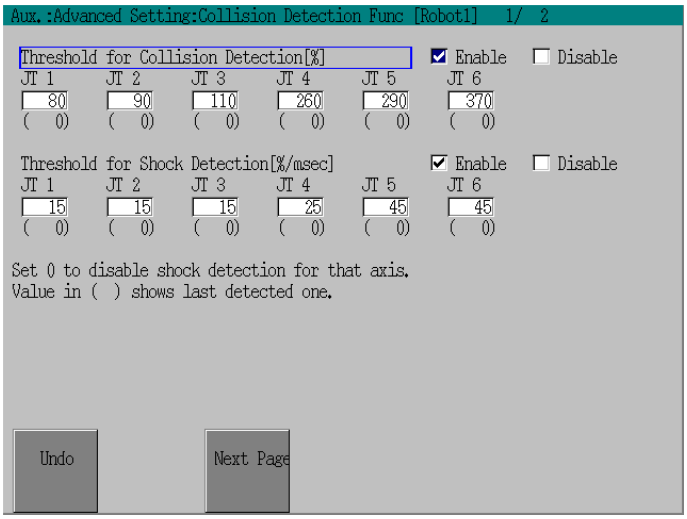
In the teach pendant screen, press <STATUS>. From the pull-down menu that appears, select [FUNCTION]. Next, select [5. Advanced Setting] from the menu hat appears, and than select [10. Collision Detection Function].

[1 Set the threshold for Teach Mode], [2 Set the threshold for Repeat Mode]
Select the mode, and then enter the threshold for each joint. Set the desired functions ON (enable) or OFF (disable) for each mode.

[1 Set the threshold for Teach Mode]



[2. Set the threshold for Repeat Mode]



Move the cursor to the desired field. Enter the thresholds using the NUMBER. The acceptable range for collision detection is 0 to 500 (for shock detection, 0 to 200). Enter 0 for joints where

collision is not to be detected. Select [Enable] to enable the threshold for the desired detection. The values in parentheses are values at which collision occurred the last time. When all data are input, press ↵. If there is no error, "Setting complete" is displayed.

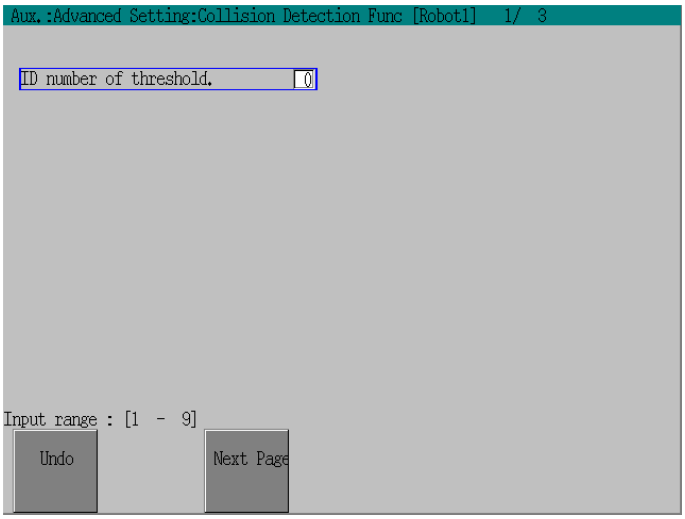
⚠ CAUTION

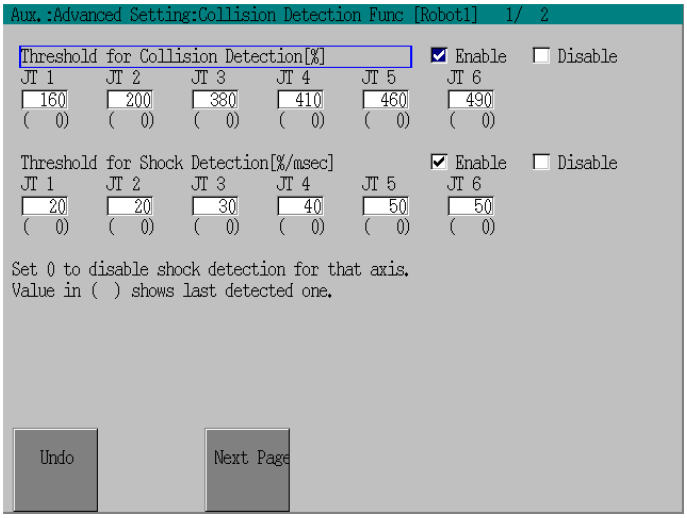
The acceptable range of threshold for collision detection is 0 to 500 for both teach mode and repeat mode. For shock detection, it is 0 to 200. When a value that is out of rage is entered and ↵ is pressed, the message "Value is out of range" will be displayed followed by a prompt for modification.

The setting must be done in Teach mode. If not, the message "Change to Teach mode" will appear followed by a prompt for re-entering.

[3 Setting threshold ID]

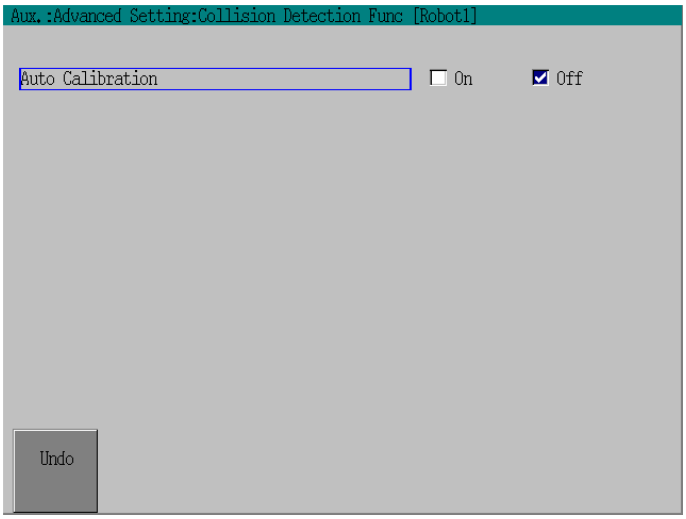
Thresholds for collision and shock detection in repeat mode can be registered under threshold ID numbers 1-9.





[4 Auto calibration]

Select [On] or [Off] and press ↵. When starting calibration, the message "Are you sure?" will appear. Enter 1 to continue or 0 to cancel. When 1 is selected, auto calibration will start and the thresholds will keep on updating until it is turned off or the motion mode is changed. The threshold set here will be valid from the motion immediately following the auto calibration. The thresholds for shock detection will be changed together with the thresholds for collision detection.

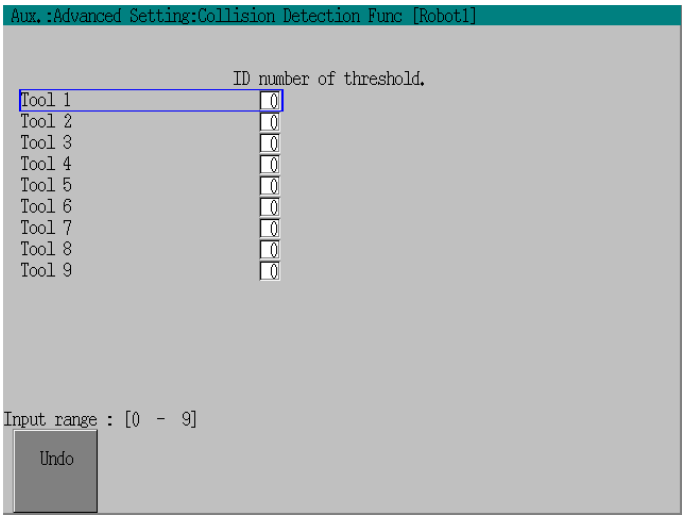


CAUTION

Change to the motion mode in which you want to set the thresholds before starting auto calibration. To set the thresholds for repeat mode, start auto calibration in repeat mode (AUTO/MAN.). To set threshold in teach mode, change to teach mode before starting auto calibration.

[5 Property]

When certain thresholds are to be used with certain tools, you can register the Threshold ID to tool numbers.



1. Enter the threshold ID under the tool number. Enter a threshold ID for every tool number.

2. When 0 is entered, the message “Threshold ID for every tool will be set 0. Are you sure?” will appear. When you want to reset all threshold ID, select 1:YES.

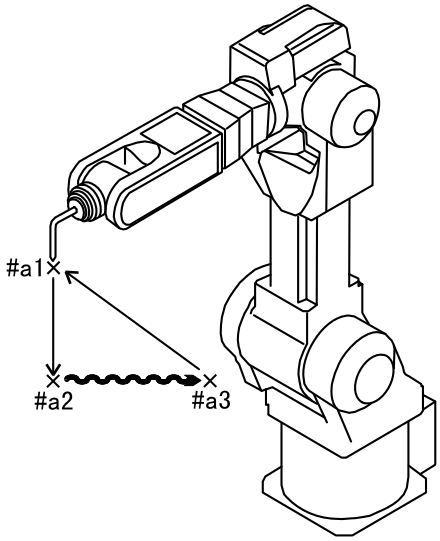
CAUTION

Set a threshold ID for every tool number. Do not leave any tool number with threshold ID 0. If there is even one 0, all the tools will be set to 0.

F2.3.3 SAMPLE PROGRAMS

In this section, programs using the collision detection function are explained.

F2.3.3.1 SAMPLE PROGRAM (1)

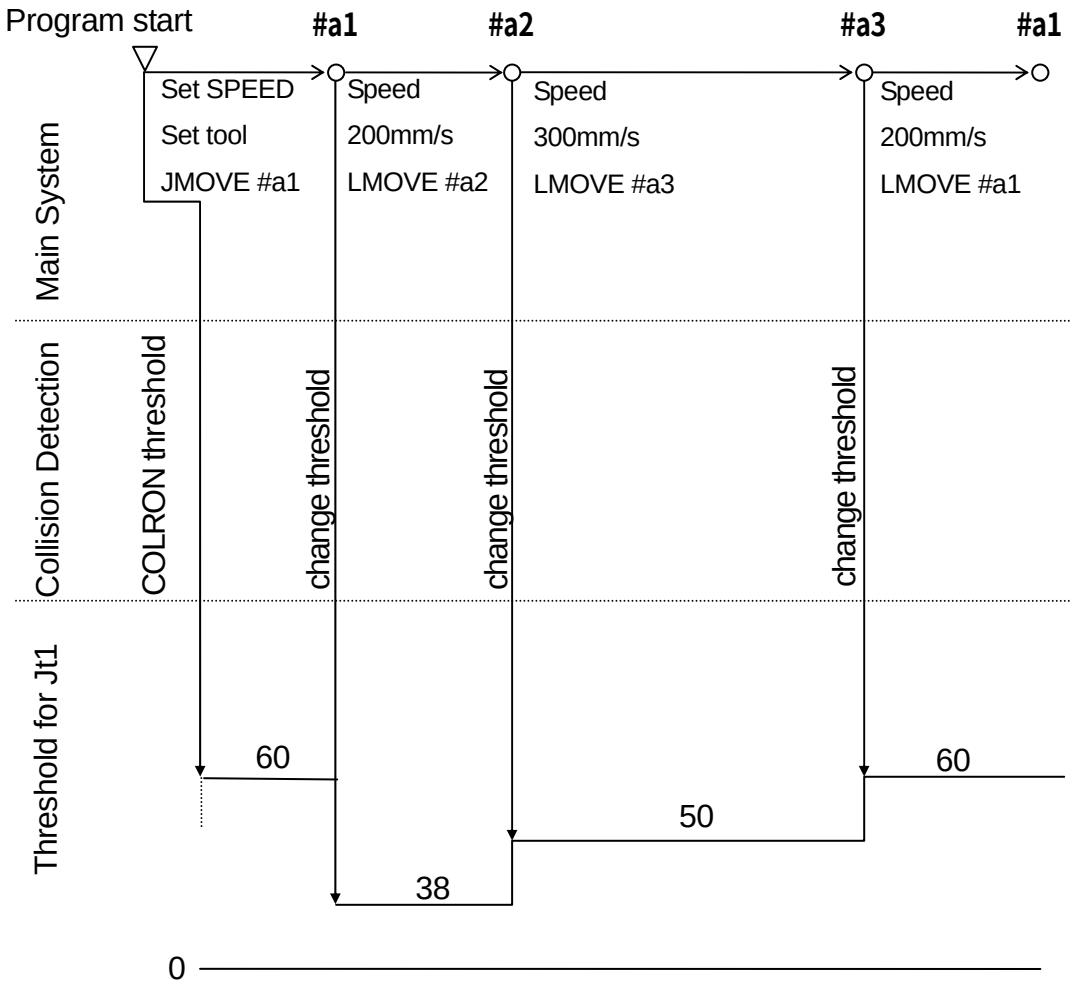


In this example, the robot moves the gun to the start point of the sealing operation by moving from #a1 to #a2 and outputs material (sealant, etc.) while moving from #a2 to #a3. Then, it moves back to #a1 from #a3. The sensitivity of collision detection should be increased when approaching the workpiece (#a1 → #a2). Also, collision may occur when welding between #a2 and #a3, or when moving between #a3 and #a1, so collision detection function is enabled during the whole operation. The program below shows how to detect collisions in all the motions. The steps instructing the actual sealing operation are omitted here.

```
PROGRAM COLLISION_DETECT
  1     COLRON                      Enables collision detection in repeat mode.
  2     SPEED 1400 MM/S ALWAYS
  3     WEIGHT 10, 100, 40, 40      Sets tool load data.
  4     COLR 60, 35, 60, 120, 140, 110   Sets repeat motion thresholds (threshold A).
  5     JMOVE #a1                   Moves to #a1.
  6     COLR 38, 30, 58, 60, 80, 90 Sets thresholds for the approaching motion
                                    (threshold B)
  7     SPEED 200 MM/S
  8     LMOVE #a2                   Approaches the workpiece (#a2).
  9     DELAY 1
  10    SPEED 300 MM/S
  11    COLR 50, 48, 62, 82, 91, 98 Sets threshold for the sealing motion
                                    (threshold C)
```

```
12      LMOVE #a3
13      COLR 60, 35, 60, 120, 140, 110      Sets thresholds for motion from #a3 to #a1
                                            (threshold A)
14      LMOVE #a1
```

The figure below describes the motion throughout the program.



F2.3.3.2 SETTING THRESHOLDS FOR SAMPLE PROGRAM (1)

Thresholds can be obtained easily by auto calibration using a motion program.

This section explains the procedures to obtain the three thresholds used in the sample program COLLISION_DETECT. Set the robot motion and tool data to emulate the actual operation conditions as closely as possible.

Threshold A
Threshold A is effective throughout the program. Therefore, use program COLLISION_DETECT to set this threshold automatically. First, delete or comment out the threshold data in line 4. Then, set up the actual operation conditions (set workpiece in place, etc). Set the tool data accurately in the program (WEIGHT instruction).

Now, start auto calibration using COLCALON command or [Collision Detection Function (R510)] and execute the program.

After executing the program several times, terminate auto calibration using COLCALOFF command or [Collision Detection Function (R510)]. Check the threshold values for repeat mode using COLR command or [Collision Detection Function (R510)]. Program the obtained values in line 4 of COLLISION_DETECT.

Threshold B
Threshold B is only valid during motion from #a1 to #a2. Create a separate program for motion #a1 to #a2 and #a2 to #a1, and use that program to obtain the threshold.

```
.PROGRAM CALIB1 ( )
        WEIGHT 10, 100, 40, 40
        SPEED 200 MM/S ALWAYS
        JMOVE #a1
10
        LMOVE #a2
        DELAY 1
        LMOVE #a1
        GOTO 10
.END
```

Threshold C

ThresholdC is valid during motion #a2 to #a3. In the same manner as threshold B, create a program that moves the robot from #a2 to #a3 and use that program to obtain threshold C.

```
.PROGRAM CALIB2( )
        WEIGHT 10, 100, 40, 40
        SPEED 200 MM/S ALWAYS
        JMOVE #a2
10
        LMOVE #a2
        DELAY 1
        LMOVE #a3
        DELAY 1
        GOTO 10
.END
```

CAUTION

Collision detection is in effect even while auto calibration is running. Therefore, false detection may occur if the current threshold values are too small. Reset the threshold to the values set at factory shipment. If false detection still occurs, set a greater threshold.

F2.3.3.3 SAMPLE PROGRAM (2) (USING SETCOLTHID INSTRUCTION AND THRESHOLD ID)

Thresholds can be changed within a program using the SETCOLTHID instruction and the thresholds registered under threshold IDs 1 to 9. The following sample program changes the threshold according to the motion.

In this program, there are three motion blocks: A, B, C. Different thresholds are set for each motion block. Write the SETCOLTHID instruction at the beginning of each motion block to specify the ID number of the threshold to be used in that motion. Register the thresholds using the auxiliary functions or SETCOLTHID command.

When auto calibration is done using this program, the values for all threshold IDs used in the program are set automatically. If necessary, reset the values of the threshold IDs to 0 before starting auto calibration. (See COLINIT command.)

Motion block A is monitored by thresholds registered in threshold ID number 1.
Motion block B is monitored by thresholds registered in threshold ID number 2.
Motion block C is monitored by threshold values specified in the program.

```
PROGRAM     CHG_TH
1       SETCOLTHID   1
2       CALL COLLISION_DETECT.....Motion Block A
3       SETCOLTHID   2
4       WEIGHT     8, 10, 0, 25
5       C1MOVE          #C1
6       C1MOVE          #C2      .....Motion Block B
7       C1MOVE          #C3
8       C1MOVE          #a1
9       COLR     30, 20, 40, 30, 30, 30
10      JMOVE           #home .....Motion Block C
```

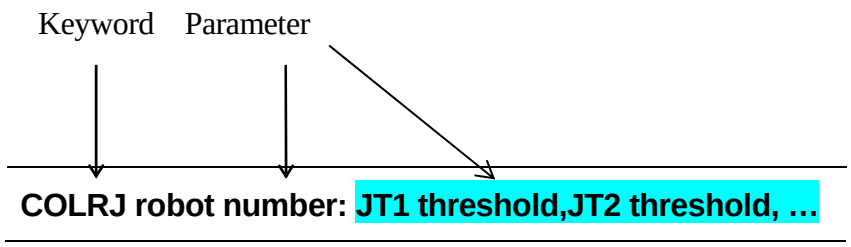
```
PROGRAM   COLLISION_DETECT
1       WEIGHT     10, 100, 40,40
2       JMOVE           #a1
3       LMOVE           #a2
4       LMOVE           #a3
5       LMOVE           #a1
```

F2.4 AS LANGUAGE

The following AS language commands and instructions are used with the collision detection function.

COLR command/instruction
COLRON/OFF command/instruction
COLRJ command/instruction
COLRJON/OFF command/instruction
COLT command
COLTON/OFF command
COLTJ command
COLTJON/OFF command
COLMVON/OFF command/instruction
COLCALON/OFF command
WEIGHT command/instruction
SETCOLTHID command/instruction
COLINIT command
COLSTATE command

Example



Parameters marked with can be omitted.

Always enter a space between the keyword and the parameter.

↵ represents the Enter key in the examples.

Monitor command
Program instruction

COLR robot number: Jt1 threshold, Jt 2 threshold,…, Jt6 threshold(,…Jtn threshold)

Function

Sets the threshold for collision detection in repeat mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Jt1 threshold, …, Jtn threshold
   Sets the threshold for each joint in integers. Acceptable range is 0 – 500. Setting 0 disables collision detection for that joint. Unit is percentage (%). (The rated current is 100%)

   When used as a monitor command and no parameters are specified, the current values are displayed for modification.

Explanation

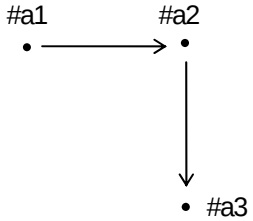
In collision detection, the robot determines that a collision has occurred when the force applied to the joint exceeds the set threshold. Therefore, the smaller the threshold, the more sensitive the detection will be. However, if the threshold is set too small, the robot may mistake the torque load caused by its own motion as collision. Preferably use the threshold obtained from the auto calibration using COLCAL command. If false detection occurs repeatedly, set the threshold greater, e.g. multiply current value by 1.2. (See also COLRJ.)

This command/instruction is only effective in repeat mode.

Example (When UX120 is used)

The robot moves from #A1 to #A2, #A2 to #A3, and the threshold is changed for each motion block.

```
1  COLR      0, 40, 52, 81, 72, 68
2  JMOVE #a1
3  JMOVE #a2
4  COLR      40, 0, 56, 90, 83, 75
5  JMOVE #a3
```



In this example, collision is not detected in joint 1 when moving from #A1 to #A2, and in joint2 when moving from #A2 to #A3.

Monitor command
Program instruction

COLRON robot number:
COLROFF robot number:

Function

Enables/disables collision detection in repeat mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

Explanation

COLRON starts monitoring for any irregular load that may occur during repeat mode.
COLROFF stops monitoring.

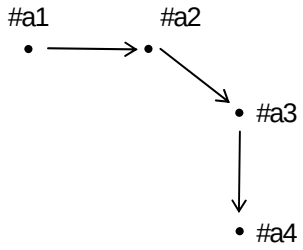
When these commands/instructions are used, the setting remains in effect until reset. The default setting is ON.

Use COLSTATE command to check the current ON/OFF status.

Example

Collision is only detected during motion #a2 to #a3, in a program that moves the robot from #a1 to #a2 to #a3 to #a4.

```
1  COLR        38, 40, 52, 81, 72, 68
2  COLROFF
3  JMOVE #a1
4  JMOVE #a2
5  COLRON
6  JMOVE #a3
7  COLOROFF
8  JMOVE #a4
```



When spot welding, collision detection is not effective while the weld gun is operating.

CAUTION

Do not put a space in between COLR and ON/OFF in COLRON and COLROFF commands/ instructions.

Program instruction

COLRJ robot number: Jt1 threshold, Jt2 threshold, ･･･Jtn threshold

Function

Sets the thresholds for shock detection in repeat mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Jt1 threshold, ･･･, Jtn threshold
   Sets the thresholds for each joint in integers. Acceptable range is 0 to 200. Setting 0 disables shock detection for that joint. Unit is %/ msec.

When used as a monitor command and no parameters are specified, the current values are displayed for modification.

Explanation

In shock detection, the robot monitors the changes in force put to the joint per unit time and detects shock/ collision when the amount of change exceeds the threshold set here. This function is effective in reducing damage to the robot or tool by detecting collision as soon as possible. (See also COLR.)

This function is sensitive to even small changes of the robot motion. Use this function when collision has to be detected sensitively, e.g. when the tool approaches the workpiece.

Use the threshold values obtained by COLCALON / COLCALOFF.

This command/instruction is effective only in repeat mode. Use in the same manner as COLR command/instruction.

Monitor command
Program instruction

COLRJON robot number:
COLRJOFF robot number:

Function

Enables/ disables shock detection in repeat mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

Explanation

This command/ instruction is valid only in repeat mode.

It is not recommended that COLRJON should not be applied to operations with extreme motion. The robot may detect its own motion as collision.

Use these commands/ instructions in the same way as COLRON/OFF commands/ instructions.

Use COLSTATE command to check the current ON/OFF status.

⚠ CAUTION

Do not put a space in between COLRJ and ON/OFF when writing COLRJON and COLRJOFF commands/instructions.

Monitor command

COLT robot number: Jt1 threshold, Jt2 threshold, … Jt6 threshold(, …Jtn threshold)

Function

Sets the thresholds for collision detection in teach/ check mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Jt1 threshold, …, Jtn threshold
   Sets the threshold for each joint in integers. Acceptable range is 0 to 500. Setting 0 disables collision detection for that joint. Unit is %. (The rated current is 100%).

When used as a monitor command and no parameters are specified, the current values are displayed for modification.

Explanation

This command/ instruction is valid only in teach/ check mode.

Use this command/ instruction in the same way as COLR command/ instruction.

Monitor command

COLTON robot number:
COLTOFF robot number:

Function

Enables/ disables collision detection in teach/ check mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

Explanation

COLTON starts monitoring for any irregular load that may occur during teach/ check mode.
COLTOFF stops monitoring.

When these command/instruction are used, the setting remains in effect until reset. The default setting is ON.

Use COLSTATE command to check the current ON/OFF status.

⚠ CAUTION

Do not put a space in between COLT and ON/OFF when writing COLTON or COLTOFF commands/instructions.

Monitor command

COLTJ robot number: Jt1 threshold, Jt2 threshold, (…, Jtn threshold)

Function

Sets threshold for shock detection in teach/ check mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Jt1 threshold, …, Jtn threshold
   Sets the threshold for each joint in integers. Acceptable range is 0 to 200. Setting 0 disables shock detection for that joint. Unit is %/msec.

   If the parameters are not specified when used as a monitor command, the current values are displayed for modification.

Explanation

This command/instruction is effective only in teach/ check mode. Use this command/instruction in the same way as COLR command/ instruction.

Use the threshold values obtained by COLCALON / COLCALOFF commands.

This function is sensitive to even small changes in robot motion. Use this function when collision has to be detected sensitively, e.g. when the tool approaches the workpiece.

Monitor command

COLTJON robot number:
COLTJOFF robot number:

Function

Enables/ disables shock detection in teach/ check mode.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

Explanation

This command is effective only in teach/ check mode.

When shock detection is enabled in teach mode, the robot motion itself is may easily be mis-detected as collision. If false detection occurs repeatedly, set the threshold again by using COLCALON/ COLCALOFF or turn OFF this function.

CAUTION

Do not put a space in between COLTJ and ON/OFF when writing COLTJON or COLTJOFF commands/instructions.

Monitor command

COLMVON robot number:
COLMVOFF robot number:

Function

Sets whether or not retraction is performed after collision is detected. COLMVON enables retraction, and COLMVOFF disables it.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

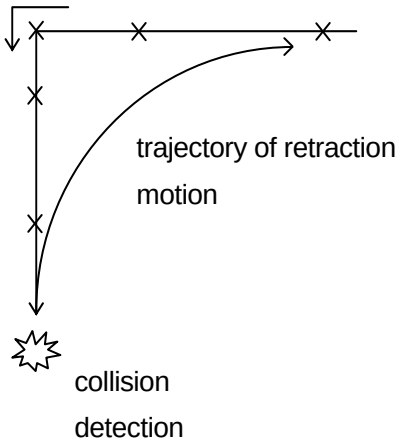
Explanation

When COLMVON is entered (retraction enabled), the robot will relieve the stress caused by the collision by retracing backwards the trajectory the robot has drawn before the collision. The amount of retraction depends on the speed of the TCP before the collision. The faster the speed, the more the tool retracts.

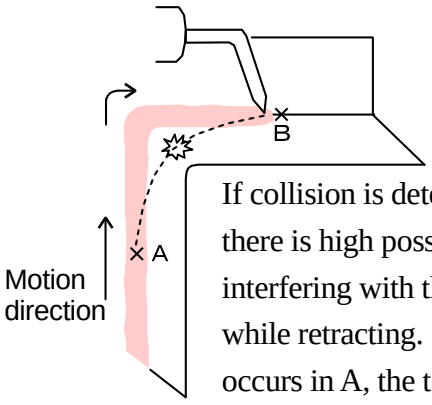
When retracting, the robot takes a shortcut passing inside the path of the trajectory it has drawn up to the collision. Therefore, when operating the robot in a crowded environment, it might be better to cancel retraction to avoid unnecessary interferences.

When these command/instruction are used, the setting remains in effect until reset. The default setting is ON.

Check the current setting using COLSTATE command.



Example of case in which retraction should be canceled:



If collision is detected in point B, there is high possibility of the tool interfering with the workpiece while retracting. (If collision occurs in A, the tool will retract without interfering with the workpiece.)

Monitor command

COLCALON
COLCALOFF

Function

Automatically calibrates the most appropriate threshold in a motion.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

Explanation

Calculates the optimal threshold for a motion by measuring the greatest external force given to the joints during the motion executed between COLCALON and COLCALOFF commands.

To obtain the thresholds effective for the whole motion in program a( ), execute that program after entering COLCALON ↵. When the program has finished executing, enter COLCALOFF ↵. The threshold that best suits the motion is automatically calculated. Execute COLSTATE command to check the thresholds. Include these thresholds in the beginning of the program to run the program using them.

To find out the threshold used in a certain motion in a program, create a program that repeats only that motion, and execute COLCALON/COLCALOFF commands using the program. Include the threshold before that motion so that the motion block is monitored using that threshold. When specifying the threshold for a certain motion block, make sure to reset the threshold at the end of that motion block.

When SETCOTHID instruction is used in a program and the thresholds are specified by threshold ID, COLCALON/COLCALOFF calibrates all the thresholds registered under the ID used in the program. Enter COLCALON ↵ and execute the program. When the execution is completed, enter COLCALOFF ↵. To check the thresholds set to a particular ID, execute COLSTATE command specifying the desired threshold ID.

⚠ CAUTION

Do not put a space between COLCAL and ON/OFF when writing COLCALON and COLCALOFF commands.

Monitor command
Program instruction

WEIGHT robot number: tool mass, center of gravity X, center of gravity Y, center of gravity Z, inertia moment ab. Xg axis, inertia moment ab. Yg axis, inertia moment ab. Zg axis

Function

Sets tool mass, center of gravity, and inertia moment around the tool axis.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Tool mass
   Sets tool mass data. The unit is kilograms (kg). Acceptable range: 0 kg to maximum load

3. Center of gravity X, center of gravity Y, center of gravity Z
   Sets the center of gravity X, Y, Z as seen from the null tool coordinates. The unit is millimeters (mm).

4. Inertia moment about Xg axis, inertia moment about Yg axis, inertia moment about Zg axis
   Sets the inertia moment around Xg, Yg, Zg axes. Unit is $kg \cdot m^2$.

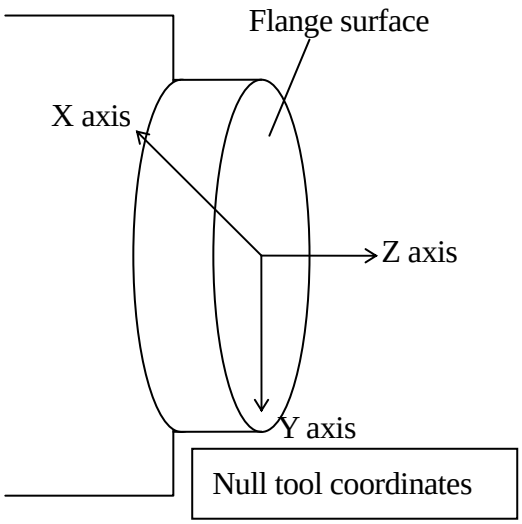
Explanation

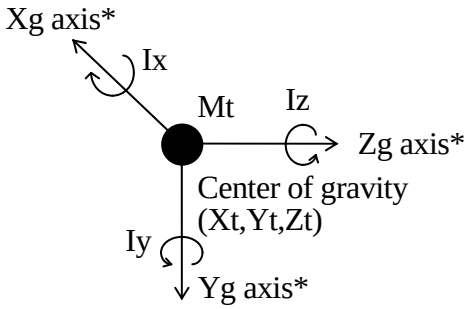
The robot moves based on the values set by this command/ instruction. Ensure accurate data. The center of gravity Xt, Yt, Zt is defined relative to the null tool coordinates.

The inertia moment about each axis is defined as the moment around the coordinates axes parallel to the null tool coordinates with the center of rotation at the tool's center of gravity.

When the parameters are omitted in monitor command, the current setting will be displayed for modification.

When the parameters are omitted in program instruction, the maximum load will be set.





NOTE* Xg, Yg, Zg axes pass through the center of gravity and are parallel to the X, Y, Z axis of the null tool coordinates

Mt: Mass of tool
Xt: Center of gravity X
Yt: Center of gravity Y
Zt: Center of gravity Z
} Center of gravity of tool
Ix: Inertia moment around tool Xg axis
Iy: Inertia moment around tool Yg axis
Iz: Inertia moment around tool Zg axis

Monitor command
Program instruction

SETCOLTHID robot number: threshold ID

Function

When used as a monitor command, this command displays and allows modification of the threshold values registered under the specified threshold ID.

When used as program instruction, this instruction applies the threshold values registered under the specified threshold ID to the robot motion.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Threshold ID
   Specifies the threshold ID in integer from 1 to 9. Cannot be omitted.

Explanation

When used as a monitor command, the current values of the threshold for collision detection in repeat mode are displayed followed by a message “Change?”. To change the registered values, enter the values separating each with comma and press ↵. To exit without making any changes, press only ↵. Next, the threshold for shock detection in repeat mode is displayed. Change the values in the same way as above.

When used in a program, the threshold values specified in this instruction will be used to monitor all motions thereafter and until the values are changed.

When auto calibration is run for a program that includes SETCOLTHID instruction, the threshold values registered under the threshold ID used in the program are calibrated.

To check the threshold values registered under each threshold ID, execute COLSTATE command specifying the desired ID number.

To reset the threshold values registered under each ID number to zero, execute COLINIT command specifying the desired threshold ID.

Monitor command

COLINIT robot number: threshold ID

Function

Initializes the threshold.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Threshold ID
   Specifies the threshold ID in integers between 1 and 9. When not specified, the threshold currently effective is reset to the values set at factory shipment.

Explanation

When this command is used without the threshold ID, the threshold currently effective is reset to the values set at factory shipment.

When this command specifies a threshold ID, the threshold values for both collision detection and shock detection registered under the specified ID are reset to 0.

⚠ CAUTION

The thresholds for collision detection are set at the level where collision can be correctly detected when the robot moves at maximum speed with the rated load. Therefore, this function can be used as is without having to set the thresholds. In particular motions where damage is to be kept minimal, adjust the sensitivity of this function by changing the thresholds. Also, this function is automatically turned OFF when the moving tip of the weld gun comes in contact with the workpiece in spot welding applications.

The threshold is set prior to shipment using the rated load, but by setting the tool data accurately, the sensitivity of the collision detection will be increased.

The currently effective threshold is displayed with COLSTATE command (without parameter). To display the values registered under each threshold ID, execute COLSTATE specifying the desired ID number.

To change the values registered under each threshold ID, execute SETCOLTHID command.

Monitor command

COLSTATE robot number: threshold ID

Function

Displays the current settings and thresholds for the collision detection function.

Parameter

1. Robot number (Monitor command only)
   Sets which robot to use.

2. Threshold ID
   Specifies the threshold ID in integers from 1 to 9. When omitted, the values for the currently effective threshold are displayed.

Explanation

This command functions differently when and when not specifying the parameter.

When the ID number is not specified, the current values for each of the motion modes are displayed. In other words, latest set of values from either 1 or 2 below are displayed:
1. the thresholds set using the COLR or COLT command/ instruction
2. the last thresholds used in a program.
The ON/OFF status of the thresholds in each motion mode is also displayed.

When the threshold ID is specified as the parameter, the thresholds currently registered under that ID number are displayed.

COLR collision detection in repeat mode
COLRJ shock detection in repeat mode
COLT collision detection in teach/check mode
COLTJ shock detection in teach/check mode
COLMV retraction
COLCAL auto calibration of thresholds

Example

```
>colstate 1:
Thresholds for collision detection in teach mode
        JT1/JT8  JT2/JT9  JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        15       35       42       120     110      160
```

```
Thresholds for shock detection in teach mode
        JT1/JT8 JT2/JT9 JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        5       6       4       15      44      23

Threshold for collision detection in repeat mode
        JT1/JT8 JT2/JT9 JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        45      60      75      235     305     225

Threshold for shock detection in repeat mode
        JT1/JT8 JT2/JT9 JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        3       5       5       11      11      15
COLT    ON      COLTJ   ON
COLR    ON      COLRJ   ON
COLMV   OFF     COLCAL          OFF
>


>colstate 1: 3
Threshold for collision detection in repeat mode
        JT1/JT8 JT2/JT9 JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        20      35      60      112     120     116
Threshold for shock detection in repeat mode
        JT1/JT8 JT2/JT9 JT3/JT10        JT4/JT11JT5/JT12        JT6/JT13
        JT7/JT14
        3       4       3       6       7       6
>
```

F2.5 OPERATION AFTER COLLISION

The following error message will appear when collision is detected. The cause of the error and its countermeasure are as follows:

(Error: E1130) Jt-XX-M collision is detected.
Cause: An unpredictable torque was detected in the motor of the specified joint and robot has detected it as collision.
Countermeasure: Remove the obstacles in the robot motion area.

If this error occurs frequently where there is no obstacle, try increasing the threshold by 1.2 times its current value. Also, check if the tool data is set accurately.

F2.6 TROUBLE SHOOTING

The following table shows typical troubles that may occur in applying this function and the countermeasures for each case:

Trouble	Countermeasure
Frequent false detection	1. Check if the tool data is accurate. 2. Retry auto calibration of threshold 3. If false detection still occurs, manually change the thresholds to greater values.
Detection is slow/ not sensitive	1. Check if the tool data is accurate. 2. Retry auto calibration of threshold
Does not detect collision	Check if collision detection is ON. Also, be aware that if 0 is set as the threshold, collision is not detected in that joint.
Retraction too big	If the robot retracts too much and if it seems dangerous, turn OFF the retraction using COLMVOFF command/ instruction.

F3.0 3D SENSOR COMPENSATION FUNCTION

F3.1 OVERVIEW

In an automobile production line, normally robot executes sealing, etc. to a workpiece (car body) after the workpiece is conveyed to the robot position. When the workpiece is stopped by the conveyor, three-dimensional translation/rotation deviation may occur in the workpiece stop position/posture (=pose) due to loading/conveying inconsistencies or machine deviations in the conveyor, etc.

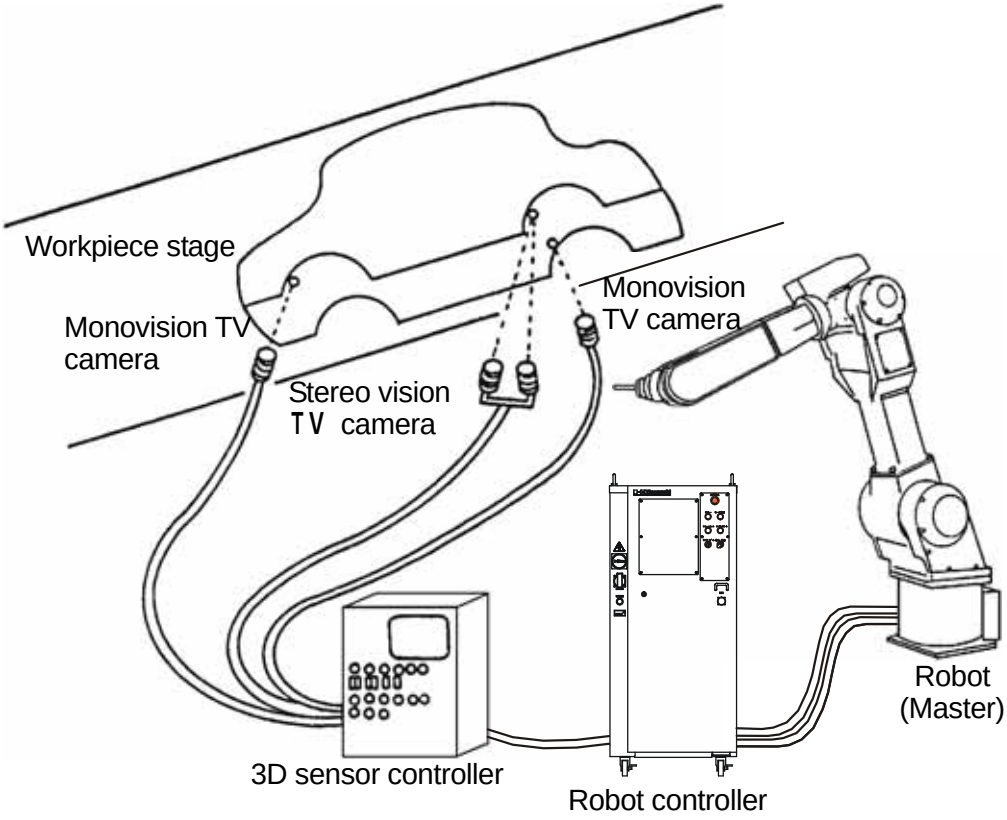
In these cases, this function enables the robot to detect the deviations and adjust its motion to compensate for the distance the workpiece deviates from its taught position. Specifically, this function measures the three-dimensional position of specified points (gauge holes) on the workpiece by 3D sensing cameras and obtains the three-dimensional pose deviation of each workpiece. The robot uses this information to adjust its motion so that the sealing work is performed consistently and without variation for each and every workpiece.

This function eliminates the need for having special devices to provide accurate loading/conveyance of workpieces thereby reducing the number of machines deployed and simplifying the factory production line.

F3.2 BASIC CONSTRUCTION

Figure below shows the basic system construction when using 3D sensor function. Note that descriptions in this manual are based on this figure.

This manual does not describe the operation methods of the 3D sensor controller*, TV camera, etc. For details on operating these devices, see their instruction manuals.



NOTE* 3D sensor controller loads the image data from the cameras, and converts the data so that the robot controller can process the data.

F3.3 OPERATION FLOW

Calibration and measurement/compensation are executed in concert with the 3D sensor controller as described below:

1. Calibration:

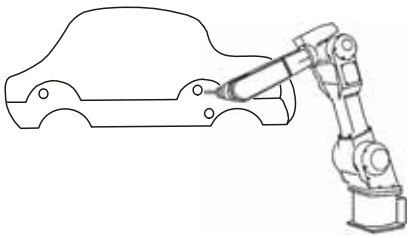
(1) Needed to convert the measured data based on the workpiece reference points (=gauge holes) to the data based on robot coordinates.

(2) The calibration process will vary depending on the type of 3D sensor controller used. See the instruction manual of each device for more details.

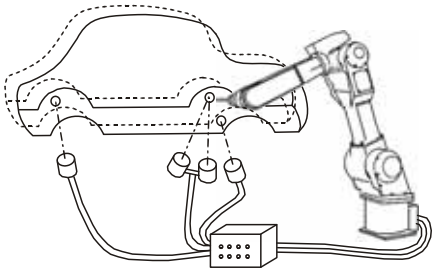
2. Measurement:

Reads the 3-dimensional position data for the gauge holes that is sent from the 3D sensor controller, determines the deviation between the measured workpiece coordinates and the reference workpiece coordinates, and then compensates the teach data.

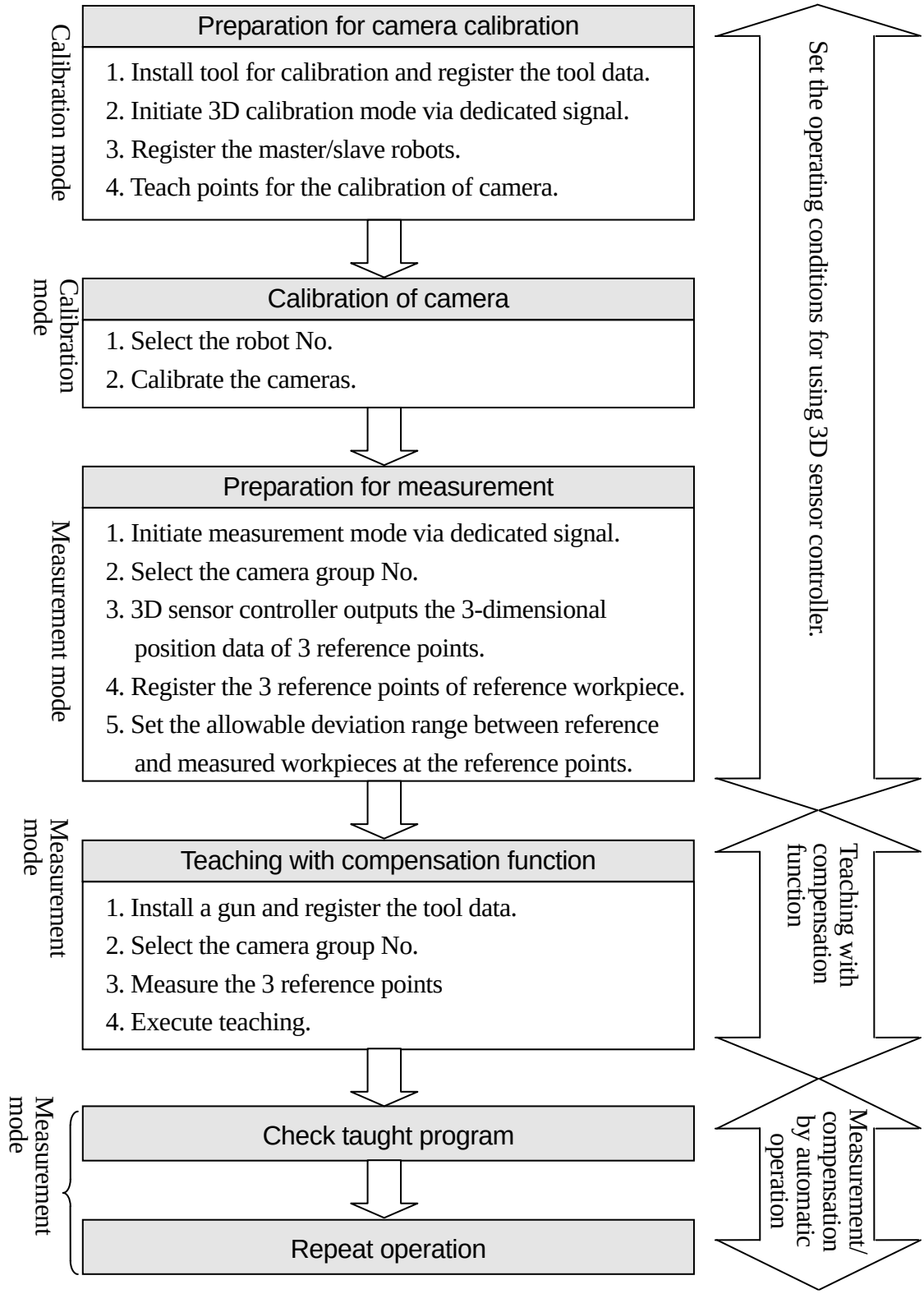
At teaching:
Converts the points taught on the workpiece into points on reference workpiece, and records it as teach data.



At repeat operation:
Converts the taught data (on reference workpiece) to points on measured workpiece, and then executes repeat operation.



Follow the procedure below to make the robot compensate for deviations in workpiece positioning using the 3D sensor measurement data.



F3.4 OPERATION PROCEDURE

F3.4.1 SYSTEM ENVIRONMENT SETTINGS

This section describes the various conditions that must be set in the system in order to use the 3D sensor compensation function.

F3.4.1.1 TEACHING AT CALIBRATION

1. Check the switches and modes.

Check if the operation panel on the robot controller and the switches on the teach pendant are set as follows. Also, make sure the LCD of the teach pendant displays the top menu.

(1) Turn ON the CONTROLLER POWER switch of controller.
(2) Turn ON the motor power by pressing TEACHING READY on the operation panel.
(3) Turn the MODE SELCTOR switch on the operation panel to TEACH.
(4) Turn the HOLD/RUN switch on the operation panel to RUN.
(5) Turn ON the TEACH LOCK switch of the teach pendant.

2. Register the tool data.

Register the tool data to be used during calibration before teaching the calibration points.

Set this registration in [FUNCTION]-[3. Aux. Data Setting] - [4. Tool Coordinates] (R304).

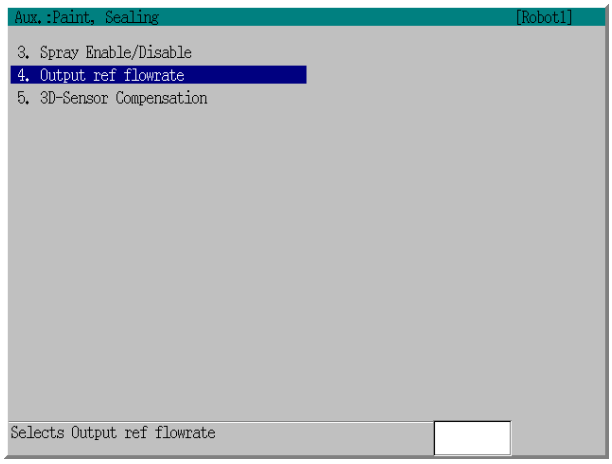
3. Start the calibration mode.

Allocate the dedicated input signal [3D. Calibration mode] as a general purpose signal and input ON signal to the port of that signal (setting usually done at time of shipment). See F3.6 Interlock Signals for more details on this and other dedicated signals available for this function.

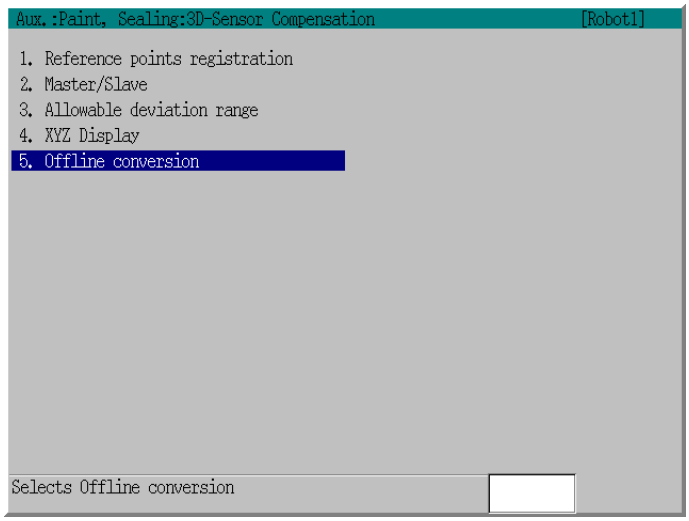
4. Register the master/slave robots*.

Register which robot is used for calibration, master robot or slave robot.

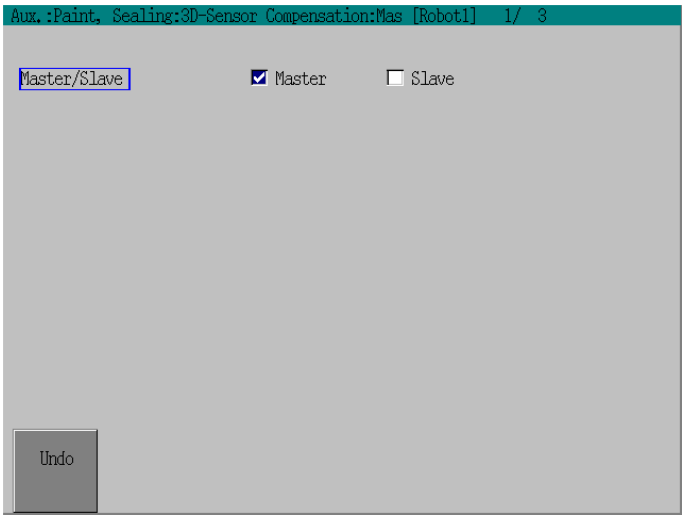
(1) Press <STATUS>. From the pull-down menu that appears, select [FUNCTION]. Select [12. Paint, Sealing] from the menu. In the next screen that appears, shown below, select [5. 3D-Sensor Compensation].



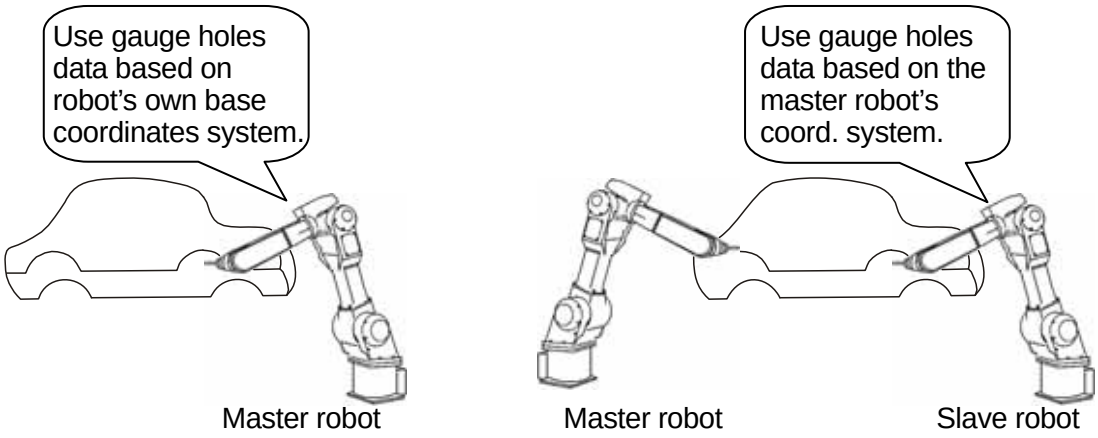
(2) Selecting [5. 3D-Sensor Compensation] displays the list below, so select [2. Master/Slave].



(3) Select [Master] or [Slave], and press ↵. (When slave robot is selected, see F3.4.1.4 Registration of Slave Robot.)



NOTE* When maser robot is used for calibration, the gauge holes data are based on its base coordinates system. When slave robot is used for calibration, gauge holes data based on the master robot are used, and in this case, 4 reference points shared by master and slave robots must be registered to identify the mutual poses between the two robots.



To execute calibration and measurement, take note that gauge hole data is handled differently by the master and slave robots. For more details, see F3.4.1.4 Registration of Slave Robot.

5. Teach the calibration points.

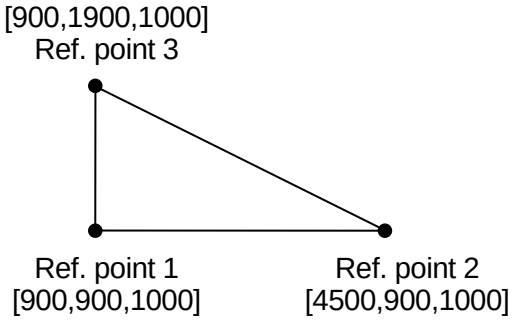
The teaching for calibration will vary per system construction, application program, etc. For more details, refer to the instruction manual relevant to your system and application.

F3.4.1.2 REGISTRATION OF REFERENCE POINTS ON REFERENCE WORKPIECE

This is preparation for F3.4.2 Teaching after Measurement. Register the coordinates data (X, Y, Z) of 3 reference points on the workpiece (body) as the reference workpiece poses to robot.

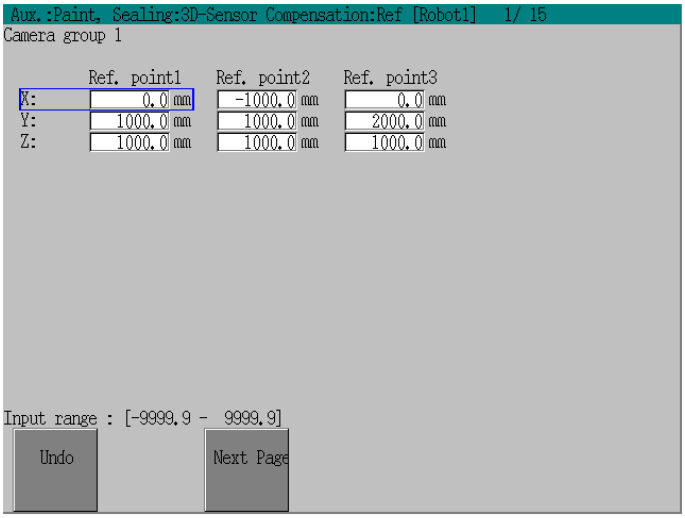
[NOTE]

1. Set Ref. points 1, 2, 3 so that each vertex in the triangle is at least 1000mm from its opposing base side.



2. Ref. points are set the same way in traverse axis specification.

1. Select [FUNCTION] – [12. Paint, sealing] - [5. 3D-Sensor Compensation] and then select [1. Reference Points Registration] to display the screen below.



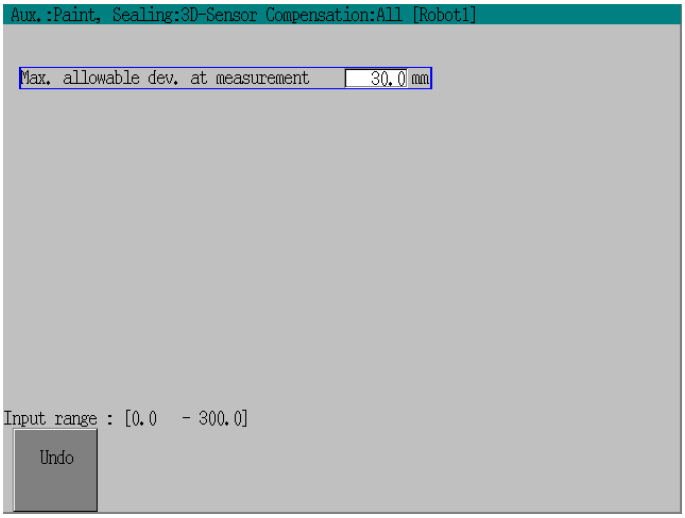
2. Input the coordinates data of 3 reference points for each camera group. To display the screen for camera groups 2 to 15, press <Next Page>. Pressing <Undo> displays previously registered coordinates data.

3. Input the coordinates data by NUMBER (0-9), and press ↵.

F3.4.1.3 REGISTRATION OF DEVIATION RANGE BETWEEN REFERENCE AND MEASURED WORKPIECES

Register the allowable deviation range between the 3 reference points on the reference workpiece and those of the measured workpiece. 0 mm to 300 mm can be set as the max. allowable deviation between measured and reference values.

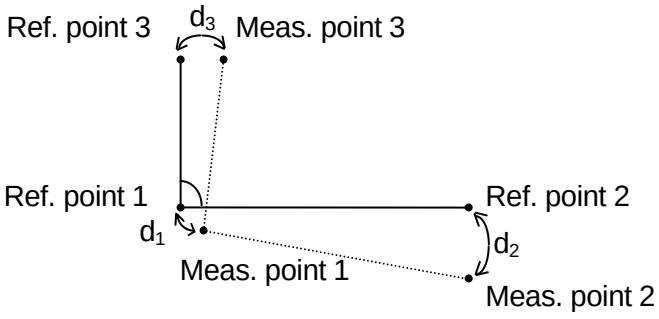
1. Select [FUNCTION] – [12. Paint, sealing] - [5. 3D-Sensor Compensation] and then select [3. Allowable deviation range] to display the screen below.



2. Input the max. allowable deviation between measured and reference values (30.0 mm in this example) by NUMBER (0-9), and press ↵.

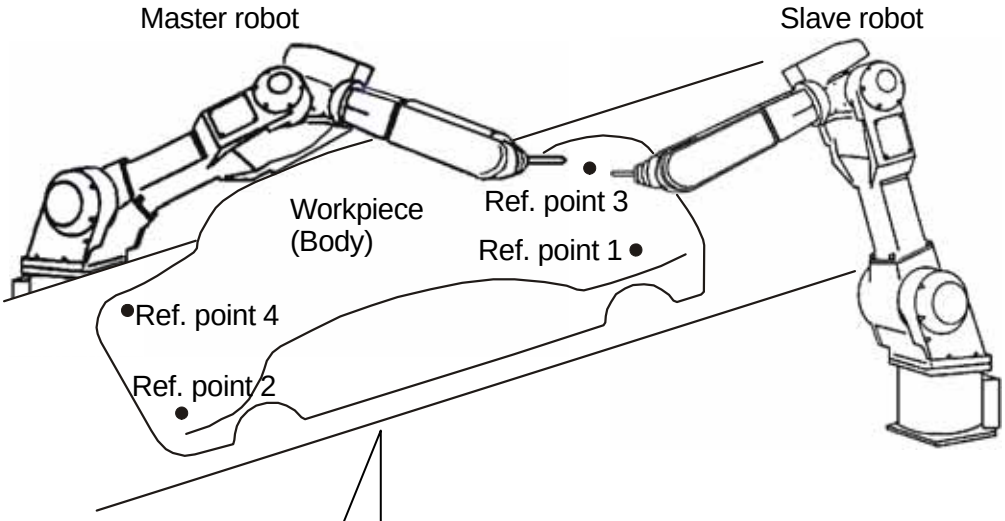
[NOTE]

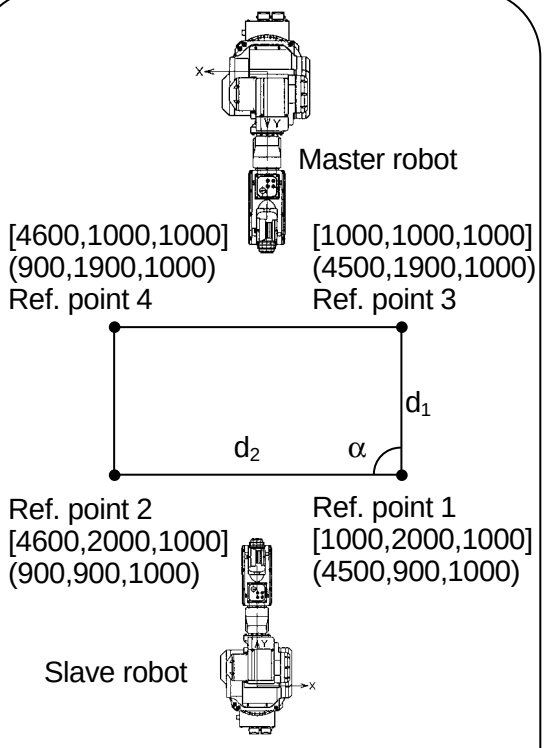
Error occurs when one of d_1, d_2 , d_3 (distance between points on reference and measured workpieces) exceeds the max. allowable deviation.



F3.4.1.4 REGISTRATION OF SLAVE ROBOT

In order to perform calibration on a slave robot, calibration data must be based on the master robot. To do so, register the same 4 reference points on the workpiece (e.g. car body) in both the master and slave robots; this operation is called “Matching of data” between master and slave robots.





Values in brackets [ ] shows XYZ based on the master robot and values in parentheses ( ), slave robot.

[NOTE]

Note the following items when registering reference points.

1. Be sure to register the tool data of the tool installed on the master and slave robots. For the sample figure here, register the points in the order of 1→2→3→4.

2. Set the reference points 1, 2, 3 so that the angle α is approx. 90 degree (at least 45 degree or more).

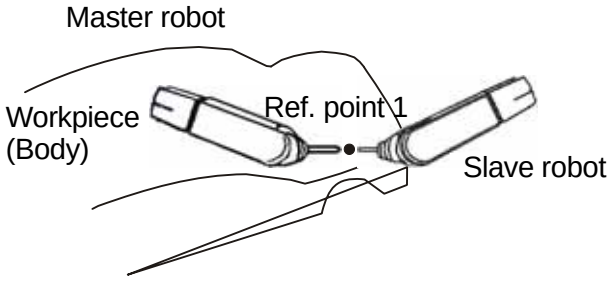
3. Set the reference points 1, 2, 3, 4 so that d_1 and d_2 are 1,000mm or more respectively.

4. Ref. points are set the same way in traverse axis specification.

1. Teach 4 reference points.

Teaching operations specific to 3D sensor compensation function are described here. For standard teaching methods, refer to Operation Manual, a separate volume.

(1) By operating +/- on teach pendant of both of master and slave robots, move tool tips of each robot near Ref. point 1.



(2) Set the tool tips of each robot to Ref. point 1 accurately, and confirm the current XYZ values by displaying [FUNCTION] – [12. Paint, sealing] - [5. 3D-Sensor Compensation]- [4. XYZ Display].

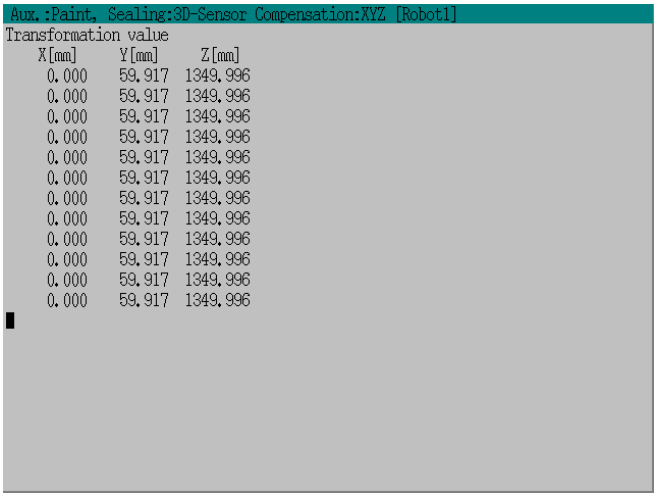


Figure above is an example when current XYZ of Ref. point 1 are displayed in the slave robot controller. Be sure to display and confirm the current XYZ of Ref. point 1 in the master robot.

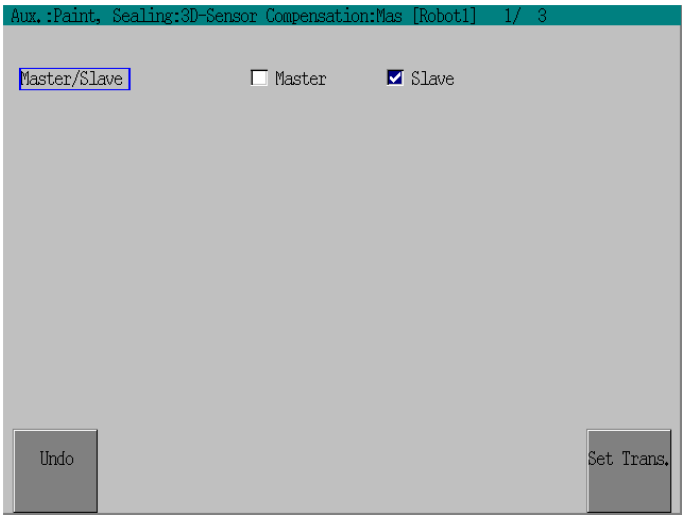
Following the same procedure, set and check the current XYZ values for Ref. points 2, 3 and 4. These 4 reference points are necessary for matching data between master and slave robots.

[NOTE]

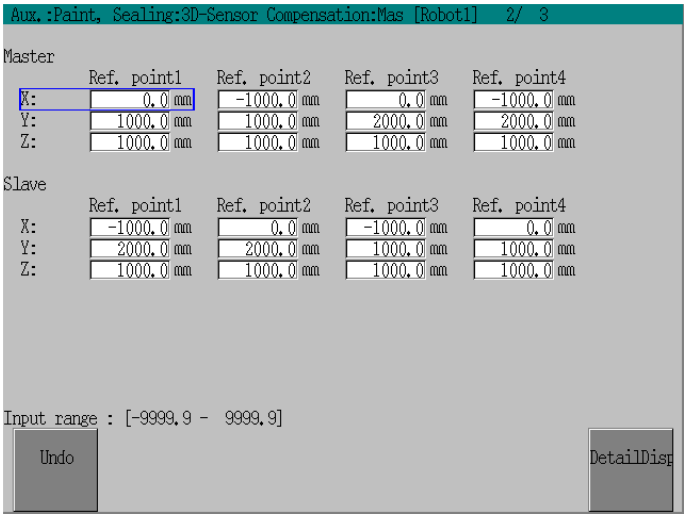
Values displayed by other procedures (WHERE command, etc.) may deviate from the actual tool tip position, as the deflection of robot arm caused by gravity is not considered. Be sure to take the procedure described here to check the tool position.

2. Register 4 reference points.

(1) Select [FUNCTION] – [12. Paint, sealing] - [5. 3D-Sensor Compensation] and then select [2. Master/Slave] to display the screen below. Select [Slave], and press ↵.

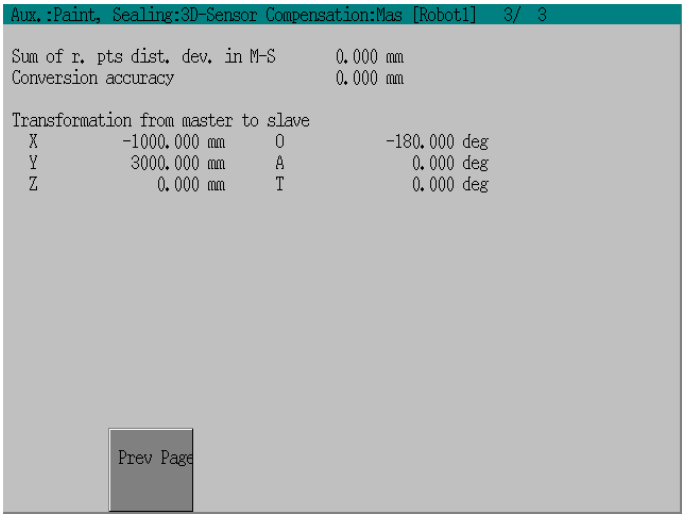


(2) Select <Set Trans.> to display the screen below, and input coordinates data of 4 reference points for master and slave robots by NUMBER (0-9). Press <Undo> to display the previously registered data. Pressing <Detail Disp> after data input displays transformation values between master and slave robots, shown in (4) on the next page.

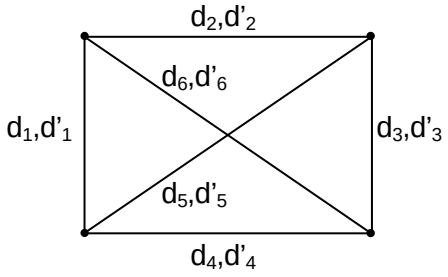


(3) When the registered data is correct, press ↵. When "Setting complete." is displayed on the lower left of the screen, the setting is done.

(4) Press <Detail Disp> to display the screen below, and press ↵ if the data is OK. After registration, transformation values between master and slave robots are displayed as in the screen below.



NOTE* Displays the sum of the distance deviations between the reference points for the master d_1-d_6 and those for the slave d'_1-d'_6.



NOTE** Displays S when d_i (i=1-6) is calculated from d_i and Transformation matrix.

F3.4.2 TEACHING AFTER MEASUREMENT

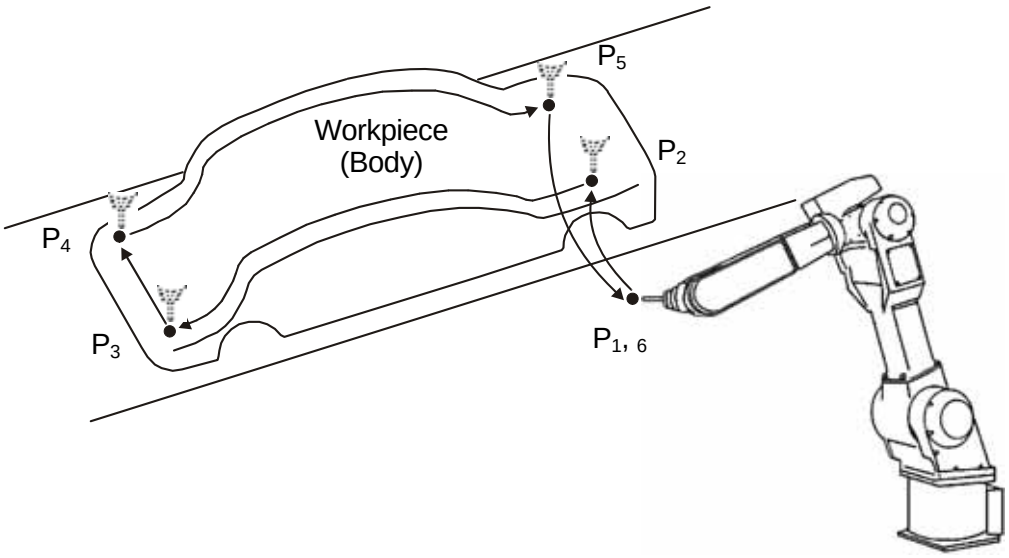
This section describes how to teach the sealing program after workpiece positions have been measured by 3D sensor controller. For standard teaching methods, refer to chapters 1- 4.

1. Confirm the following items are in effect before starting the teaching.

(1) Be sure to input the measurement mode dedicated input signal and camera group No. before starting measurement of the workpiece.
(2) To teach program using an actual workpiece, remove the tool for calibration attached to the wrist flange, and fix the gun used for sealing.
(3) After the gun is fixed, be sure to register the tool data in [Tool Coordinates (R304)].
(4) Select the program (e.g. pg1), and set to teach mode.

2. Teaching

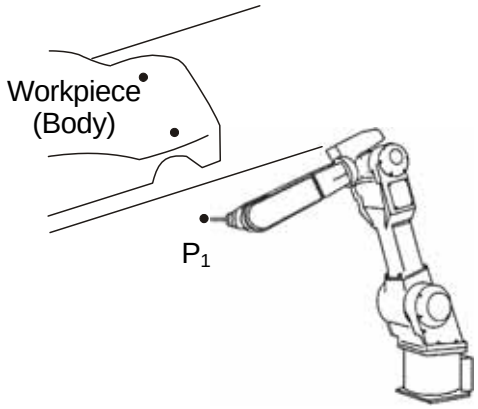
Teach the program for sealing the car body as in the figure and table below. To make robot compensate for deviation in the workpiece pose, teach "C" in the auxiliary data column under "WK" or teach "0" if not compensating.



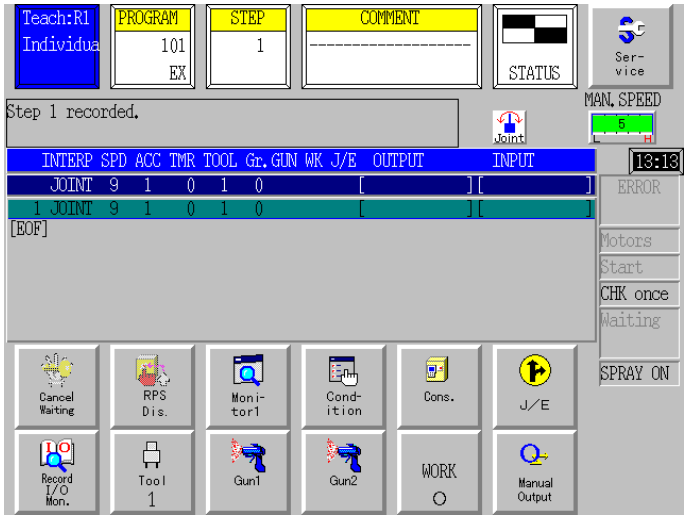
Teaching point	Teaching contents
Step1	Sets the evacuating point of arm (P_1).
Step2	Moves from P_1 to P_2 and starts sealing from P_2. (Set "C" in "WK".)
Step3	Moves from P_2 to P_3 and continues sealing. (Set "C" in "WK".)
Step4	Moves from P_3 to P_4 and continues sealing. (Set "C" in "WK".)
Step5	Moves from P_4 to P_5 and stops sealing at P_5. (Set "C" in "WK".)
Step6	Moves from P_5 to P_6 (=P_1), and completes teaching. (Set "0" in "WK".)

(1) Teach step1.

Move the gun tip to P_1 (evacuating point) by +/- in joint mode.

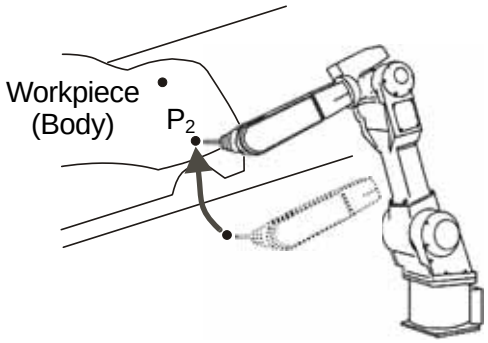


(2) When auxiliary data and gun tip position are correct, press RECORD to teach the pose and the auxiliary data of step1 at the same time.

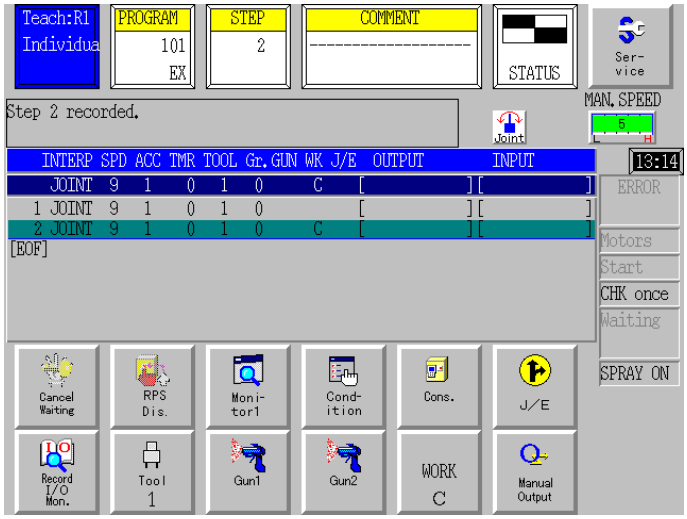


(3) Teach step2.

Move the gun tip to P_2 by +/- in base mode.



(4) To compensate for the deviation of workpiece position, teach “C” in the auxiliary data “WK”.



(5) When auxiliary data and gun tip position are correct, press RECORD to teach the pose and the auxiliary data of step2 at the same time.

(6) In the same way, teach steps 3 to 6.

F3.5 PROGRAM CHECK AND REPEAT OPERATIONS

After teaching, check if robot moves as taught in the program and that the 3D sensor controller operates normally before starting repeat operation.

This section describes how to check the program and robot motion and to execute repeat operations with the 3D sensor function. For standard check/repeat operation methods, refer to chapters 5-6.

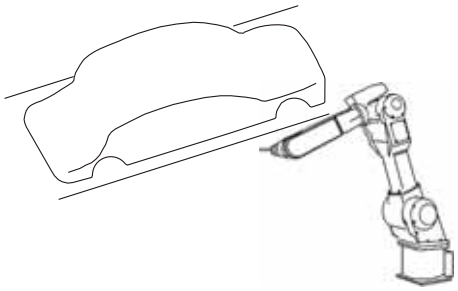
1. Check the teaching path and communication between 3D sensor and robot controllers.

(1) Turn the MODE SELECTOR switch to MAN. in repeat mode.

(2) Select [Disable] for [Spray] in [FUNCTION] – [12. paint, Sealing] – [3. Spray Enable/Disable] (R1203) so that sealing does not start. (For more details, see the chapter for Sealing Specification in Operation Manual.)

(3) Set the slow repeat speed (approx. 10%).

(4) If check points deviate from the points taught for the body (workpiece), execute measurement again.



(5) Press CYCLE START switch and start repeat operation.

(6) Check if robot moves as taught, and correct the program if necessary.

(7) Check if 3D sensor and robot controllers communicate normally. If necessary, inspect and adjust the devices and check the program again.

(8) Check if the speed is as in the set program, and return to step (5) and restart if necessary.

(9) Move to check the next item.

2. Check the sealing operation and total operation.

(1) Select [Enable] for [Spray] in [FUNCTION] – [12. paint, Sealing] – [3. Spray Enable/Disable] (R1203) so that sealing can start.

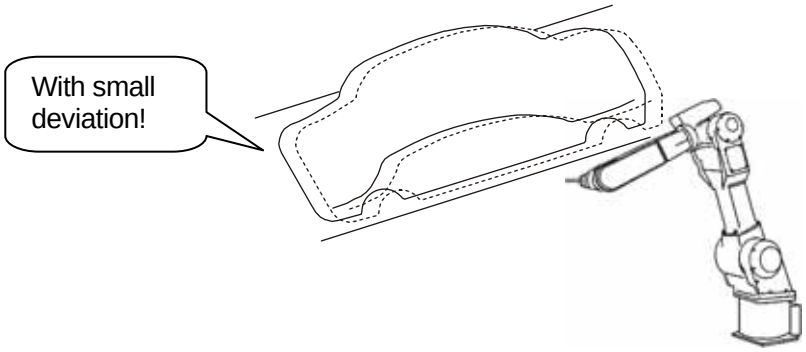
(2) Set 100% repeat speed.

(3) Start repeat operation.

(4) Complete checking the total operation.

3. Check if deviations are compensated for correctly.

(1) Set the workpiece (body) with a small deviation, and execute measurement.



(2) Press CYCLE START switch and start repeat operation at the speed set in the program.

(3) Check if the operation is executed normally.

After check operations described above are complete, automatic operation of sealing is possible.

F3.6 INTERLOCK SIGNALS

3D sensor compensation is realized using several devices including: cameras, controllers for 3D sensor/robot, interface panel, etc. Signal communication between devices is very important for the system to operate correctly. This chapter describes the interlock signals necessary for the robot controller to process the compensation signals set in 3D sensor controller.

Signal name	Mode	Description
3D. Calibration mode (Input)	Calib.	When this signal and output signal "3D Calibration mode" are both dedicated, output signal "3D Calibration mode" is output when this signal turns ON, and is not output if output signal "3D Calibration mode" is not dedicated. Use this signal for confirming the calibration mode ON/OFF status with the interface panel.
3D.Measurement mode (Input)	Meas.	When this signal and output signal "3D Measurement mode" are both dedicated, output signal "3D Measurement mode" is output when this signal turns ON, and is not output if output signal "3D Measurement mode" is not dedicated. Use this signal for confirming the measurement mode ON/OFF status with the interface panel.
3D. Communication start (Input)	Calib./ Meas.	Input ON of this signal activates PC program3 of AUTO3DRCV.PC(). For example, compensation matrix is automatically created when this signal turns ON and S3DXYZRCV instruction is described in AUTO3DRCV.PC(); S3DXYZRCV instruction receives compensation data from 3D sensor controller via RS232C communication and creates transformation matrix. Before using this signal, be sure to define the program AUTO3DRCV.PC().
3D. Compensation OFF (Input)	Meas.	When this signal is ON, registered reference point data is considered as received data and transformation matrix (not for compensation) is created. This is level detection.
3D. Camera group No. (Input)	Calib./ Meas.	Selects camera groups 1 to 15 by 4 bit WX signal. This is level detection.
3D. Calibration mode (Output)	Calib.	Shows that robot is in calibration mode.
3D.Measurement mode (Output)	Meas.	Shows that robot is in measurement mode.

Signal name	Mode	Description
3D. In communication (Output)	Calib./ Meas.	Shows that communication with 3D sensor controller is in progress.
3D. Communication error (Output)	Calib./ Meas.	Outputs when communication error (Error code E4065 to E4069) occurs. When this signal is dedicated, robot does not stop by error. When communication error occurs, compensation value is cleared (compensation OFF). When input signal “3D. Communication start” is input, this signal turns OFF.

F3.7 COMMUNICATION OF COMPENSATION DATA

There are two types of methods for communicating compensation data, via either RS232C communication or network communication (Option). To use network communication, prepare and install the board (1HS board) for network communication and the 1HS board software that supports 3D sensor compensation.

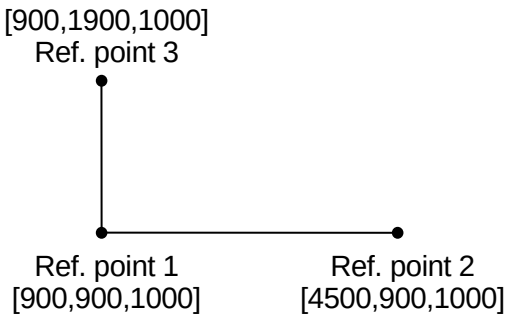
F3.7.1 COMMUNICATION OF COMPENSATION DATA BY RS232C

F3.7.1.1 AS LANGUAGE FOR COMMUNICATION

The following AS language commands/instructions are provided for RS232C communication. (For details about AS language, see F3.9 AS Language.)

1. S3DXYZRCV command/instruction
2. SXYZRCV command/instruction
3. SXYZSND command/instruction

F3.7.1.2 COMMUNICATION FORMAT



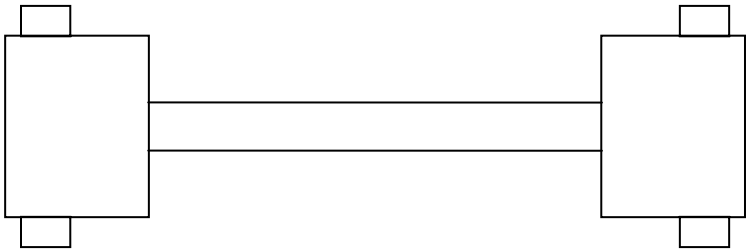
The coordinates data of the 3 reference points is received by the format below. In this case, reference point1 is the first point.

	SOT	+0900.000	+0900.000	+1000.000	EOT		SOT	+0900.000	+1900.000	+1000.000	EOT	
	(01)	X	Y	Z	(04)		(01)	X	Y	Z	(04)	
	1 byte	9 bytes	9 bytes	9 bytes	1 byte		1 byte	9 bytes	9 bytes	9 bytes	1 byte	
	Ref. point 1					…	Ref. point 3					

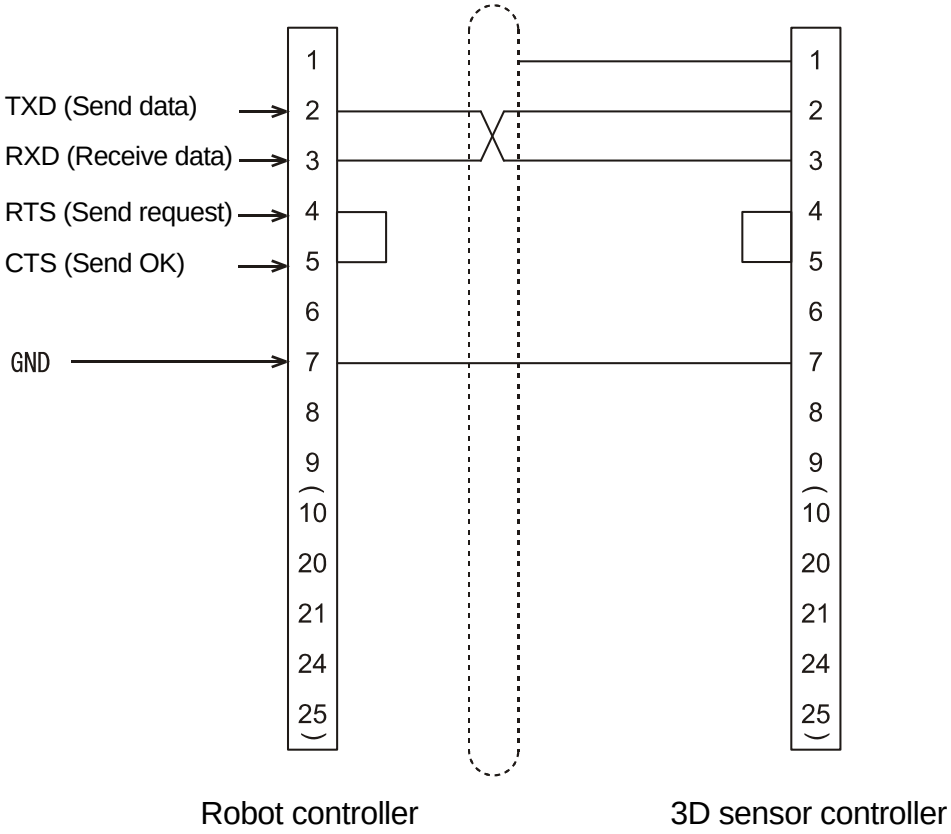
Coordinates data have 9-byte field length with the sign in the first byte. Fill the places not used with 0.

F3.7.1.3 RS232C INTERFACE SPECIFICATION

Interface method : EIA RS232C
Transfer speed : 9600bps
Parity : No parity
Data length : 8 bits
Stop bit : 2 bits
Connection spec. : See the figure below



HDBB-25P (or equivalent model)
Plug case HDB-CTF (or equivalent model)



Note that numbers in parenthesis ( ) are for 25 pins spec.

F3.7.1.4 PROCEDURE FOR CONNECTING RS232C CABLE

To communicate data, etc. between 3D sensor controller and robot controller, connect the controllers using RS232C cable.

F3.7.2 NETWORK COMMUNICATION OF COMPENSATION DATA

F3.7.2.1 AS LANGUAGE FOR COMMUNICATION

The following instructions are provided as AS language to use for Ethernet connection. (For details on AS language, please refer to F3.9 AS Language and TCP/IP Operation Manual, a separate volume.)

1. TCP_RECV instruction

Example

⑴ In calibration mode, receives data for robot displacement amount

```
TCP_RECV( tcp_rcv,tcp_sock,.$rcv[0],.1,.0,255 )
i=0
DO
v3d.rcv[i]= $DECODE($rcv[0], “,”, 0)
i=i+1
IF $rcv[0]==”” goto end
$temp=$DECODE($rcv[0], “,”, 1)
UNTIL $rvc[0]==””
end:
JMOVE SHIFT(kousei.loc BY v3d.rcv[0], v3d.rcv[1], v3d.rcv[2])
```

⑵ In measurement mode, receives the workpiece gauge hole measurement data and creates the conversion matrix for 3D sensor calibration.

```
TCP_RECV( tcp_rcv,tcp_sock,.$rcv[0],.1,.0,255 )
i=0
DO
v3d.rcv[i]= $DECODE($rcv[0], “,”, 0)
i=i+1
IF $rcv[0]==”” goto end
$temp=$DECODE($rcv[0], “,”, 1)
UNTIL $rvc[0]==””
```

```
end:
POINT keisoku [0]=TRANS(v3d.rcv[0], v3d.rcv[1], v3d.rcv[2], 0, 0, 0 )
POINT keisoku [1]=TRANS(v3d.rcv[3], v3d.rcv[4], v3d.rcv[5], 0, 0, 0 )
POINT keisoku [2]=TRANS(v3d.rcv[6], v3d.rcv[7], v3d.rcv[8], 0, 0, 0 )
GETGHTRANS keisoku[0], keisoku[1], keisoku[2]
```

2. TCP_SEND instruction

Example

Transmits the current value of the robot to the 3D sensor controller

```
HERE k.loc
DECOMPOSE k.data[0]=k.loc
$send[0]=$ENCODE(/F8.3, k.data[0], “,”, k.data[1], “,”, k.data[2])
TCP_SEND tcp_snd,tcp_sock,.$send[0],1,0.255
```

F3.8 OFFLINE CONVERSION VIA 3 REFERENCE POINTS

F3.8.1 OVERVIEW OF OFFLINE CONVERSION FUNCTION

Typically in robot systems not loaded with the 3D Sensor Function, data taught with an offline machine or CAD (ROSET) system is converted for use in an online machine via [FUNCTION] – [1. Program Conversion] – [3. Transform Data] (R9). When converted by this method, 4 reference points must be set in both the offline and online machines in order to measure the deviation between the two machines.

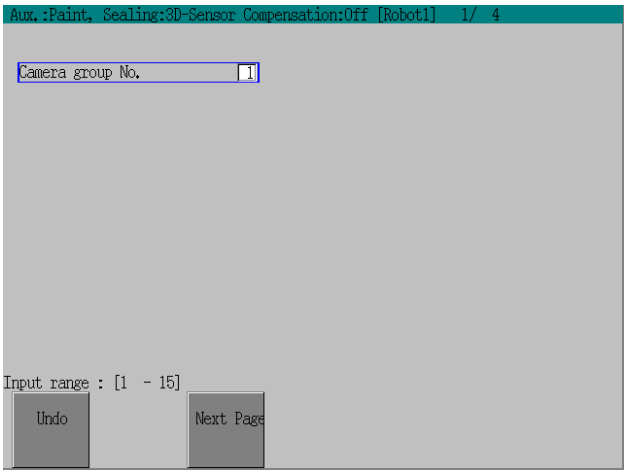
The function described here can convert the data easily by using the 3 reference points registered for 3D sensor compensation instead of registering 4 new reference points. However, take note that the accuracy of data converted by this function may not be as precise as data converted by registering 4 new points.

[NOTE]

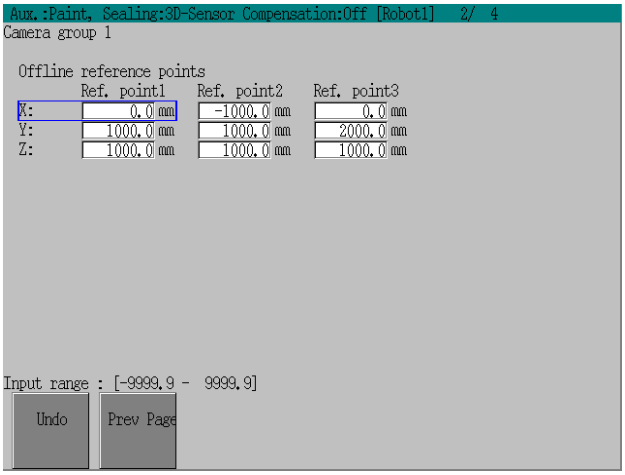
Reference points for the selected camera is to be set beforehand in [3D-Sensor Compensation (R69)] – [1. Reference Points Registration]. Refer to F3.4.1.2 Registration of Reference Points on Reference Workpiece for setting procedures.

F3.8.2 CONVERSION FLOW

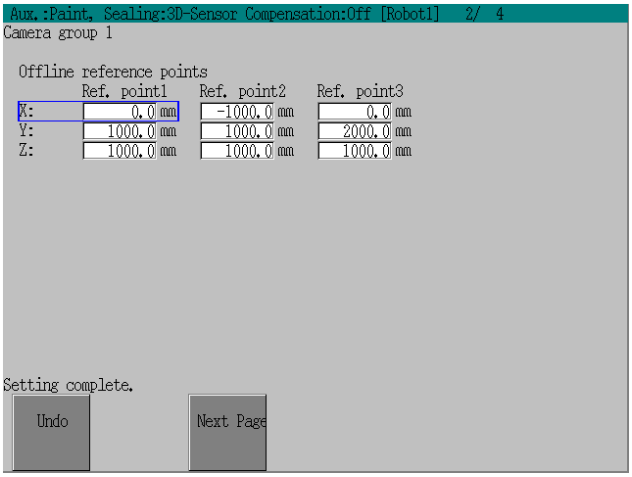
1. Press <STATUS>. From the pull-down menu that appears, select [FUNCTION]. In the menu screen, select [12. Paint, Sealing] and then select [5. 3D-Sensor Compensation]. From the menu for [3D-Sensor Compensation], select [5. Offline conversion] to display the screen below. Input the camera group No. used to measure the 3 points that will become the reference points for the online machine.



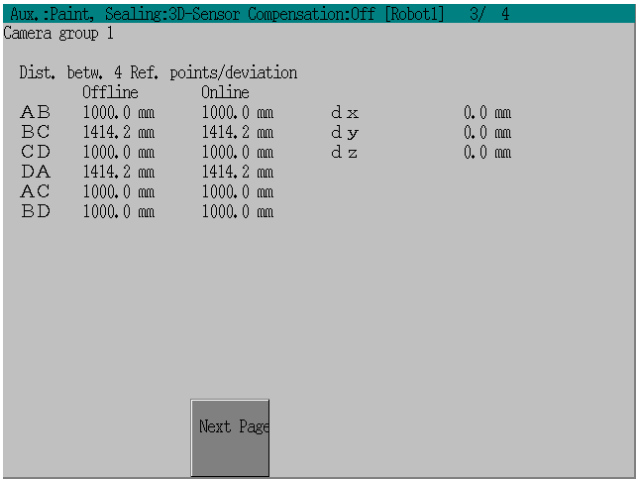
2. Press <Next Page> to display the screen below. Register the 3 reference points in offline machine.



3. Press ↵ to create transformation matrix from offline to online machines. When the setting is complete normally, <Next Page> is displayed.



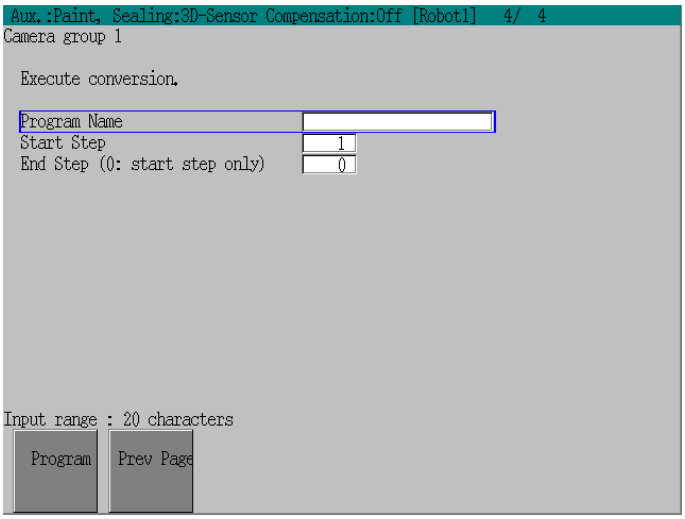
4. Press <Next Page> to display the transformation results.



[NOTE]

When any of the dx, dy, or dz values are not within ±3.0mm, the data may not be correct. Register the value again.

5. Press <Next Page> to display the screen below, and input program name and the range of steps to be transformed.



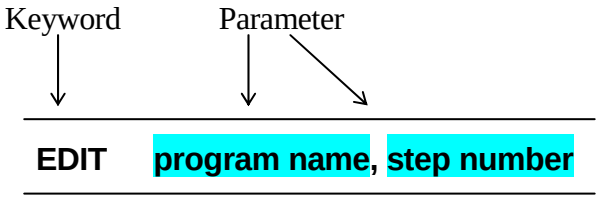
6. When the set data is correct, press ↵. Confirmation screen is displayed. Select [Yes] to execute offline conversion for the specified range of steps, and select [No] to stop the offline conversion and return to the data input screen.

F3.9 AS LANGUAGE

GETGHTRANS command/instruction
S3DXYZRCV command/instruction
SXYZRCV command/instruction
SXYZSND command/instruction
SETGHERR command
SETMSTRANS command
SETGAUGE command
WHERE command
GETGAUGE instruction
SETGAUGE instruction
GHMSTRANS transformation value function
BHERE transformation value function
GHTRANS transformation value function
GHMSTENA real value function
GHSLAVE real value function
GETGHERR real value function

[NOTE]

Commands/instructions are described as follows.



1. Parameters marked with [ ] can be omitted.
2. Always enter a space between the keyword and the parameter.
3. ↵ represents the ENTER key in the examples.

Monitor command
Program instruction

GETGHTRANS Transformation variable name1, Transformation variable name2, Transformation variable name3, Camera group number

Function

Creates transformation matrix for 3D sensor compensation (in teach/repeat) based on measurement values taken at the 3 gauge holes of the workpiece that corresponds to the specified Camera group number.

Parameter

1. Transformation variable name 1, 2, 3
   Specifies transformation values of the 3 measured gauge holes.

2. Camera group number
   Specifies the camera group No. of the desired workpiece. If omitted, camera group No. is specified by external signal.

Example

Receives data measured from the gauge holes of the workpiece, and creates the 3D sensor compensation matrix for the workpiece that corresponds to the camera group No.

```
FOR i=0 TO 2
    SXYZRCV
    POINT keisoku[i]=TRANS(v3d.rcv[0],v3d.rcv[1],v3d.rcv[2],0,0,0)
END
    GETGHTRANS keisoku[0],keisoku[1],keisoku[2]
```

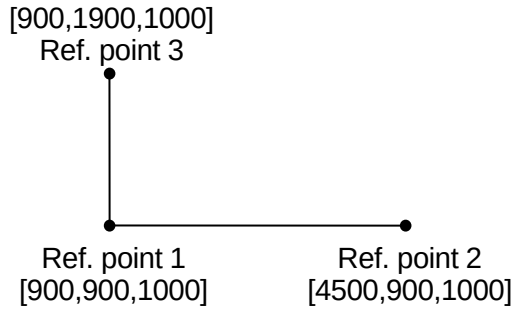
Monitor command
Program instruction

S3DXYZRCV

Function

Receives gauge hole data for the workpiece corresponding to the camera group No. specified via external signal from the 3D sensor controller through RS232C communication, and creates transformation matrix for 3D sensor compensation (in teach/repeat).

Explanation



Receives coordinates data of the 3 reference gauge holes from the 3D sensor controller via RS232C communication in the format below.

SOT	+0900.000	+0900.000	+1000.000	EOT		SOT	+0900.000	+1900.000	+1000.000	EOT
(01)	X	Y	Z	(04)		(01)	X	Y	Z	(04)
1 byte	9 bytes	9 bytes	9 bytes	1 byte		1 byte	9 bytes	9 bytes	9 bytes	1 byte

Ref. point 1 … Ref. point 3

Coordinates data have 9-byte field length with the sign in the first byte. Fill the places not used with 0.

After receiving data, transformation matrix is created which shows 3D deviation between the frame coordinates systems made by the 3 points of the received data and the frame made by the 3 reference points in reference position of the workpiece corresponding to camera group No. specified by external signal.

Example

When this command/instruction is described in program AUTO3DRCV.PC(), compensation data is automatically received from 3D sensor controller by input of “3D Communication start” dedicated signal, and then transformation matrix is created.

```
.PROGRAM AUTO3DRCV.PC()
    S3DXYZRCV
.END
```

Monitor command
Program instruction

SXYZRCV

Function

Receives character strings from 3D sensor controller via RS232C communication.

Explanation

Use this command/instruction in the below cases.

1. Receives data showing the amount of robot calibration motion at calibration mode.
   (See Example1.)
2. Receives data measured at the gauge holes of the workpiece at measurement mode.
   (See Example 2.)

Execute this command/instruction to assign the data input in the format shown in table below from the RS232C port into real variables: v3d.rcv[0], v3d.rcv[1], v3d.rcv[2].

Format

SOT	±#####.###	±#####.###	±#####.###	EOT
(01)	X	Y	Z	(04)
1byte	9byte	9byte	9byte	1byte

Coordinates data have 9-byte field length with the sign in the first byte. Fill the places not used with 0.

Example

1. Receives data showing the amount of robot calibration motion at calibration mode.

```
SXYZRCV
JMOVE SHIFT(kousei.loc BY v3d.rcv[0],v3d.rcv[1],v3d.rcv[2])
```

2. Receives data measured at the gauge holes of the workpiece and creates transformation matrix for 3D sensor compensation at measurement mode.

```
FOR i=0 TO 2
    SXYZRCV
    POINT keisoku[i]=TRANS(v3d.rcv[0],v3d.rcv[1],v3d.rcv[2],0,0,0)
END
GETGHTRANS keisoku[0],keisoku[1],keisoku[2]
```

Monitor command
Program instruction

SXYZSND

Function

Sends character strings to 3D sensor controller via RS232C communication.

Explanation

Use this command/instruction to send current values of robot to the 3D sensor controller when calibrating with the cameras (in calibration mode).

After assigning current values of robot to real variables (kousei.sx, kousei.sy, kousei.sz), execution of this command/instruction outputs the data to the RS232C port. The data is sent in the format shown in the table below.

Format

SOT	±#####.###	±#####.###	±#####.###	EOT
(01)	X	Y	Z	(04)
1byte	9byte	9byte	9byte	1byte

Coordinates data have 9-byte field length with the sign in the first byte. Fill the places not used with 0.

Example

Sends current values of robot to 3D sensor controller.

```
HERE k.loc
k.data[6]=0
DECOMPOSE k.data[0]=k.loc
kousei.sx=k.data[0]+k.data[6]
kousei.sy=k.data[1]
kousei.sz=k.data[2]
SXYZSND
```

Monitor command

SETGHERR

Function

Sets the max. allowable deviation when gauge holes are measured. If the deviation measured in measurement mode exceeds the value set here, error is output.

Explanation

0mm to 300mm can be set.

Example

```
>SETGHERR ↵
Max. allowable deviation between measured and reference values
      100.0[mm]
Change? (To terminate, input RETURN only.)
200 ↵
Max. allowable deviation between measured and reference values
      200.0[mm]
Change? (To terminate, input RETURN only.)
↵
```

Monitor command

SETMSTRANS

Function

Registers 4 reference points for master and slave robots, and sets the transformation values between those two robots.

Explanation

Executing this command displays the message “Master (or slave) robot. Change? (Input 0: master robot, 1: slave robot.” Input 0 to terminate without changing current settings. Or, input 1 and then input the 4 reference points for the master robot and those for the slave robot. Doing so will display the transformation values between master and slave robots.

Example

```
>SETMSTRANS ↵
Master robot.
Change? (Input 0: master robot, 1: slave robot.) 1 ↵
Master robot   First reference point
        X       Y       Z       [mm]
      0.0     0.0     0.0
Change? (To terminate, input RETURN only.)
1.0,1.5,2.0  ↵
Master robot   First reference point
        X       Y       Z       [mm]
      1.0     1.5     2.0
Change? (To terminate, input RETURN only.)
↵
              .
              .
              .
```

Monitor command

SETGAUGE

Function

Registers the coordinate values of the 3 reference points of the workpiece that corresponds to the specified camera group No.

Explanation

Executing this command displays the message “Camera group No.? (Specify 0 to select all, or 1 to 15.)”. Input the camera group No. Then, the reference point values and “Change?” are displayed, and the data can be edited. Message “Change?” is displayed until data changes are complete (until only ↵ is pressed without entering values.)

Example

```
>SETGAUGE ↵
Camera group No.? (Specify 0 to select all, or 1 to 15.) 1 ↵
Reference points of camera group 1
     1X     1Y     1Z     2X     2Y     2Z     3X     3Y     3Z   [mm]
    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0    0.0
Change? (To terminate, input RETURN only.)
100.0, 150.5, 200.3 ↵
Reference points of camera group 1
     1X     1Y     1Z     2X     2Y     2Z     3X     3Y     3Z   [mm]
  100.0  150.0  200.3    0.0    0.0    0.0    0.0    0.0    0.0
Change? (To terminate, input RETURN only.)
↵
```

Monitor command

WHERE robot number: 17

Function

Displays XYZ values of tool tip (TCP) compensated for the robot deflection caused by gravity.

Parameter

1. Robot number
   Sets which robot to use.

Explanation

Normally, WHERE 2 command does not consider the robot deflection caused by gravity and displays current position that deviates slightly from the actual tool tip position.

Specifying 17 as a parameter for WHERE command displays values compensated for the robot deflection by gravity, and values close to the actual tool tip position can be obtained. For traverse axis specification, the displayed XYZ values will also reflect the motion amount of the traversing axis.

Example

```
>WHERE 1:17
Transformation values XYZ
      X[mm]      Y[mm]      Z[mm]
    143.198    -60.683   3359.954
    143.198    -60.683   3359.954
       …          …          …
```

Program instruction

GETGAUGE Transformation variable name1, Transformation variable name2, Transformation variable name3, Camera group number

Function

Assigns the values of the 3 reference points of the workpiece corresponding to the specified Camera group number into the 3 variables described as the parameters Transformation variable name 1, 2, 3.

Parameter

1. Transformation variable name 1, 2, 3
   Specifies the transformation variable names to be set.

2. Camera group number
   Specifies the camera group No. of the desired workpiece. If omitted, camera group No. is specified by external signal.

Example

Sets the position data for the 3 reference points of camera group No.1.

```
GETGAUGE kijun[0],kijun[1],kijun[2],1
```

Program instruction

SETGAUGE Transformation variable name1, Transformation variable name2, Transformation variable name3, Camera group number

Function

Registers the 3 specified transformation values as the position data for the 3 reference points of the workpiece corresponding to the specified camera group No.

Parameter

1. Transformation variable name 1, 2, 3
   Specifies transformation variable names to be set.

2. Camera group number
   Specifies the camera group No. of the desired workpiece. If omitted, camera group No. is specified by external signal.

Example

Sets the position data for the 3 reference points of camera group No.1.

```
SETGAUGE kijun[0],kijun[1],kijun[2],1
```

Transformation value function

GHMSTRANS

Function

Returns transformation values between master and slave robots.

Explanation

Returns transformation values between the robots specified as master and slave by SETMSTRANS command.

Example

```
HERE k.here
IF GHMSTENA THEN
POINT k.here=-GHMSTRANS+k.here
END
```

Converts the current position value of slave robot into position values on the coordinates system of master robot.

Transformation value function

BHERE

Function

Returns transformation values showing current position of the tool tip (TCP) whose values are compensated for the deflection caused by gravity.

Explanation

Normally, WHERE command does not consider the robot deflection caused by gravity and displays current position that deviates slightly from the actual tool tip position.

Use this function so that values close to the actual tool tip position are returned after current position is compensated for the robot deflection caused by gravity.

Example

```
POINT kijun[0]=BHERE
```

Transformation value function

GHTRANS

Function

Returns transformation values showing deviation amount between the taught frame coordinates (reference frame coordinates) made by the 3 reference points of the workpiece at reference position and the frame coordinates made by the data of the 3 reference points received from 3D sensor controller.

Explanation

Use this function to find the amount of deviation between the data sent from 3D sensor controller and the data at reference position.

Example

Extracts the deviation amount from the received measurement data.

```
FOR i=0 TO 2
    SXYZRCV
    POINT keisoku[i]=TRANS(v3d.rcv[0],v3d.rcv[1],v3d.rcv[2],0,0,0)
END
GETGHTRANS keisoku[0],keisoku[1],keisoku[2]
delta=GHTRANS
```

Real value function

GHMSTENA

Function

Returns a flag value enabling transformation matrix between master and slave robots.

Explanation

Checks if transformation values are set between master and slave robots. If set, 1 is returned, and if not, 0 is returned.

Example

```
IF GHMSTENA THEN
"Process 1"
ELSE
"Process 2"
END
```

If transformation values between master and slave robots are set, "Process 1" is executed, and if not, "Process 2" is executed.

Real value function

GHSLAVE

Function

Returns flag value for slave robot.

Explanation

Checks whether slave or master robot is used. If slave robot, 1 is returned, and if master robot, 0 is returned.

Example

```
IF GHSLAVE THEN
"Process 1"
ELSE
"Process 2"
END
```

If slave robot is used, "Process 1" is executed, and if master robot, "Process 2" is executed.

Real value function

GETGHERR

Function

Returns the max. deviation allowed for measured values.

Explanation

Returns value currently set as max. allowable deviation range in
[3D-Sensor Compensation (R69)]-[3. Allowable Deviation Range] or SETGHERR command.

Example

```
err=GETGHERR
```

F3.10 ERROR MESSAGE LIST

Code	Former code	Error Message	Description
E4061	-882	Received gauge hole data exceeds allowable range.	Deviation between reference points and received data exceeds allowable range.
E4062	-883	Master/slave data is not registered.	For slave robot, matching data is not registered.
E4063	-884	Reference point data is not registered.	Data for reference points is not registered.
E4064	-887	3D calibration/measurement modes are both ON.	Calibration and measurement modes set via interlock signals are both ON.
E4065	-889	Unregistered variable specified to receive data.	Data was received from 3D sensor controller but variable specified to receive data is not registered.
E4066	-890	Variable specified to receive data is broken.	Data was received from 3D sensor controller but variable specified to receive data is broken.
E4067	-891	Received data is broken.	Data was received from 3D sensor controller but the data is broken.
E4068	-892	Start code is not correct.	Received data (start code) is abnormal.
E4069	-893	End code is not correct.	Received data (end code) is abnormal.
E4070	-894	3D camera group No. not specified.	Interlock signal for 3D camera group No. is not specified. In this case, camera group No. defaults to 1 and robot does not error stop.
E4071	-895	Incorrect 3D camera group No.	Camera group No. is not specified within 1 to 15.

H. PAINTING (FINAL/MIDDLE COAT)

This section describes items specific to final/middle coat painting.

H1.0 CONVEYOR SYNCHRONOUS FUNCTION

H1.1 OVERVIEW OF CONVEYOR SYNCHRONOUS FUNCTION

In normal robot operations, the workpiece remains stationary during the operation. The conveyor synchronous function enables operations on workpieces moving on a conveyor.

By using the conveyor synchronous function, the robot moves by synchronizing its motion with the moving workpiece. To move with the workpiece, the robot may use all six axes (conveyor tracking) or use a traverse axis (conveyor follow).

When teaching, conveyor synchronous operations should be divided into blocks considering the motion order and workload, and the following should be avoided:

1. Motion that takes the workpiece part/area to be operated upon beyond the operating range of the robot
2. Unnecessary idling time (robot stopping while workpiece passes by the robot)
3. Division of the operations that may cause quality defects.

Data settings must be done prior to using the conveyor synchronous function. Set the data in Auxiliary function 1102 Conveyor Sync. The following auxiliary functions are available.

Function No.	Name	Explanation
2	Data setting	Sets conveyor position* and data for CVF_LS2, CVF_PH2
3	Environment Data Setting	Sets data relating to the conveyor.
4	Simulation	Turns ON/OFF simulation function and sets data for the simulator such as conveyor ON/OFF, conveyor value**, conveyor speed, current pose, conveyor max. value***, etc.

NOTE* Describes “the travel distance of the workpiece on the conveyor from the start point (reference point).”

NOTE** Describes the “distance between the reference position and the position defined by the conveyor position.”

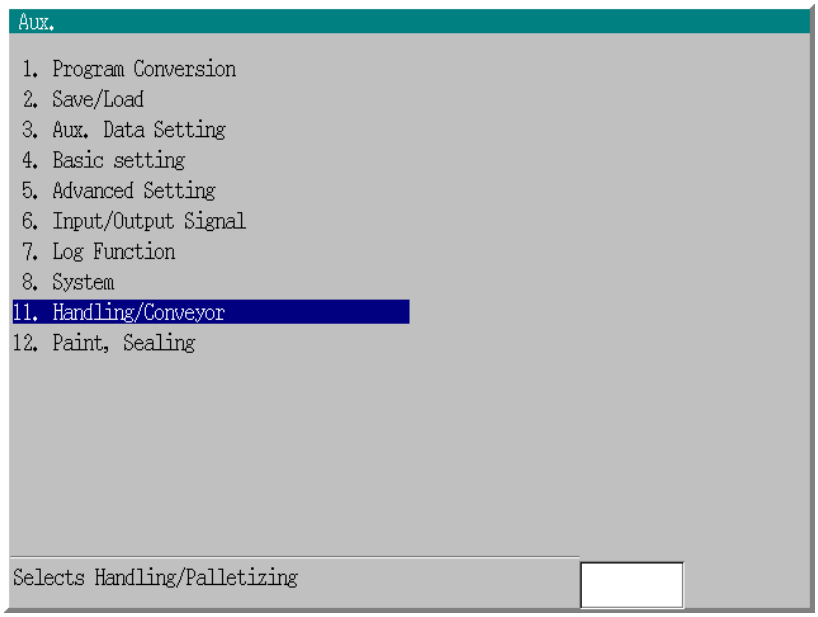
NOTE*** Describes the “distance between the reference position and the position defined by the maximum distance conveyor is allowed to move.”

H1.2 SETTINGS FOR OPERATING THE CONVEYOR SYNCHRONOUS FUNCTION

This chapter describes the procedures for setting necessary data for the conveyor synchronous operation.

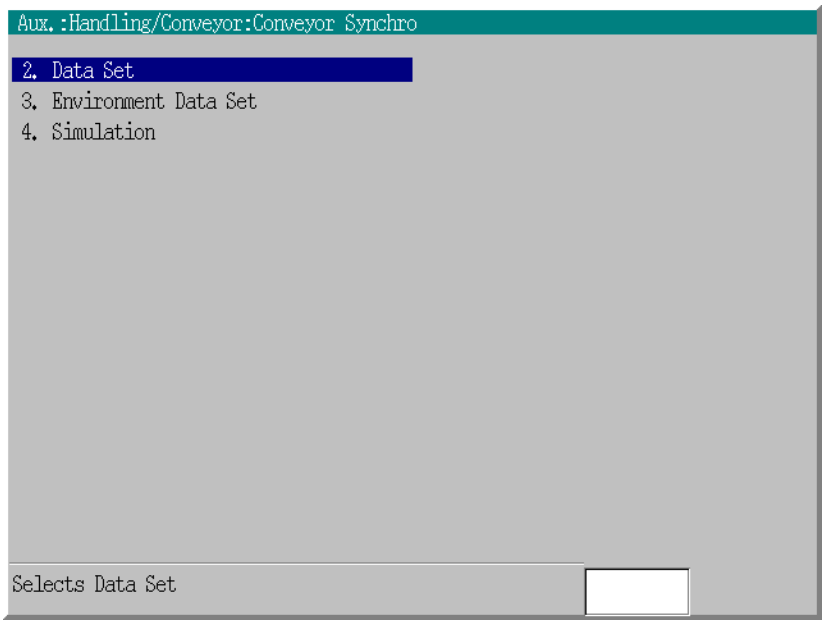
H1.2.1 SELECTING THE AUXILIARY FUNCTIONS FOR CONVEYOR SYNC.

1. Open the Aux. Function Screen using the teach pendant.



2. In the Aux. function screen, enter Auxiliary Number 1102 (Conveyor Sync.) using the NUMBER (0- 9) keys. Or, select [11. Handling/ Palletizing] and press ENTER. The list of functions in that group appears. Select [2. Conveyor Sync.] from that list and press ENTER.

3. The screen for Aux. 1102 Conveyor Sync. appears. Settings necessary for conveyor synchronous operation are done from this screen. Each function is described in details starting from page 3.


Aux.:Handling/Conveyor:Conveyor Synchro
2. Data Set
3. Environment Data Set
4. Simulation
Selects Data Set

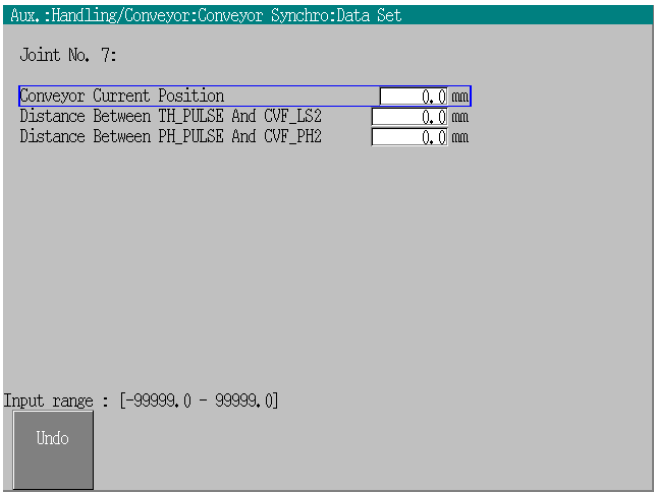
H1.2.2 DATA SETTING

In this function screen, position data for conveyor, CVF_LS2 (pseudo limit switch signal), and CVF_PH2 (pseudo phototube signal) are set.

1. Select [2. Data Setting] from the menu, and press ↵.

2. Select the axis number of the conveyor axis, and press ↵.

2. The screen below appears. Enter necessary values using NUMBER (0 – 9).



3. Press RESET to return to the menu screen for Aux. 1102 Conveyor Sync.

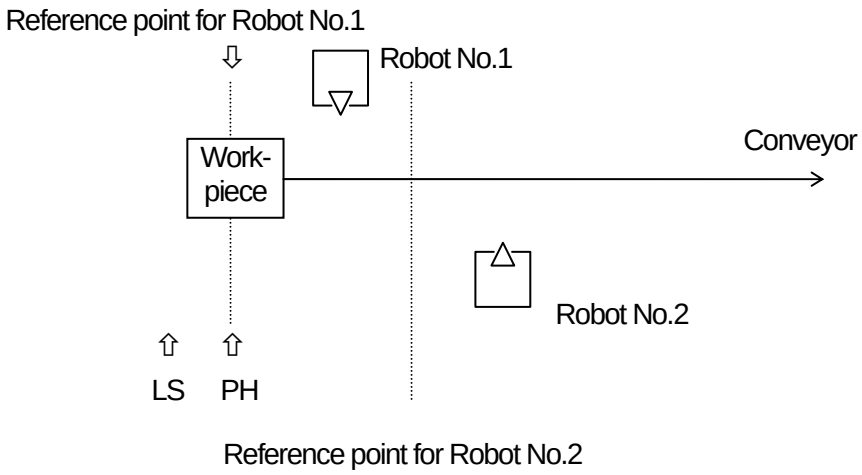
[NOTE]

1. To reset conveyor value, enter 0 for [Conveyor value].
2. When not using signals CVF_LS2 and CVF_PH2, distances do not need to be set.
3. When CVF_LS2 and CVF_PH2 are used, signals CVF_LS2, CVF_PH2, and PH_PULSE must be defined as software dedicated signals. Software dedicated signal settings are done in Aux. 2050, Aux. 2051 or by using AS language command DEFSIG.

H1.2.2.1 USING PH_PULSE, CVF_LS2, AND CVF_PH2 SIGNALS

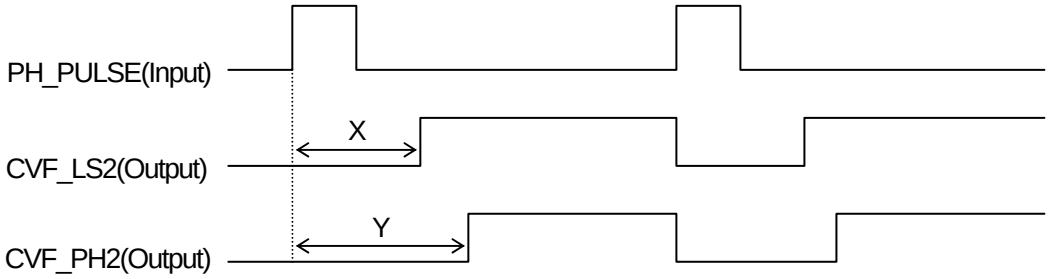
These signals are used in conveyor synchronous operations that employ more than one robot. CVF_LS2 and CVF_PH2 signals are pseudo (imaginary) signals generated from the robot instead of from actual phototubes and limit switches. Once the limit switch (LS) and phototube (PH) devices are installed to determine the first Reference point* for Robot No.1, these signals can be used to set the Reference points for all robots thereafter, thereby eliminating the need for actual LS and PH devices for each robot.

NOTE * Describes "the position of the representative point of a workpiece (front edge, center, etc.) at the moment the PH signal is input to the robot and the conveyor value is reset." The travel distance from the workpiece reference position is expressed as "workpiece position". For the conveyor, these positions are called conveyor reference position and conveyor position respectively.



Signals from the actual phototube and limit switch devices are input to the interlock panel as signals (for RPS-ON) for Robot No.1. For Robot No.2, after the PH signal for Robot No.1 (PH-PULSE) is input, instead of signals from an actual phototube and limit switch, pseudo phototube (PH) signal CVF-PH2 and pseudo limit switch (LS) signal CVF-LS2 are output from the robot according to the offset value between the two robots.

The signal time chart for these is shown below:



[NOTE]

X and Y represent the travel distance of the conveyor (workpiece) from the point where the actual phototube signal was output. (Unit: mm)

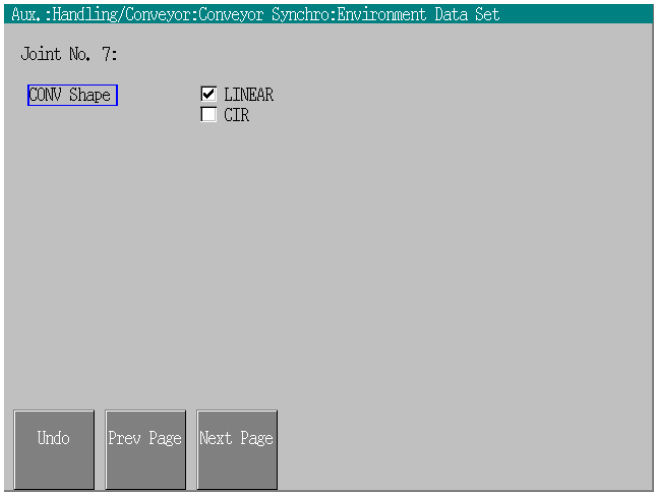
H1.2.3 ENVIRONMENT DATA SETTING

In this function screen, environment data for the conveyor are set.

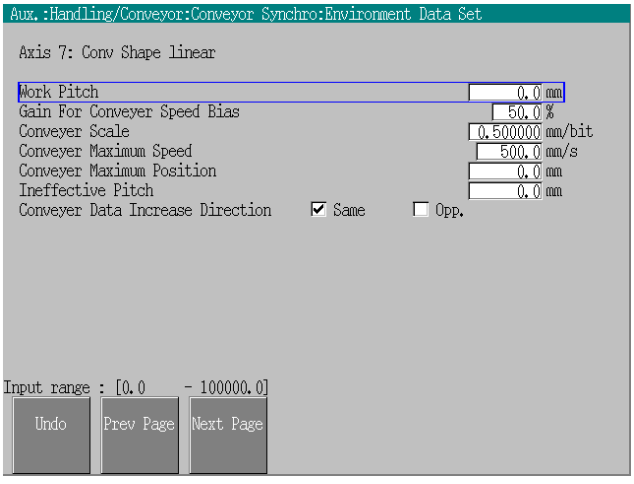
1. Select [3. Environment Data Setting] from the Conveyor Sync. function menu, and press ↵.

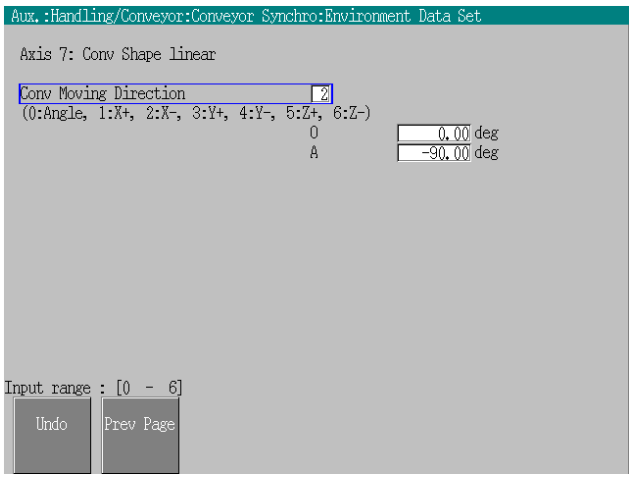
2. The screen below appears. Select the JT number set as the conveyor axis, and press ↵. (Normally select JT 7.)

3. Select the conveyor shape, and press ↵. (Normally select LINEAR.)



4. The following screen appears when [LINEAR] is selected. Enter the necessary values using NUMBER keys.





5. Press RESET to return to Aux. 1102 Conveyor Synchronization screen.

[NOTE]

In conveyor follow operations (using traverse axis), conveyor transfer direction cannot be changed. (Only X direction can be set.)

H1.2.3.1 WORKPIECE TRANSFER PITCH

Sets the distance between workpieces transferred on the conveyor (e.g. the distance between the front edge of a workpiece to the front edge of the next workpiece on the conveyor).

Setting the workpiece transfer pitch enables checking of the distance between workpieces, and eliminates any troubles that may arise when using phototubes/signals (malfunction, false detection, etc.).

If the phototube signal is input when the conveyor value is smaller than the value set here, workpiece transfer pitch error occurs. The phototube signal input remains effective.

H1.2.3.2 GAIN FOR CONVEYOR SPEED BIAS

Unless adjusted, the robot moves with the conveyor keeping steady-state velocity error. The gain is set to adjust this steady-state velocity error. Decreasing the gain increases the deviation. Increasing the gain decreases the deviation. The gain is set at 50% as default setting, and generally, should not need any adjustments.

Adjusting range for speed bias

Speed bias	Small(0) ← (50%) → Big(999.9 %)
Steady-state velocity error	Big ← → Small

⚠ CAUTION

The greater the bias, the greater the effect on the robot motion as the conveyor speed increases.

H1.2.3.3 CONVEYOR ENCODER RESOLUTION

Sets the distance of the conveyor transfers per one (1) bit of conveyor encoder signal. This is set in mm/bit.

H1.2.3.4 CONVEYOR MAXIMUM SPEED

When the conveyor surges, causing great changes in speed, the robot may move in a jerky motion as it tries to track the conveyor. To avoid this, the robot can be made to ignore sudden speed changes by setting a maximum speed here. The robot will ignore any speed exceeding this maximum speed. This setting does not affect the conveyor encoder value. Set the maximum speed at about twice the average speed. The default setting is 200 (mm/sec).

H1.2.3.5 CONVEYOR MAXIMUM VALUE

If the conveyor value exceeds the maximum value set here when executing step taught with "workpiece C (synchronize)", error "E1133 Conveyor has reached max. value position" is displayed and the motor power is turned OFF.

[NOTE]

1. Setting the conveyor maximum value to 0 mm disables this function.
   The default setting is 0 mm.
2. Initializing the system does not affect the conveyor maximum value setting.
3. When the conveyor maximum value is exceeded during conveyor operation,
   error message "E1133 Conveyor has reached max. value position" is displayed.

H1.2.3.6 CONVEYOR VALUE BELOW WHICH RESET IS NULLIFIED

After the first RPS-ON signal has been input, nullifies input of the next RPS-ON signal (no reset of conveyor encoder value) until the conveyor moves the distance specified here.

For example, in an operation that carries a workpiece by two hangers, unless specified otherwise, the RPS-ON signal is input for both the first hanger and the second hanger, when the program is repeated. By nullifying the input of RPS-ON signal for the second hanger with this distance setting, the two hangers are viewed as one hanger, thus enabling completion of the operation using a single program.

RPS-ON is always effective when the distance set here is zero (0).

H1.2.3.7 CONVEYOR VALUE INCREASE DIRECTION

Sets whether the conveyor encoder value increases when the conveyor moves in the set conveyor transfer direction or when it moves in the reverse direction.

⚠ CAUTION

In addition to these environmental settings above, set the actual conveyor speed via AS language CVSPEED monitor command.

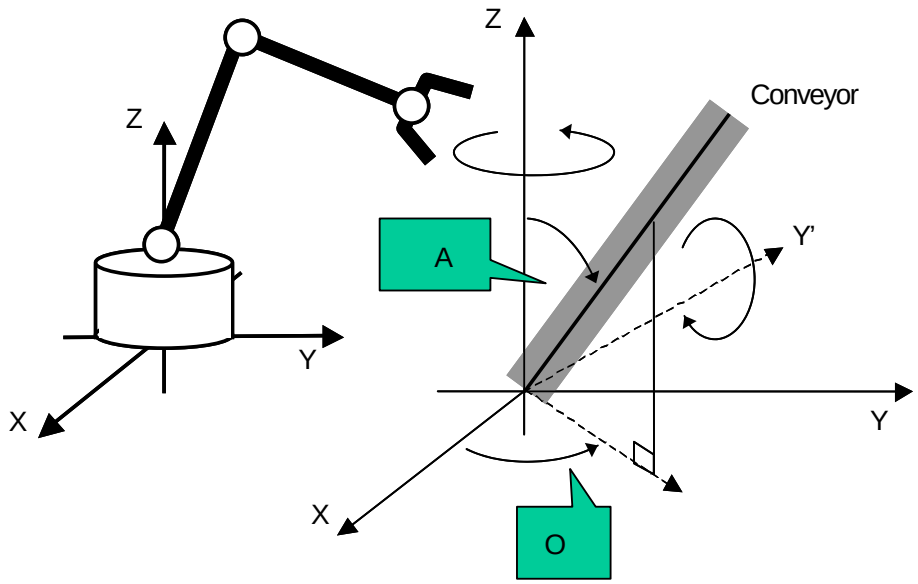
H1.2.3.8 CONVEYOR INSTALLATION INCLINATION (CONVEYOR SHAPE LINE)

Sets the transfer direction of linear conveyor by setting types 0 to 6.
O (°) is the rotation amount around base Z axis. A (°) is the rotation amount around Y axis (Y' axis) of the coordinate after it has been rotated.

There is no need to set the angles for O and A when Types 1- 6 are selected. The list below shows the relation between the type number (0- 6) set to [Conv Moving Direction] and Euler's angles O and A.

Setting Types	Conveyor transfer direction	O (°)	A (°)
0	Any	Any	Any
1	X+ direction	0	90
2	X- direction	0	-90
3	Y+ direction	90	90
4	Y- direction	90	-90
5	Z+ direction	0	0
6	Z- direction	0	180

When setting the conveyor direction to a random direction, input “0” for the setting type and enter the desired angles for O and A.



H1.3 SIMULATION FUNCTION

Simulation function allows checking of the conveyor synchronous operation by moving only the robot and not the conveyor.

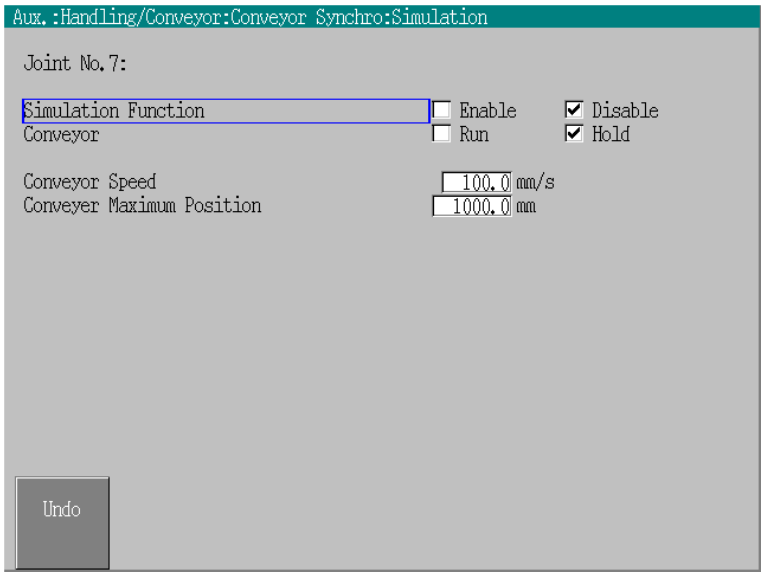
In this way, by simulating synchronous motion with the conveyor, the robot motion can be checked when no conveyor (encoder) is installed or when conveyor is not moving.

This function can be used to safely check the teaching for any sudden changes in wrist axis posture and to observe if the whole operation runs smoothly without trouble.

H1.3.1 SETTING THE SIMULATION FUNCTION

1. Select [4. Simulation] from the conveyor sync. menu and press ENTER.

2. The following screen appears. Enter the necessary values using NUMBER (0 – 9).



3. Press RESET to return to menu screen for Aux. 1102 Conveyor Sync.

H1.3.1.1 SIMULATION FUNCTION ENABLE/DISABLE

Selecting [Enable] activates the simulation function so that synchronous motion can be checked without moving the conveyor.

⚠ CAUTION

When simulation function is turned ON (enabled), the conveyor value is rest to zero.

H1.3.1.2 CONVEYOR RUN/ HOLD

When the simulation mode is ON (enabled), selecting [Run] starts the conveyor simulation and the conveyor value increases. Selecting [Hold] stops the conveyor simulation and the increasing of conveyor value.

H1.3.1.3 CONVEYOR SPEED

Sets the conveyor speed for simulation function. Unit is mm/sec.

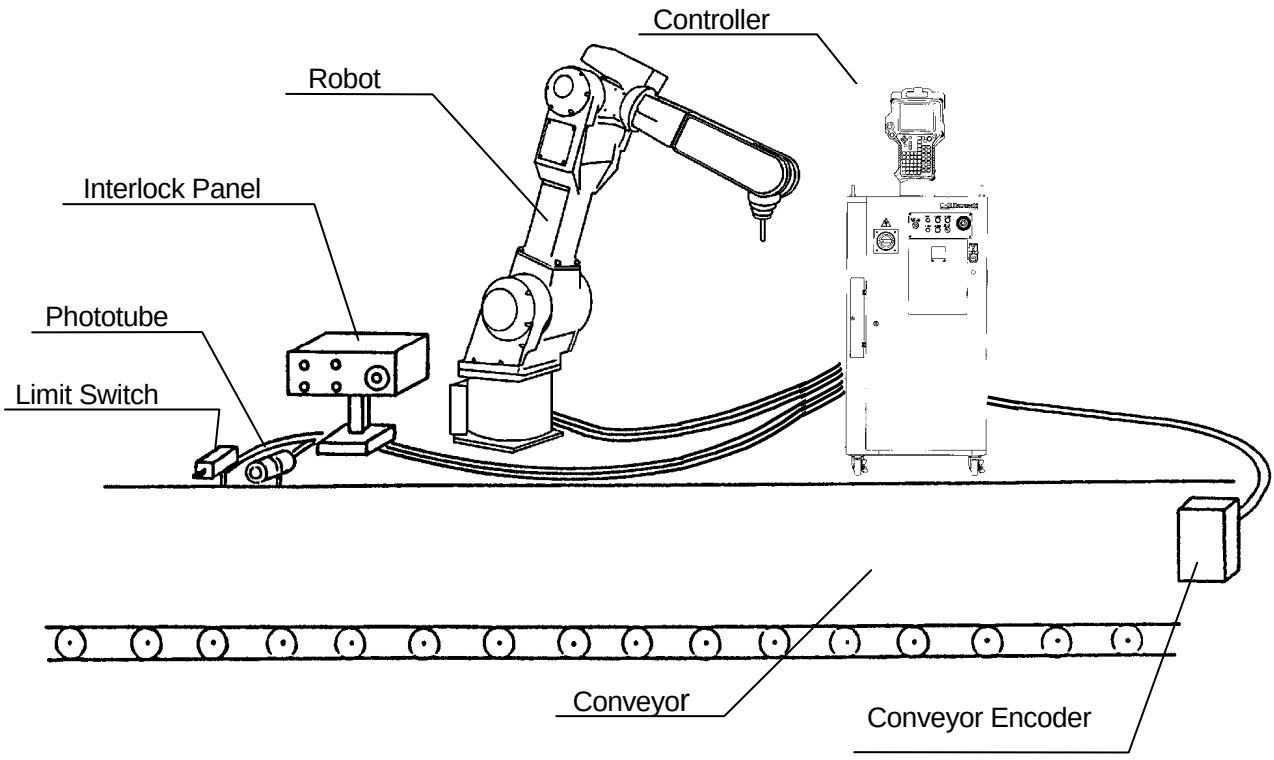
H1.3.1.4 CONVEYOR MAXIMUM VALUE

When the current value for the conveyor exceeds this value in simulation mode, “Out of range” error occurs. (Current conveyor value stops at this max. value when error occurs.)

H1.4 OVERVIEW OF TEACHING PROCEDURES

H1.4.1 SYSTEM CONFIGURATION FOR CONVEYOR SYNCHRONOUS OPERATIONS

System configuration as shown below is necessary to make the robot follow the workpiece using the conveyor synchronous function. (Both phototube and limit switch, or either one of them can be used).



H1.4.2 SETTING SYNCHRONOUS ZONE

When performing a conveyor synchronous operation, a synchronous zone must be set to ensure that the operations are performed correctly. The synchronous zone defines the acceptable limits for conveyor values, thus limiting and controlling synchronous motion of the robot. The conditions below should be satisfied when setting the synchronous zone, while taking in consideration other application conditions* such as workpiece area, cycle time, maximum conveyor speed, number of robots, block** etc.

NOTE* Robot simulators such as PC-ROSET should be used for testing such conditions before attempting actual motions.

NOTE** For operations including procedures that should be completed without pause in one continuous motion such as spray painting or application of sealant, divide the motion over the workpiece into several blocks. In this way, continuous motion can be set for each block, assuring quality of the result of the workpiece, even when the conveyor stops or changes speed, etc.

When Setting Synchronous Zone

For the robot to perform without trouble, set the synchronous zone of a workpiece or block in accordance with these conditions:

1. Continuous operation can be for the entire workpiece or block without pause even when the workpiece at the set maximum conveyor speed moves.
2. Continuous operation can be done for the entire workpiece or block without pause even when the workpiece stops anywhere within the synchronous zone.

Synchronous zones are set using Function instruction FN592.

H1.4.3 ROBOT MOTION RANGE

When teaching the conveyor synchronous function, set the motion range of the robot carefully.

1. The positional relation between the workpiece and robot differ between teaching and repeating. Therefore, “out of range” error may occur when the program is repeated.

2. When dividing the workpiece into blocks, determining the order of operations, and setting the synchronous zone, plan robot motion in consideration of conveyor speed and so that the robot operation and installation position relative to the workpiece fit within the desirable range.

H1.5 TEACHING PROCEDURES

This chapter demonstrates teaching of the conveyor synchronous operation using a painting application on a workpiece divided into two blocks.

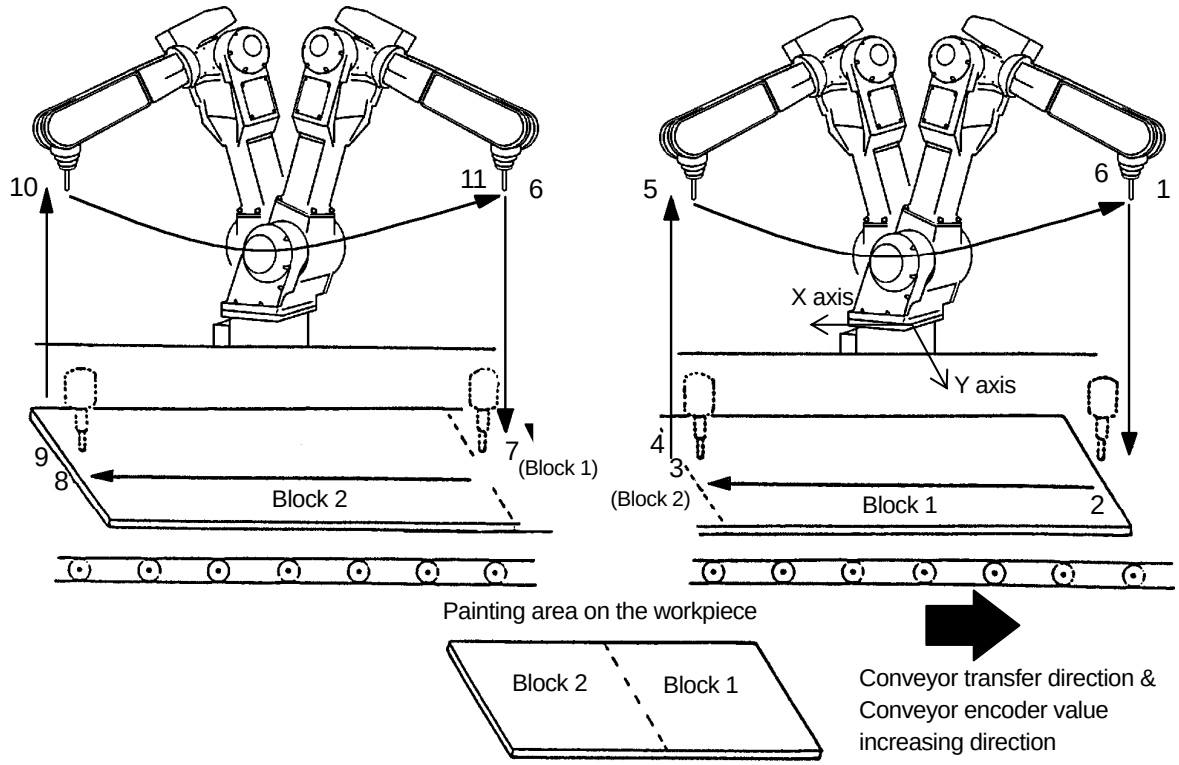
The tool transformation values for the paint gun to be used and program “pgl” for teaching this sample program are assumed to be already registered.

Since this example is for a painting application, GUN 1 and GUN 2 are used, but for handling operations, CLAMP 1 and CLAMP 2 are used.

Refer to the Operation Manual for details on teach pendant operation procedures.

H1.5.1 OPERATIONAL CONDITIONS IN SAMPLE PROGRAM

The motions shown below are executed by the robot.



Sample Program

Block	Teach point	Instructions
Block 1	1	Moves the gun tip to the point directly above the painting start point of Block 1 (stand-by pose).
	1	Sets the synchronous zone for Block 1.
	2	Moves the gun tip to the start position of the block.
	3	Turns ON GUN signal and moves gun tip to the spray stop position of Block 1.
	4	Turns OFF GUN signal.
	5	Moves gun tip to the escape position for Block 1.
	6	Returns gun tip to the stand-by pose.
Block 2	6	Sets the synchronous zone for Block 2.
	7	Moves the gun tip to the start position of the block.
	8	Turns ON GUN signal and moves gun tip to the spray stop position for Block 2.
	9	Turns OFF GUN signal.
	10	Moves gun tip to the retrieve position for Block 2.
	11	Returns gun tip to the stand-by pose.

The workpiece is divided into two blocks, and the synchronous zone is set for each block as follows:

Block 1: acceptable limit 100 mm -

Block 2: acceptable limit 500 mm -

Press FN button and set the synchronous zone by the function instruction FN592.

Set a limit switch and/or phototube at the beginning of the conveyor so that the workpiece can be detected. Process the limit switch (LS) and phototube (PH) signals in the interlock and input them as RPS ON signal to the robot.

H1.5.2 CREATING A PROGRAM SHEET

The auxiliary data are written as follows for this sample program.

Block	Step	Teach point	Inter-polation	Speed	Accu-racy	Timer	Tool	Work piece *	GUN1**	GUN2**	OX	WX	J/E
Block 1	1	1	Joint	9	3	0	1	0	OFF	OFF	-	-	-
	2	1	FN592 (100)										
	3	2	Linear	9	1	0	1	C	OFF	OFF	-	-	-
	4	3	Linear	3	1	0	1	C	ON	OFF	-	-	-
	5	4	Linear	9	1	0	1	C	OFF	OFF	-	-	-
	6	5	Linear	9	3	0	1	C	OFF	OFF	-	-	-
	7	6	Joint	9	3	0	1	C	OFF	OFF	-	-	-
Block 2	8	6	FN592 (500)										
	9	7	Linear	9	1	0	1	C	OFF	OFF	-	-	-
	10	8	Linear	3	1	0	1	C	ON	OFF	-	-	-
	11	9	Linear	9	1	0	1	C	OFF	OFF	-	-	-
	12	10	Linear	9	3	0	1	C	OFF	OFF	-	-	-
	13	11	Joint	9	3	0	1	0	OFF	OFF	-	-	End

NOTE* C is set for Workpiece when using synchronous function, 0 (default) is set for Workpiece when synchronous function is not used.

NOTE** In handling applications, GUN 1 and GUN 2 become Clamp 1 and Clamp 2, respectively.

H1.5.3 SETTING ENVIRONMENT DATA

The environment data shown in Aux. 1102-3 are set as below for this sample program:

1. Workpiece Transfer Pitch
   Set the distance between workpieces to 1000 mm.

2. Gain For Conveyor Speed Bias
   Set at 50 %. (default setting)

3. Conveyor Encoder Resolution
   Set at 0.5 mm/bit. (default setting)

4. Conveyor Transfer Direction
   Set along robot base X axis.

5. Positive Direction of Robot X Axis
   Set as opposite of the conveyor transfer direction. (Conveyor moves towards minus (-) direction of robot base X axis).

6. Conveyor Value Increase Direction
   Set as same direction as the conveyor transfer direction.

For more details on these settings, see section H1.2.3.

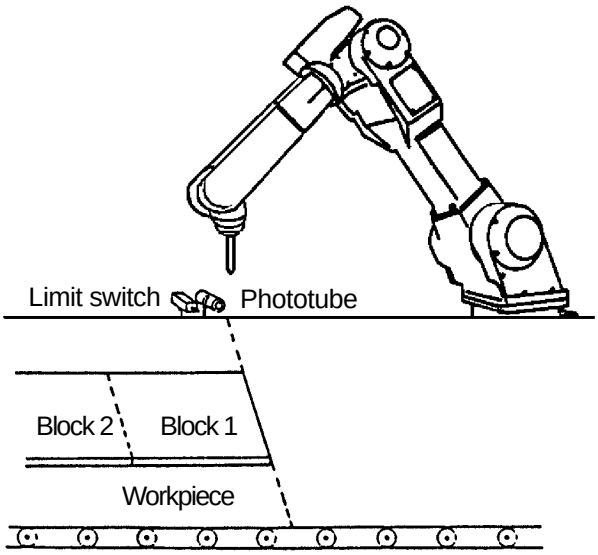
H1.5.4 TEACHING PROCEDURES

<Teaching Point 1>

For point 1, two steps are taught. The first step is to teach the starting pose of the operation (stand-by home pose). The second step is to set the synchronous zone for the conveyor synchronous operation in this program.

Step 1

1. First, the pose information for Pont 1 is taught. Press INTER (interpolation) key and select Joint mode for the manual operation mode.
2. Jog the robot using the +/– key so that the gun tip is directly above the point to start painting block 1, as shown below. Be careful so that Point 1 does not interfere with other workpieces.



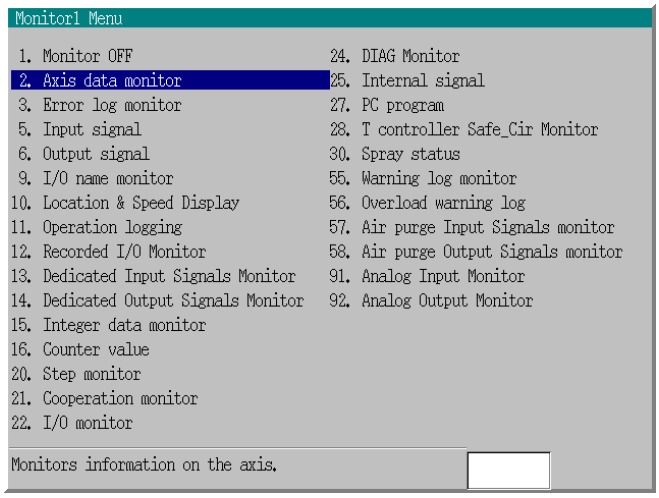
3. Turn ON the phototube signal at the beginning edge of the block, and reset the conveyor encoder.
4. Check that the conveyor encoder is reset to zero.

   Via AS language: use WHERE command.

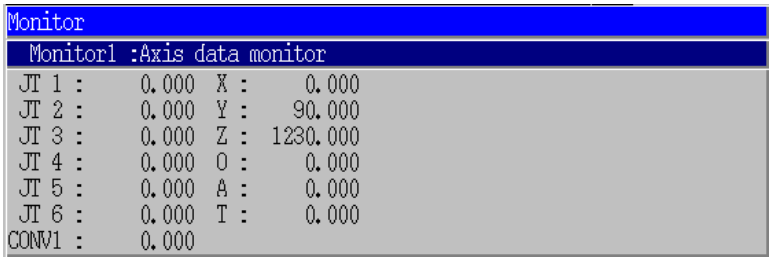
   Example >WHERE 1:21↵

Via Joint Monitor on teach pendant:

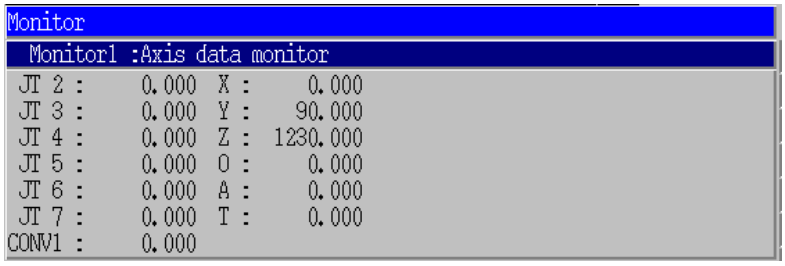
(1) Click <Monitor 1> on teach pendant screen, and select [Joint Monitor] from the menu.



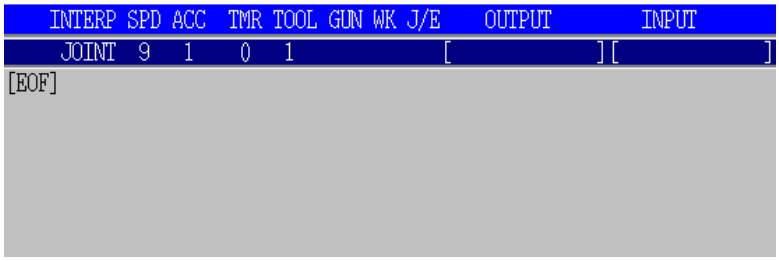
(2) When using 6-axis robot without traverse axis (in conveyor tracking), the conveyor value is displayed below JT6.



When using traverse axis (in conveyor follow), JT7 displays the value of the traverse axis, and the conveyor value is displayed below JT7.



5. If the conveyor encoder value is properly reset, set the auxiliary data. The setting should be as below. At this point, the robot is not synchronized with the conveyor, so workpiece is set to zero (0).



6. Press RECORD to register step 1.

Step 2

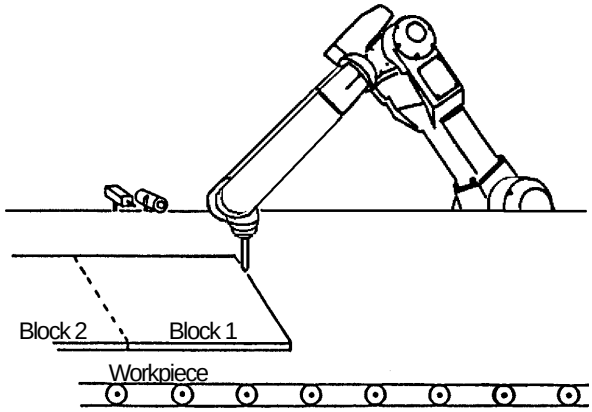
The second step (Step 2) for Point 1 is taught. In step 1, the robot still moves independently of the conveyor, but from the next point, the robot will move in conveyor synchronous motion. Therefore, the synchronous zone is taught in Step 2 by FN592 (100) after FN is pressed.

<Teaching Point 2>

The robot moves to the start point of the painting operation and starts to synchronize with the conveyor.

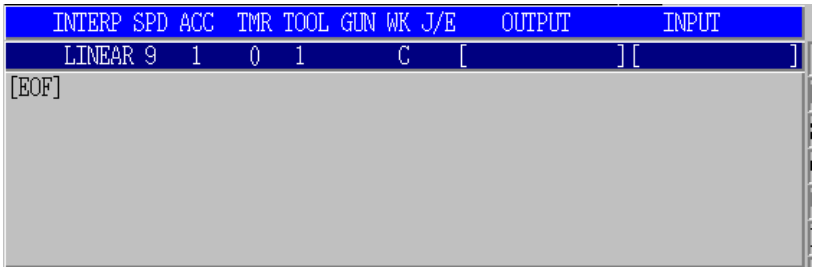
Step 3

1. Drive the conveyor to bring the workpiece to the position to start painting block 1.
2. Change the operation mode to Base mode by pressing INTER key.
3. Jog axes 1, 2, 3, and the traverse axis using +/– key to bring the robot to the start position.



4. Set the auxiliary data. Since this is the start point for the painting operation, set accuracy to 1 and interpolation to Linear.

5. Starting from this point, the robot should operate in conveyor synchronous operation, so set workpiece to C.



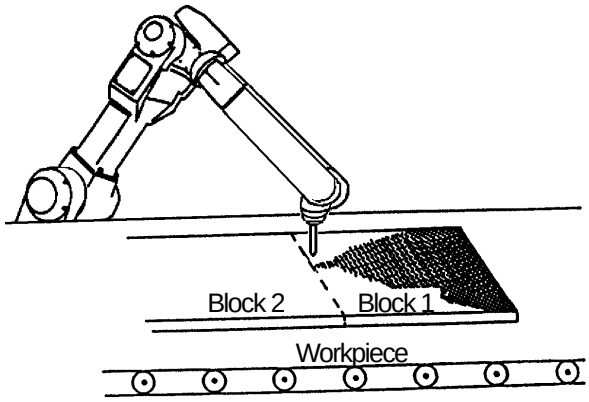
6. Pressing RECORD key registers the pose data and auxiliary data for Point 2.

<Teaching Point 3>

The robot moves to the end position as it paints Block 1.

Step 4

1. Move the conveyor to the position to end painting of Block 1.
2. The operation mode should be kept at Base mode. In base mode, jog axes 1, 2, 3, and the traverse axis to bring the robot to the end position.



3. Set the auxiliary data. The robot paints the workpiece as it moves to the end position of Block 1, so GUN signal should be ON. Pressing GUN1 key turns ON Gun 1.
4. Set the speed to 3.

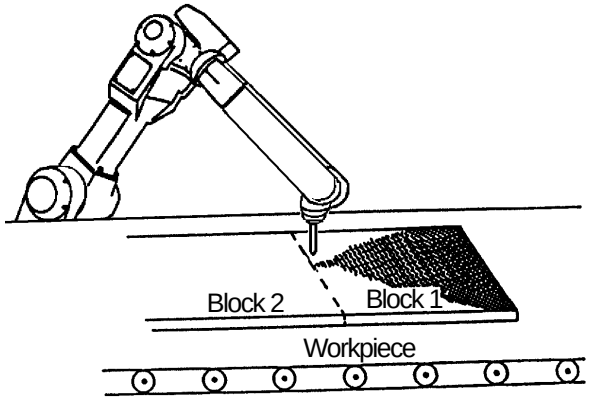
5. Pressing the RECORD key registers the pose data and auxiliary data for Point 3.

⚠ CAUTION

In conveyor tracking operation, the robot synchronizes with the conveyor while keeping the specified gun posture. However, with some posture, the wrist axis may make a sudden change, causing the robot to stop by error (sudden change in command value). If the gun must take such posture, examine the posture of the gun attachment to avoid such sudden changes of the wrist axis.

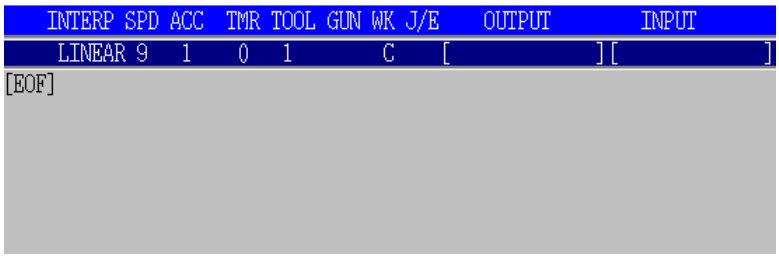
<Teaching Point 4>

The robot is at the end position of Block 1. The gun signal is turned OFF and the painting operation of Block 1 is finished. The pose data remain the same as in Step 4 (pose for Point 3). Only the auxiliary data are changed.



Step 5

1. Leave the conveyor synchronous function enabled (Workpiece C).
2. Press GUN1 key and turn OFF Gun 1 signal.



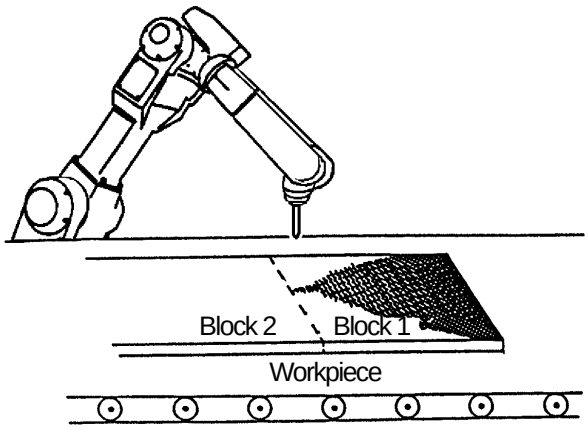
3. Pressing the RECORD key registers the pose data and auxiliary data for Point 4.

<Teaching Point 5>

The robot pulls away the arm from the workpiece while synchronizing with the conveyor. The conveyor is not moved at this step.

Step 6

1. The operation mode should be kept at Base mode. In base mode, jog axes 1, 2, 3, and the traverse axis to bring the robot to the position above the end position of Block 1(escape position).



2. Set the auxiliary data. Keep the conveyor synchronous function enabled, and change accuracy to 3.

3. Pressing the RECORD key registers the pose data and auxiliary data for Point 5.

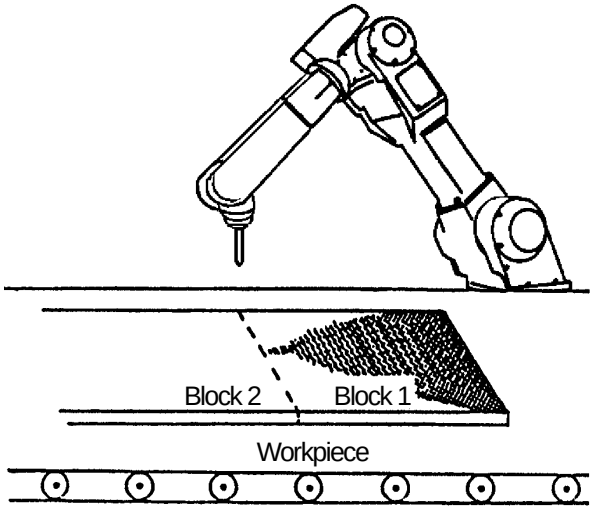
<Teaching Point 6>

The steps for Block 2 are taught starting at this point. Two steps are taught at Point 6. The first step (Step 7) teaches the stand-by pose for Block 2. The second step (Step 8) sets the synchronous zone for Block 2.

Step 7

1. Select Joint mode for the operation mode using INTER key.
2. Using +/– key, jog the robot so that the gun point comes to the stand-by point of Block 2 as shown below.
3. Set the auxiliary functions. Select [JOINT] for interpolation mode. The rest remains the same as the step before.

4. Pressing the RECORD key registers the pose data and auxiliary data for Point 6.



Step 8

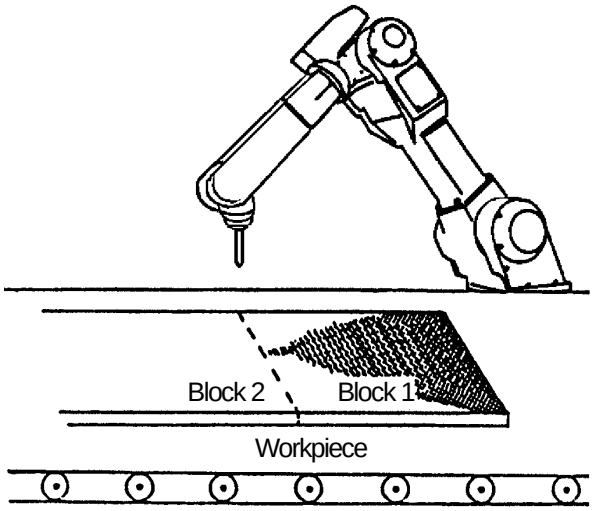
From Point 6, the robot will move in conveyor synchronous motion painting Block 2. Therefore, synchronous zone for Block 2 is taught in this step by FN592 (500) after FN is pressed.

<Teaching Point 7>

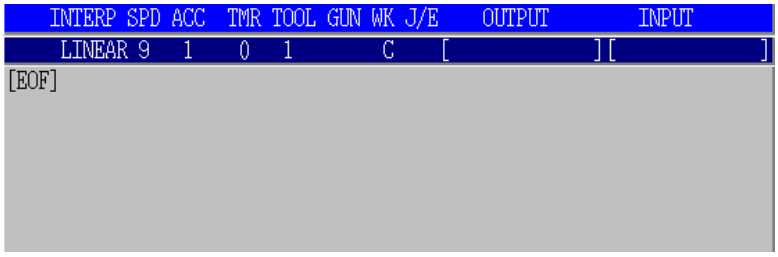
The robot moves to the starting point of Block 2 and starts to synchronize with the conveyor as in Step 3.

Step 9

1. Drive the conveyor to bring the workpiece to the position to start painting Block 2.
2. Select Joint mode for operation mode using INTER key.
3. Jog axes 1, 2, 3, and the traverse axis and move the arm to the start point of Block 2.



4. Set the auxiliary data. Since this point is the start point for the painting operation, change accuracy to 1.
5. Set workpiece to C to start synchronizing with the conveyor.



6. Pressing the RECORD key registers the pose data and auxiliary data for Point 7.

<Teaching Points 8, 9, 10>

Block 2 is painted by the same procedure as Block 1.

Step 10 (Point 8)

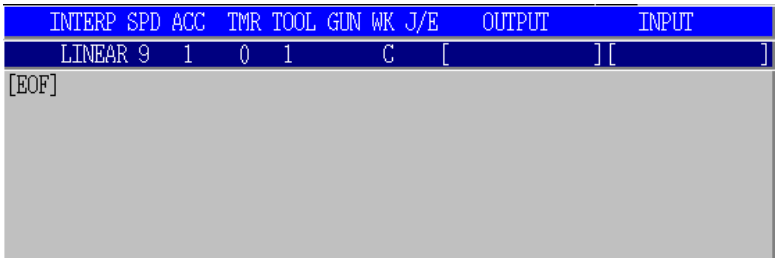
The robot moves to the end position as it paints Block 2.

1. Drive the conveyor to bring the workpiece to the position to end painting of Block 2.
2. In Base mode, jog axes 1, 2, 3, and the traverse axis to bring the robot to the end position of Block 2.
3. Turn ON Gun 1 signal.
4. Set speed to 3.

Step 11 (Point 9)

The robot turns OFF the gun signal at the end point of Block 2 and ends painting of Block 2.

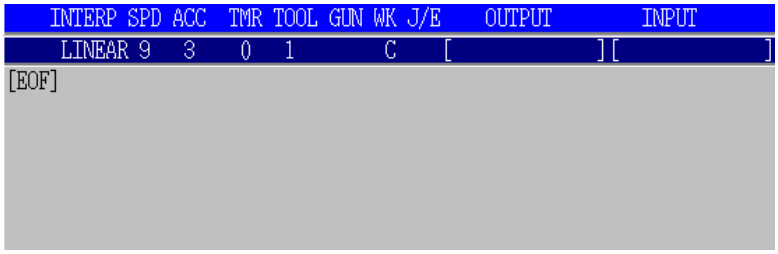
1. Leave the pose data unchanged.
2. Turn OFF Gun 1.
3. Workpiece is still kept at C.



Step 12 (Point 10)

The robot pulls the arm away from the workpiece while synchronizing with the conveyor. The conveyor is not moved at this step.

1. In base mode, jog axes 1, 2, 3, and the traverse axis to bring the robot to the position above the end position of Block 2 (escape position).
2. Set accuracy to 3.
3. Leave workpiece as C.



<Teaching Point 11>

The painting of Blocks 1 and 2 is finished. Now, the program is terminated and the robot returns to the first position (stand-by home pose).

Step 13

1. Set E (End) for J/E in the auxiliary data.
2. Synchronization with conveyor is no longer necessary so workpiece is set to 0.

3. Pressing the RECORD key registers the pose data and auxiliary data for Point 11.

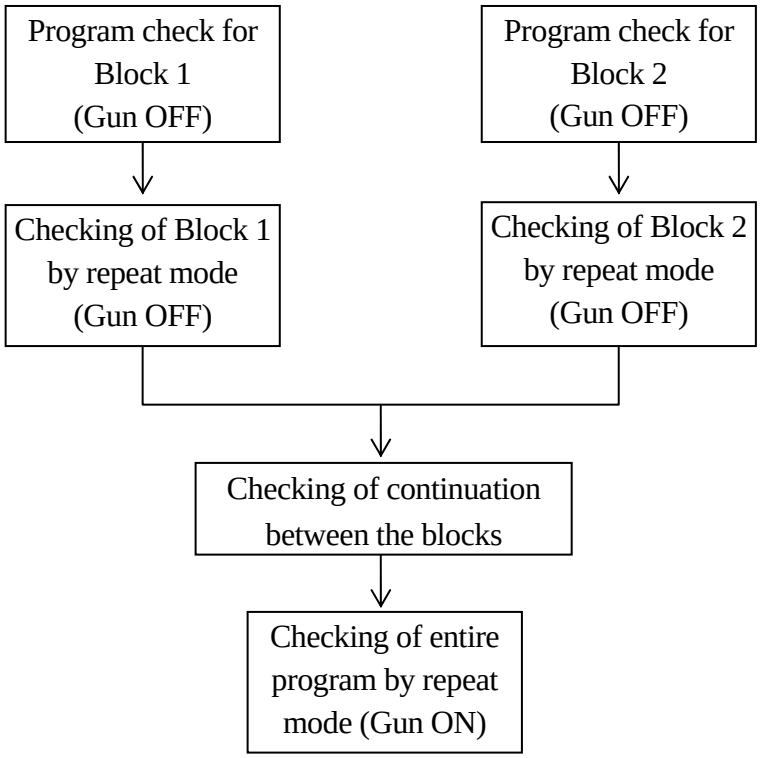
This completes the teaching procedures for painting application using the conveyor synchronous function.

H1.6 CHECKING AND REPEATING PROGRAMS

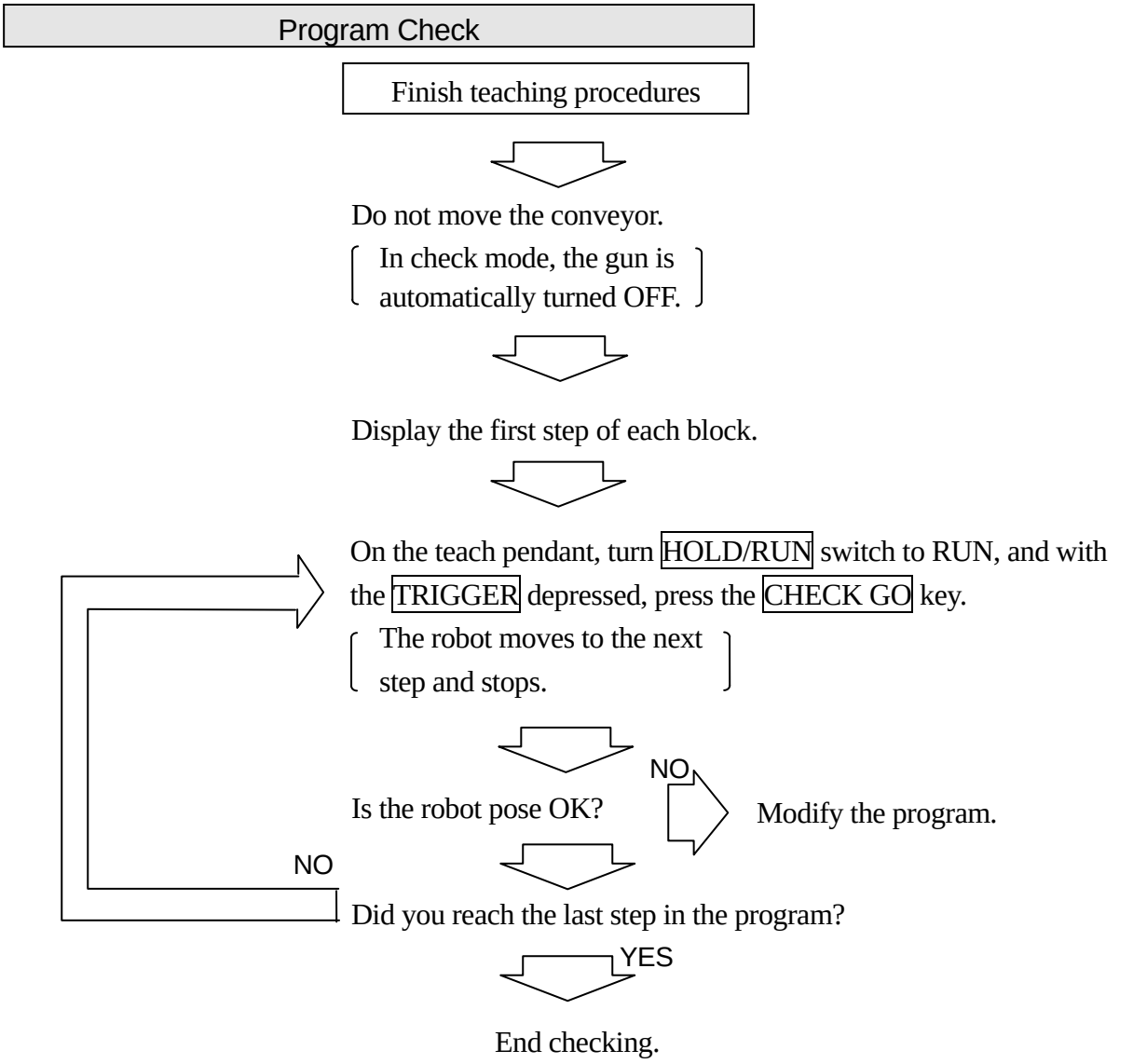
H1.6.1 OVERVIEW OF CHECKING PROCEDURE

Check the contents and motion of taught programs using the CHECK GO and CHECK BACK keys, and by repeating the program at slow speed in repeat mode. This chapter explains the checking procedures using the program taught in H1.5 Teaching Procedures.

Checking Procedures



H1.6.2 PROCEDURAL FLOWCHART FOR CHECK AND REPEAT OPERATIONS



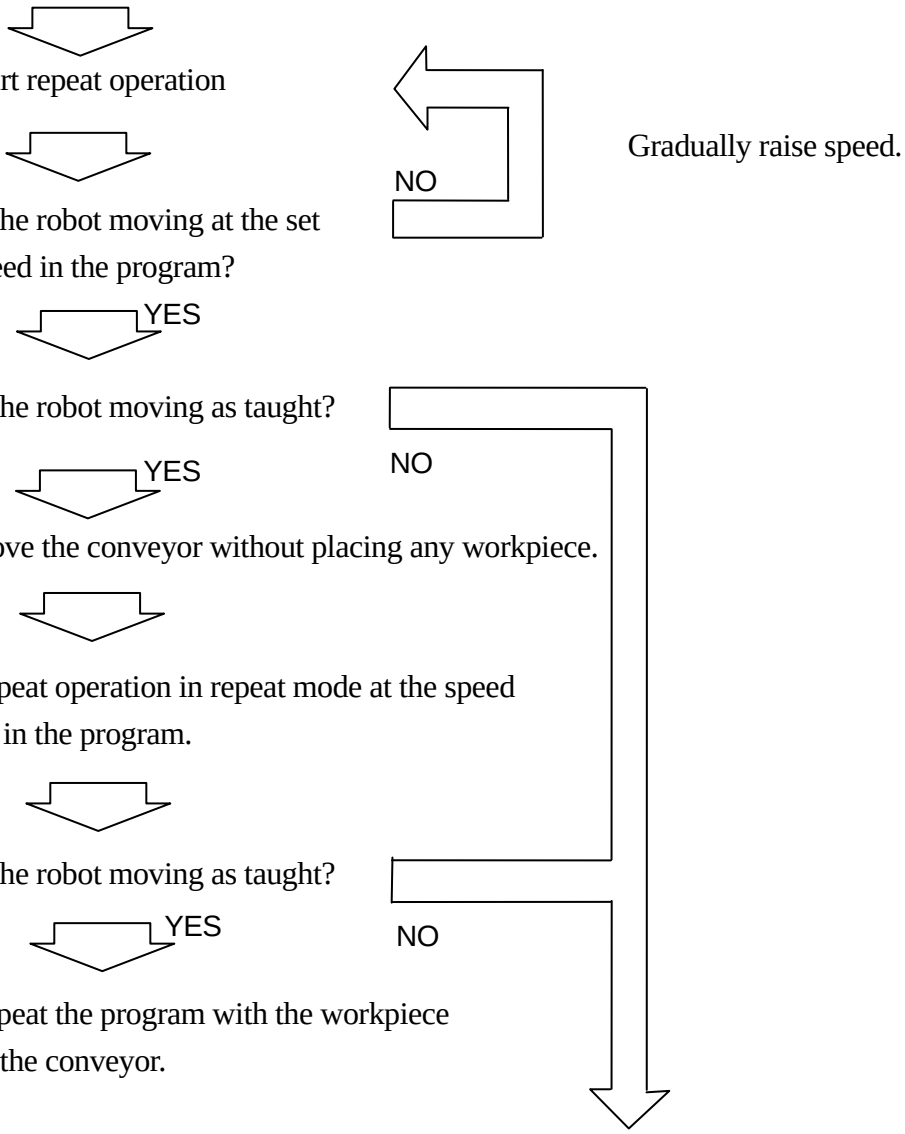
Using the procedure described above, check both blocks.

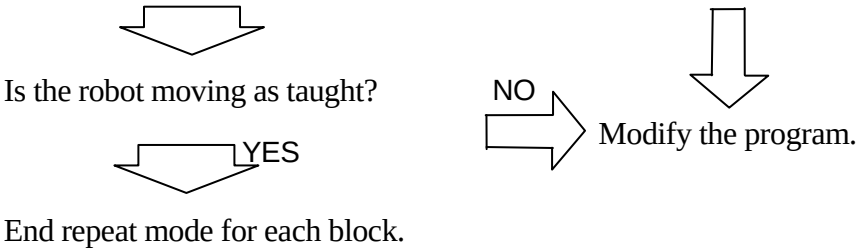
Checking Robot Motion for each Block in Repeat Mode

Before operating the robot in repeat mode, confirm that the below items are set correctly in Aux. 1102, and fix any improper settings before proceeding to operate in repeat mode.

- Current Conveyor Value
- Workpiece Transfer Pitch
- Conveyor Encoder Resolution
- Conveyor Maximum Speed
- Positive Direction of Base X/Y Axis
- Conveyor Encoder Value Increase Direction

1. Do not move conveyor. The workpiece should be stationary within the synchronous zone.
2. Switch the mode to repeat mode.
3. Set the repeat speed to a low speed.




Is the robot moving as taught?
NO
Modify the program.
YES
End repeat mode for each block.

Checking the continuation between the blocks using Repeat Mode

Do not move the conveyor.

Move the workpiece to the position past the start position of synchronous zone (over 100 mm from the start point) for Block 1.

Display the first step of Block 1 (Step 1).

Run the program using CHECK GO key to the last step for Block 1 (Step 7).

Drive the conveyor while depressing the TRIGGER switch on the teach pendant.

Is the robot in stand-by status for synchronous operation with the conveyor?

NO → Modify the program as necessary.

YES

Move the workpiece to the position past the start position of the synchronous zone (over 500 mm from the start point) for Block 2.

Does the robot move and execute the operation for Block 2 (Step 8)?

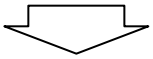
NO → Modify the program as necessary.

YES

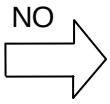
End checking of continuation between the two blocks.

Checking the Program by Repeating the Entire Program

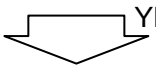
1. Place on the conveyor the workpiece divided into Blocks 1 and 2.
2. Change the mode to repeat mode.
3. Start the conveyor.



Actually operate the gun and check the painting results.
Is it OK?



Modify the program.

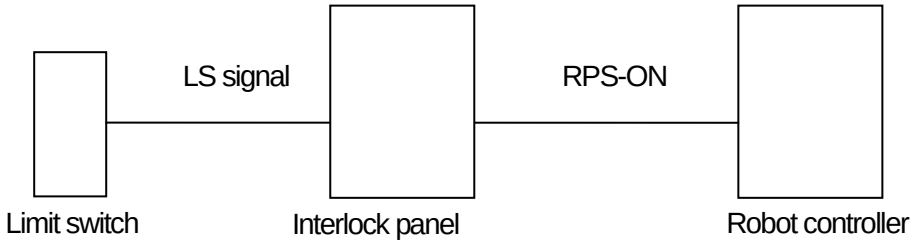


End of all program checks.

H1.7 INTERLOCK SIGNALS

In conveyor synchronous operation, input of RPS-ON signal (enabling of external program input) to the robot selects the program and resets the conveyor value.

The diagram below is an example of connection using the interlock signal. (Phototube is not used in this example.)



⚠ CAUTION

Program selection occurs only when RPS-ST signal is output (see External I/O manual for details), but conveyor value is reset every time RPS-ON signal is input.

H1.8 LIST OF CONVEYOR SYNCHRONOUS FUNCTION SETTING PROCEDURES

Operation	Procedure		
To display the current joint values incl. conveyor axis	Display the Monitor1 menu	⇨	Select 2nd axis monitor
To display the current XYZOAT values incl. conveyor axis	Display the Monitor1 menu	⇨	
To display the current conveyor encoder values incl. conveyor axis	Display the Monitor1 menu	⇨	Select 10-5. Encoder
To display the speeds for each axis incl. the conveyor speed.	Display the Monitor1 menu	⇨	Select 10-6. Joint Speed
To display the command values for each axis excl. conveyor axis	Display the Monitor1 menu	⇨	Select 10-3. Command
To display the deviation between the command value and current value for each axis excl. conveyor axis	Display the Joint Monitor	⇨	Select 10-4. Envelope (Position Envelope Error)
To reset the current conveyor value	Select Aux. 1102 Conveyor Synchronous 2 Data Setting	⇨	Set the current conveyor value to 0.
To set the current conveyor value	Select Aux. 1102 Conveyor Synchronous 2 Data Setting		Enter the desired values
To set the distance between workpieces transferred on conveyor	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Workpiece Transfer Pitch
To set conveyor speed bias	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Gain For Conveyor Speed Bias
To set conveyor encoder resolution	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Conveyor Encoder Resolution
To set the maximum conveyor speed	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Conveyor Maximum Speed
To set conveyor maximum value for online operations	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Conveyor Maximum Value
To set the limits to nullify the reset signal	Select Aux. 1102 Conveyor Synchronous 3 Environment Data Setting	⇨	Select Conveyor value below which rest is nullified

Operation	Procedure		
To set whether the conveyor transfer direction is parallel to the base x or Y axis.	Select Aux. 1102 Conveyor Synchronous 3 Environment data setting	Select Conveyor Transfer Direction	Select X or Y
To set whether the positive direction of the conveyor transfer direction is the same or reverse with the positive direction of base X (Y) axis	Select Aux. 1102 Conveyor Synchronous 3 Environment data setting	Select Positive Direction Of Base X/Y	Select Same or Opp(osite)
To set whether the conveyor encoder value increase direction is the same or reverse with conveyor transfer direction	Select Aux. 1102 Conveyor Synchronous 3 Environment data setting	Select Conveyor Encoder Value Increase Direction	
To enable simulation function	Select Aux. 1102 Conveyor Synchronous 4 Simulation	Select Simulation Function	Select Enable
To disable simulation function	Select aux. 1102 Conveyor Synchronous 4 Simulation	Select Simulation Function	Select Disable
To operate the conveyor in simulation mode	Select aux. 1102 Conveyor Synchronous 4 Simulation	Select Conveyor	Select Run
To stop the conveyor in simulation mode	Select aux. 1102 Conveyor Synchronous 4 Simulation	Select Conveyor	Select Hold
To set the conveyor speed in simulation mode	Select aux. 1102 Conveyor Synchronous 4 Simulation	Select Conveyor Speed	Enter the desired values
To set maximum conveyor value in simulation mode	Select aux. 1102 Conveyor Synchronous 4 Simulation	Select Conveyor Maximum Value	

REFERENCE 1 AS LANGUAGE LIST FOR CONVEYOR SYNCHRONOUS OPERATION

Name	Function		Parameter
CVSET	Sets the current conveyor position.	M	robot number
CVSET	Same as above.	P	current value
CVRESET	Resets current conveyor position to zero.	M	robot number
CVRESET	Same as above.	P	
CVXYSIGN	Sets whether if conveyor is parallel with the robot base X or Y axis and whether if the positive direction of that base axis is in the same or opposite of the conveyor transfer direction.	M	robot number
CVXYSIGN	Same as above.	P	setting 1*, setting 2*
CVSCALE	Sets the resolution for conveyor encoder.	M	robot number
CVSCALE	Same as above.	P	resolution
CVENCSIGN	Sets the transfer direction of the conveyor that increases the conveyor encoder value.	M	robot number
CVENCSIGN	Same as above.	P	setting*
CVMAXSPD	Sets the maximum speed of the conveyor.	M	robot number
CVMAXSPD	Same as above.	P	speed
CVGAIN	Adjust the delay amount of the robot motion from the conveyor motion.	M	robot number
CVGAIN	Same as above.	P	gain
CVPITCH	Sets the distance (pitch) between workpieces on the conveyor.	M	robot number
CVPITCH	Same as above.	P	distance
CVFNONPITCH	Nullifies input of RPS-ON signal until the conveyor moves the specified distance.	M	robot number
CVFNONPITCH	Same as above.	P	distance
CVFLS2	Delays the output of pseudo limit signal from the robot until the conveyor moves the specified distance.	M	robot number
CVFLS2	Same as above.	P	distance
CVFPH2	Delays the output of pseudo phototube signal from the robot until the conveyor moves the specified distance.	M	robot number
CVFPH2	Same as above.	P	distance
CVFMAX	Sets the maximum conveyor value when the conveyor and the robot are connected online.	M	robot number
CVFMAX	Same as above.	P	distance
CVSMAX	Sets the maximum conveyor value for simulation mode.	M	robot number
CVSMAX	Same as above.	P	distance
CVSPEED	Sets the conveyor speed for simulation mode.	M	robot number
CVSIMU	Checks the conveyor synchronous operation using the simulation mode.	M	robot number

CVSWITCH	Runs/holds the conveyor in simulation mode.	M	robot number
CVWAIT	Holds the program execution until the conveyor reaches the specified position.	P	start position, limit position
CVLMOVE	Moves in linear interpolated motion while synchronizing with the conveyor.	P	pose name, gun number
CVC1MOVE	Moves in circular interpolated motion while synchronizing with the conveyor (midway point of the circular trajectory).	P	pose name, gun number
CVC2MOVE	Moves in circular interpolated motion while synchronizing with the conveyor (end point of the circular trajectory).	P	pose name, gun number
CVLAPPRO	Approaches the specified pose in linear interpolated motion.	P	pose name, distance
CVLDEPART	Pulls away from the current pose in linear interpolated motion.	P	distance
CVDELAY	Stops the robot motion seen from the conveyor, for the specified amount of time.	P	time
CVHMOVE	Moves to the specified pose while synchronizing with the conveyor, in linear interpolated motion and equally dividing the motion of the wrist axis.	P	pose name, gun number
WHERE	Displays the current robot pose including the conveyor axis.	M	display mode

NOTE* These parameters specify X/ Y axis or the direction with 0 or 1.

Parameter marked with can be omitted.

M : Monitor Command, P : Program Instruction

REFERENCE 2 ERROR LIST FOR CONVEYOR SYNCHRONOUS OPERATION

Error Code	Message	Note
E1047	Axis number is not for conveyor follow mode.	Error occurs if the conveyor axis number is set inappropriately, e.g. the same number as the traverse axis number or an axis number not available for conveyor follow has been set.
E1133	Conveyor has reached max. value position.	Error occurs if the conveyor reaches the conveyor maximum value during execution of a robot program.
E1134	Abnormal workpiece transfer pitch of conveyor.	Error occurs if signal for resetting conveyor value is input before the conveyor reaches the position specified by the workpiece transfer pitch.
E1140	No conveyor axis.	Error occurs when trying to operate in conveyor synchronous function without preparing a conveyor axis.
E1141	Conveyor transfers beyond sync. zone.	Error occurs if, at time of execution of CVWAIT instruction, the workpiece on the conveyor has already been transferred beyond synchronous zone set via that instruction.
E1142	No traverse axis.	Error occurs if conveyor follow mode is set without a traverse axis. Conveyor follow is only possible by using a traverse axis. (Conveyor follow function synchronizes robot and conveyor motion using a traverse axis.)
E1143	Conveyor axis number is not set.	Error occurs if the axis number specified has not been set as the conveyor axis.

H2.0 MUTUAL WAIT FUNCTION

This chapter describes procedures for applying and operating the mutual wait function, and the related information.

H2.1 OVERVIEW OF THE FUNCTION

The mutual wait function is useful for preventing interference among several robots during operations. This function can be used when the robot network function (option) is set effective among robots connected by Ethernet.

H2.1.1 MUTUAL WAIT FUNCTION

Robots can wait for each other at the specified step of a program. If one robot reaches the mutual wait step, it can be programmed to wait until another robot reaches that step, by adding MUTUAL WAIT instruction to a step in each robot's programs.

H2.2 SET-UP

Mutual wait function is activated using software in the robot controller and the Ethernet option. Various data in the software needs to be set before this function can be used. This section describes procedures for introducing and installing. This manual only describes this specific function, for details on standard functions and operations, see the below manuals:
Installation and Connection Manual for Controller,
Installation and Connection Manual for Arm,
Troubleshooting Manual, etc.

H2.2.1 INSTALLING ROBOTS

Follow the Installation and Connection Manual for Arm, a separate volume, for installing robots.

H2.2.2 WIRING

For general methods and precautions for wiring/connecting the robot controller, see Installation and Connection Manual for Controller, a separate volume. This manual only describes the wiring and connections necessary for the mutual wait function.

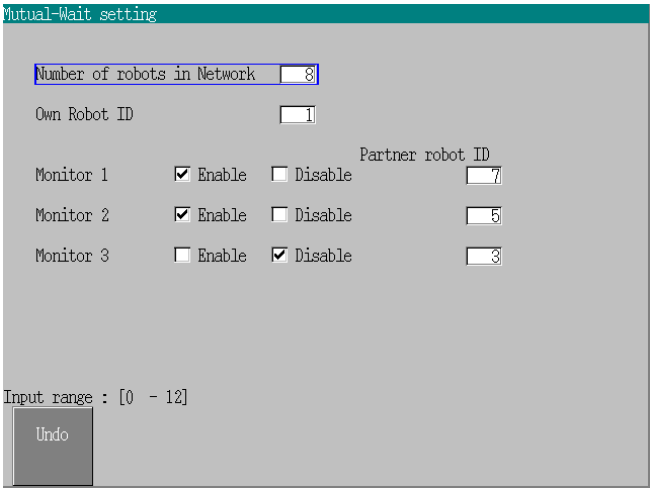
H2.3 DATA SETTING FOR SOFTWARE

This section explains software data settings necessary for using the mutual wait function.

H2.3.1 COMMUNICATION SETTING BETWEEN SYNCHRONIZING ROBOTS

1. Setting robot network function

Robot network function is used for communication among robots. For robots using mutual wait function, the robot network option is set effective at factory shipment. But it is necessary to set the software data before communication can begin. After wiring and connecting are complete (see H2.2.2 Wiring), set the following in all the connected robot controllers via A.-816 Mutual Wait Setting.



1. Select A.-816 Mutual Wait Setting from the standardized teach pendant.

2. Set the following items. See the descriptions below for details.
[Number of robots in Network]
[Own Robot ID]
[Monitor 1-3]

[Number of robots in Network]

Sets total number of robots which are connected to robot network. Set 2 when two controllers are connected directly by twisted pair cross-cable. When connecting via a common hub, set the number of controllers connected to that hub. Max. 12 controllers can be connected.

[Own Robot ID]

Sets ID Nos. to each robot connected to the network. Allocate a different ID number to each robot starting from ID=1, ID No. cannot exceed total number of connected robots. If connecting two robots directly, their ID numbers must be set ID=1 and ID=2. Error “E6022 Duplicate Mutual-Wait IDs.” occurs when the same ID is set.

[Monitor 1-3]

Mutual wait can be performed with a max. of 3 robots connected to robot network. Set [CONN.] for [CONN./DISCONN.] and robot ID No. If connecting two robots directly, use only [Monitor 1].

Error “E6023 Communication error in Mutual-Wait.” occurs during setting of the robot network but this is not abnormal. Reset this error after all the robots have been set.

2. Checking robot network function

Confirm that the robot network communication is functioning properly.

Use ROBNETCHECK command to display the connection status of robots in the same network.

```
>ROBNETCHECK 1:↵
  No.  Connect  ROBOTID  Serial No.
-------------------------------------------------------
   0       o        1       301
   1       o        2       302
   2       x        -        -
   3       o        4       304
```

In this example four robots are registered to the network but only three robots are currently connected. No.0 represents the robot connected to this controller, in this example its ROBOTID is 1. Status for the other robots is shown in No.1, 2, and 3. The robot whose No. is 3 is currently not connected to the network, note that ROBOTID number is not displayed when robot is disconnected.

H2.4 FUNCTION

H2.4.1 MUTUAL WAIT FUNCTION

By using this function, robots connected by network can be made to wait at program steps taught with the mutual wait function. Robots wait until all robots arrive at steps taught FN591. Any monitor number (1-3) can be specified as the <wait-number> in FN591, assuming the monitor number was first dedicated with a Robot ID number in A.-816 Mutual Wait Setting.

H2.4.1.1 ADDING MUTUAL WAIT INSTRUCTION

Insert a MUTUAL_WAIT instruction (FN No. 591) at the point where the robots wait in program. To add or change FN instructions, see 4.4 Function Instruction.

```
FN591 <wait-number>
```

In <wait-number>, input monitor number 1-3 set in A.-816 to specify the robot for mutual wait.

H2.4.1.2 DISABLING MUTUAL WAIT FUNCTION

To disable mutual wait function to allow robots to move to the next step, set [DISCONN.] for [CONN./DISCONN.] in the desired [Monitor 1-3] in A.-816.

Or, setting MODE SELECT switch to OFF for a robot causes partner robots to ignore the mutual wait step and to proceed to the next step. For example, to check operation of only one robot, set MODE SELECT to OFF on the partner robots.

⚠ WARNING

The robot does not wait at points specified for synchronizing operations while mutual wait function is disabled. For safety, reset [CONN./DISCONN.] to [CONN.] anytime mutual wait does not require disabling.

H2.5 ERROR HANDLING

This section deals with the error messages and information about errors particular to the robot network function, which is used in mutual wait function.

1. E6021 Communication error in robot network.

Cause:
Communication between robots is not normal.

Countermeasures:
Confirm the connecting cable and mutual-wait settings of the robots.

2. E6022 Duplicate Mutual-Wait IDs.

Cause:
Robot ID and mutual-wait ID are duplicated.

Countermeasures:
Change the mutual-wait ID by MUTUALID Command.

3. E6023 Communication error in Mutual-Wait.

Cause:
Mutual-wait settings of one robot are enabled and those of partner robot are disabled.

Countermeasures:
Make the settings of mutual-wait connection of both robots to be enabled.

H2.6 OTHER SPECIAL NOTES

Turning the control power of one robot ON with robot network in effect causes an error “E6023 Communication error in Mutual-Wait.”, if the control power of the other robot is not ON. Reset the error after turning the control power ON for both robots.

H3.0 DEDICATED SIGNALS FOR PAINTING

This section describes dedicated signals added for painting application.

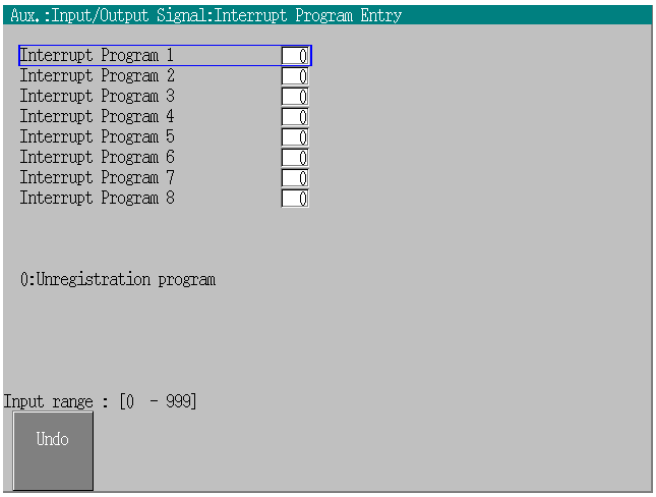
H3.1 DEDICATED INPUT SIGNALS

The following dedicated signals are provided as dedicated input signals for painting.

1. Interrupt start 1 - 8
2. Mutual_wait disabled
3. Ext. device net power

1. Interrupt start 1 - 8
   If the rising edge of this signal is detected while robot program is in “RPS waiting” condition, the interrupt program (program for cleansing, color change, etc.) registered in Auxiliary function Interrupt Program Registration is executed.

The interrupt programs 1 – 8 are set in Aux. 0618 Interrupt Program Entry.



Program numbers that can be registered in Aux. function Interrupt Program Entry is 1 – 999. When program number 0 (not registered) or number over 999 is set, it is assumed that there are no program registration and program does not interrupt.

2. Mutual_wait disabled
   When this signal turns ON, the mutual waiting function is disabled.

3. Ext. device net power
   This signal outputs the Power ON command to painting equipment built in the arm, which is connected to the DeviceNet network.

H3.2 DEDICATED OUTPUT SIGNALS

The following dedicated signals are provided as dedicated output signals for painting.

1. Dedicated signal for paint supply equipment (Level)
2. Dedicated signal for paint supply equipment (ON/OFF)
3. Air purge complete

1. Dedicated signal for paint supply equipment (Level)
   The signals specified by the parameters of program instruction FN593 and the signal corresponding to the level value are output by N-bits (2^N-1=max. level value). The following signals are provided as this type of dedicated output signals for painting equipment. Figures in parenthesis show the type number of signals set as parameter.
   - Flow rate output (2)
   - Shaping air output (3)
   - Shaping air 2 output (7)
   - Air motor output (4)
   - High-pressure output (1)
   - High-pressure output 2 (8)

2. Dedicated signal for paint supply equipment (ON/OFF)
   The signal specified by the program parameters instruction FN593 and the ON/OFF signal corresponding to the level value 1/0 are output. The following signals are provided as this type of dedicated output signals for painting equipment. Figures in parenthesis show the type number of signals set as parameter.
   - Flushing (6)
   - Push_thinner(5)

3. Air purge complete
   This signal informs outside that purging has been complete.

   ON: Purging has been complete.

   OFF: Purging is in progress

H4.0 RELATIVE GUN DISTANCE CHECK FUNCTION (OPTION)

This chapter describes procedures and related information for introducing and operating the relative gun distance check function.

H4.1 OVERVIEW OF THE FUNCTION

In the relative gun distance check function, the pose of the gun is continuously monitored to avoid them from getting nearer to each other than the set distance. Along with the arm interference prediction and mutual wait functions, this function is useful to prevent interference among several robots during operations. This function can be used when the robot controllers are connected by Ethernet via 1VA board and when the following option functions are effective:

When Gun Distance Check is set to [Enable] in one of the robots on the network, then the relative distances between the guns are checked at all times. There is no need to add any program instructions to use this function.

When the guns get nearer to each other than the set allowable approach distance the robot stops motion and the following alarms are given:

1. In teach mode

Intermittent alarm will go off before the gun reaches the allowable approach distance. The interval of the sound will be shorter as the guns approach each other. No error occurs even if the guns reach the allowable approach distance.

2. In check mode and repeat mode

When the guns get nearer to each other than the allowable approach distance, error E6012 Relative distance between guns is too near occurs. To restart the robot motion, move the robots away from each other in teach mode, and then reset the error.

H4.2 PREPARATION

This function is activated via software in the robot controller with Ethernet option. Various data in the software needs to be set before this function can be used. This manual only describes this specific function. For details on standard functions and operations, see the following manuals: Installation and Connection Manual for Controller, Installation and Connection Manual for Arm, Troubleshooting Manual, etc.

H4.2.1 ROBOT INSTALLATION AND WIRING

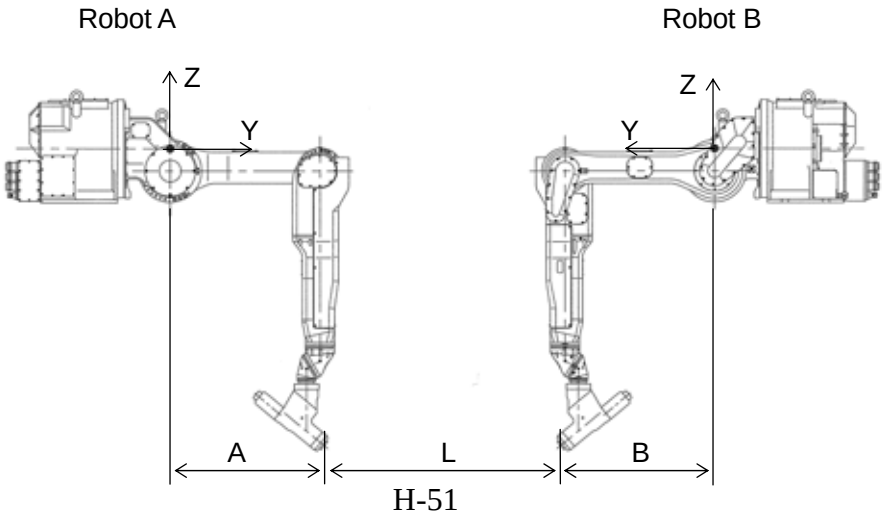
Follow the Installation and Connection Manual for Arm, a separate volume, for installing robots. For general methods and precautions for wiring/connecting the robot controller, see Installation and Connection Manual for Controller, a separate volume. This manual only describes the wiring and connections necessary for the relative gun distance check function.

H4.2.2 MEASURING RELATIVE INSTALLATION POSES BETWEEN ROBOTS

The relative installation poses of the robots need to be measured and recorded on all the controllers prior to using the relative gun distance check function.

1. Setting the tool transformation value(X,Y,Z,O,A,T)
   If the tool is already attached to the robot, select Auxiliary function [3. Aug. data setting] – [4. Tool Coordinates] on the teach pendant and set the proper tool transformation values(X,Y,Z,O,A,T) for the gun. In case no tool is to be used, enter (0,0,0,0,0,0) .

2. Measuring relative installation poses between robots
   Prior to software setting, measure the relative distance between the robots in the directions of X,Y and Z axis or confirm them from the layout drawings. The total length of L,A,B in the figure below is the relative distance between the robots in the direction of the Y axis.



H4.3 SOFTWARE DATA SETTING

This section explains software data settings necessary for using the relative gun distance check function.

H4.3.1 SYSTEM SWITCH SETTING

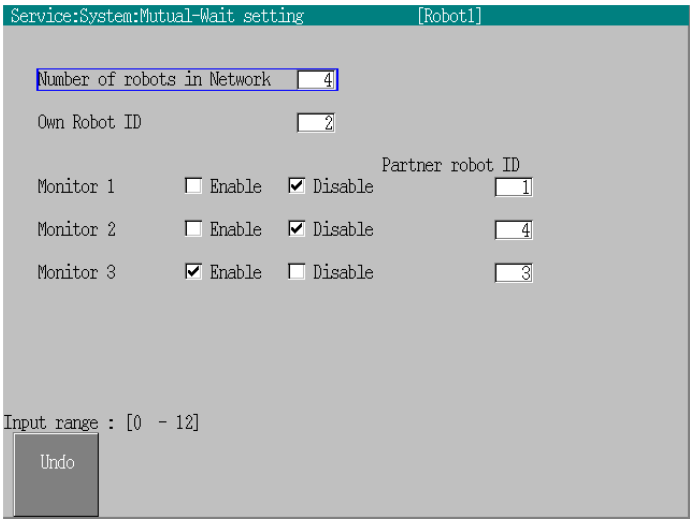
To use the relative gun distance check function, the following system switches must be turned ON. If the proper settings are not done, please contact Kawasaki.

ZILL_PC_EXIST, ZMUTUALWAIT, ZSENDGUNDIST

H4.3.2 ROBOT NETWORK FUNCTION SETTING

The robots communicate with each other via the communication function used in auto interlock generation function and arm interference prediction function. For robots with relative gun distance check option, auto interlock generation and arm interference prediction functions are made effective at time of factory shipment. However, to start communication, software data settings as in mutual wait function (see H2.0 Mutual Wait Function) are necessary once wiring has been done.

After properly completing the robot wiring, select [Aux. 8. System] – [16. Mutual-Wait Setting] and follow the setting procedure below for all connected robots. When all the settings are done, reboot the controller power (turn OFF then ON) to start transmitting the relative gun distance check data.



1. Select [Aux. 816 Mutual Wait Setting] from the standardized teach pendant.

2. Set each item on the screen. See the next page for details on each item.

Number of robots in Network

Sets total number of robots which are connected to robot network. When connecting via a common hub, set the number of controllers connected to that hub. Maximum of 12 controllers can be connected.

Own Robot ID

Sets the ID No. for the selected robot. Allocate a different ID number to each robot connected to the network starting from ID=1. ID No. cannot exceed the total number of connected robots. Error “E6022 Duplicate Mutual-Wait IDs.” occurs when the same ID is set.

Monitor 1 - 3

Relative gun distance check can be performed with a max. of 3 robots connected to robot network. Set [CONN.] for [CONN./DISCONN.] and robot ID No.

Error “E6023 Communication error in Mutual-Wait.” occurs during setting of the robot network but this is not abnormal. Reset this error after all the robots have been set.

3. Checking robot network function

Confirm that the robot network communication is functioning properly.

Use ROBNETCHECK command to display the connection status of robots in the same network.

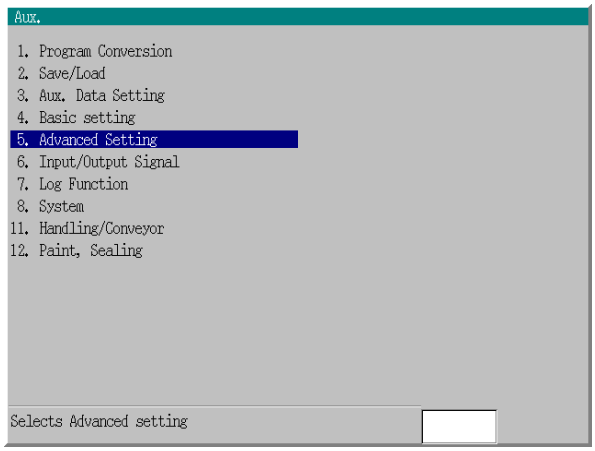
```
>ROBNETCHECK  1:↵
  No.   Connect   ROBOTID   Serial No.
-------------------------------------------------
   0        o         1       301
   1        o         2       302
   2        x         -        -
   3        o         4       304
```

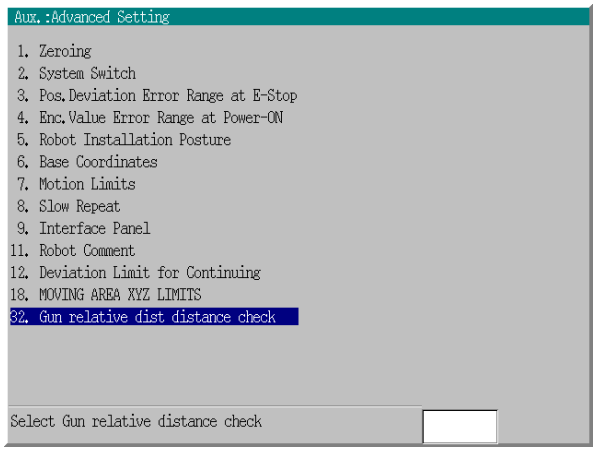
In this example, four robots are registered to the network but only three robots are currently connected. No.0 represents the robot connected to this controller and in this example its ID No. (ROBOTID) is 1. Status for the other robots is shown in No.1, 2, and 3. Note that ROBOTID is not displayed when robot is disconnected. In this example, you can tell that the robot with ID No. 3 is currently not connected to the network.

H4.3.3 RELATIVE INSTALLATION POSE SETTING

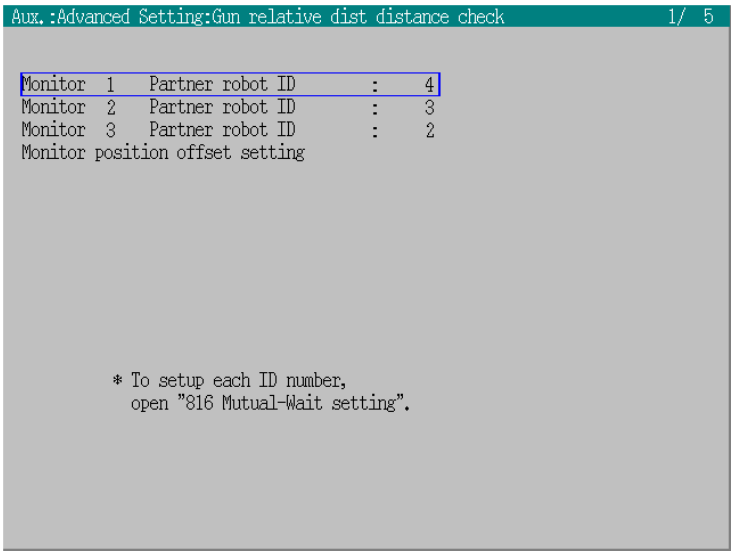
Next, set the relative installation pose among the robots.

1. From the auxiliary function menu screen, select [5. Advanced settings] - [32. Gun relative distance check].

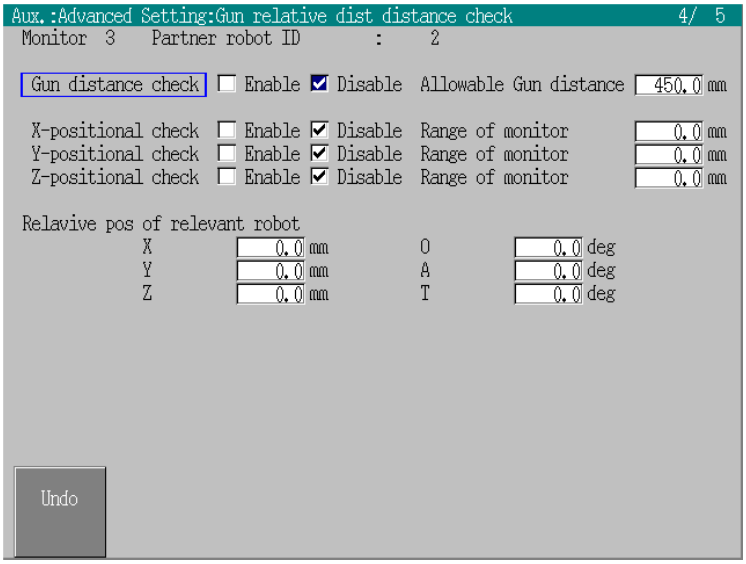




2. Select the robot to monitor.



3. Follow the explanations below to set each item.



Gun distance check Enable/ Disable

Enables/ disables the relative gun distance check function. When [Enable] is selected in one of the robots, this function becomes effective, regardless of the setting on the other robot.

* To disable the relative gun distance check function, select [Disable] in all Master and partner robots.

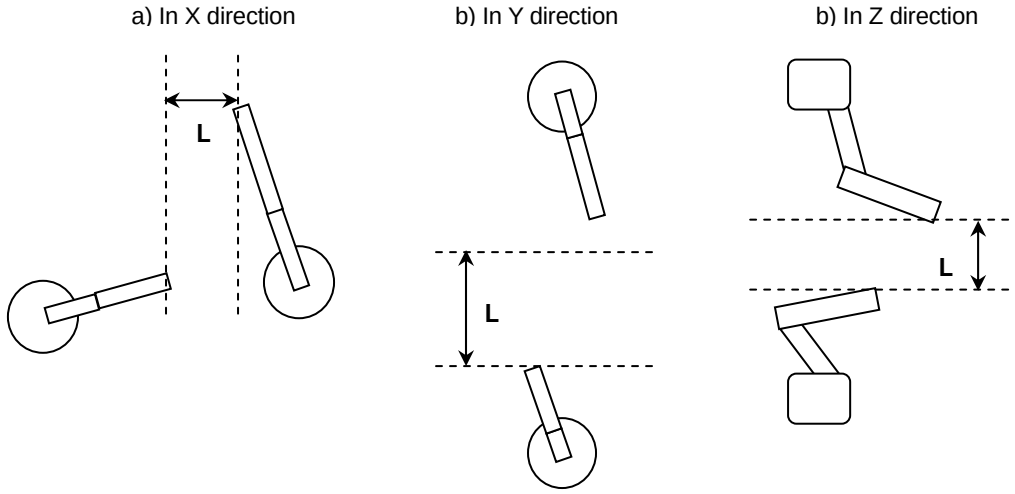
Allowable Gun Distance

Sets the maximum distance between the guns attached to the robots. When guns get nearer to each other than the distance set here, the robot motion stops in order to avoid them from approaching each other any further.

When the allowable distance setting for the Master robot and the partner robots differs, the greater distance takes precedence.

X/Y/Z Positional check

“X/Y/Z Positional check” checks degree of proximity of guns in each of the XYZ directions by proximity value L, shown as in the next figures. This is to avoid any collision between the gun and the arm that might happen even when the guns are away from each other, depending on the robot layout or the program.



Switch between enable/ disable to select whether the check in that direction is done or not.
[Range of monitor] sets the allowable proximity value in that direction.
* Selecting [Disable] for all XYZ directions does not disable the relative gun distance check function itself.

The XYZ positional check differs from the check of the distance between guns in the following ways:

1. If the check is set to [Enable] in only one of the robots, then the check is done only on that robot.
2. Negative value may be set for [Range of monitor]. In this case, the robot can move to a pose that enters within (crosses over) the motion range of the partner robots as long as it is within the allowable value. (Robot stops at reaching the allowable value).
3. When the values set in [Range of monitor] differ among the Master robot and the partner robots, each robot monitors the value set for it.

[NOTE]

The setting done via this screen must be done for all robots set to [Enable] in [Aux. 816 Mutual-wait Setting]. Be careful to set the correct values for each robot.

Relative pos(e) of relevant robot

For X, Y, Z, enter the position of the origin of the partner robot's base coordinates as seen from the base coordinate of the Master robot. Enter the XYZ values measured in 5.2.2-2. or in the layout drawing.

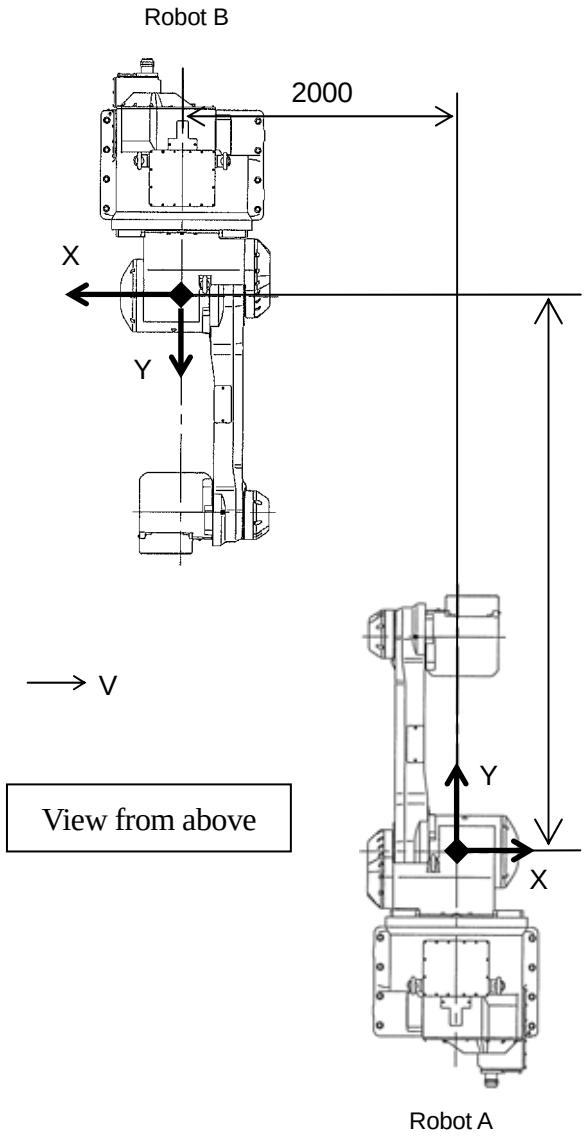
The values are set in coordinate values, so when the base coordinate system is changed from the null base coordinates, be aware of the signs (+/-) of the values.

For O, A, T values, enter the rotational angle to match the base coordinates of the Master robot to that of the partner robot. When the base coordinates orientations of the two robots are the same, all the angles here should be 0.

[**NOTE**]

This item must be set properly in both the Master and partner robots.

Example of setting the relative installation pose of the partner robot

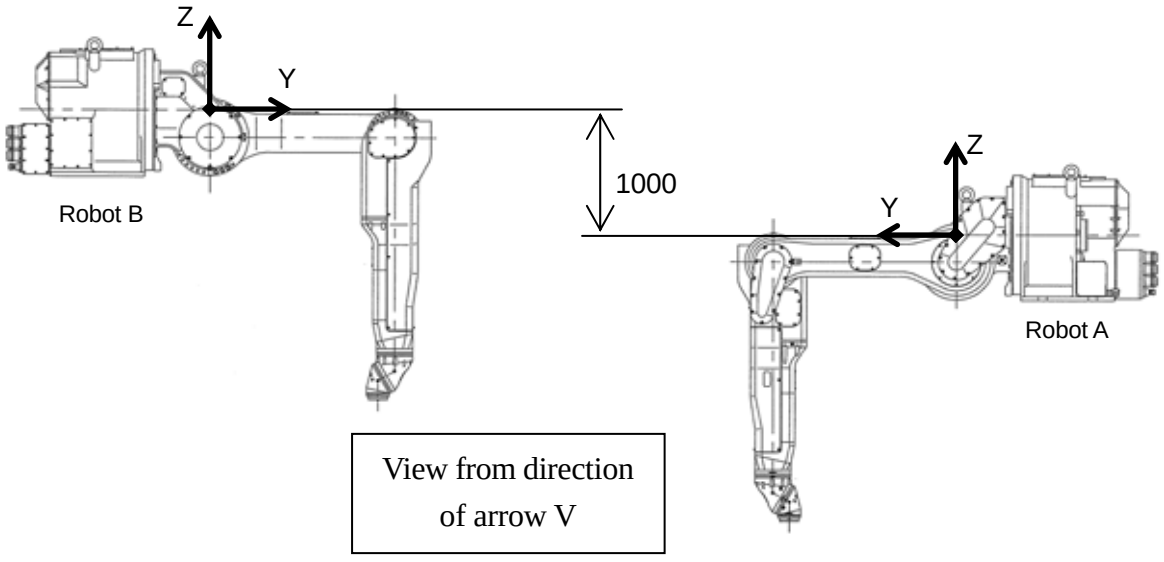


The installation pose of Robot B as seen from Robot A is:

X : -2000 mm
Y : 4000 mm
Z : 1000 mm
O: 180 deg (robots face each other)
A: 0 deg
T: 0 deg

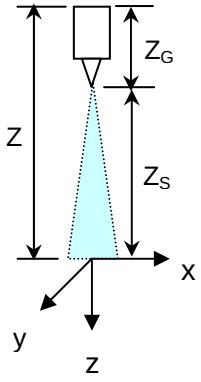
The installation pose of Robot A as seen from Robot B is:

X : -2000 mm
Y : 4000 mm
Z : -1000 mm
O: 180 deg (robots face each other)
A: 0 deg
T: 0 deg

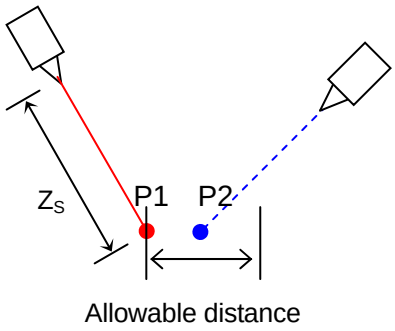


H4.3. 4 MONITOR POSITION OFFSET SETTING

In explosion-proof specification robots, the Z value of the tool transformation value is normally set as the sum of Z_G (gun length) + Z_S (spraying distance).



If the relative gun distance check is done using this tool Z value, error will occur even when the actual guns are not so close. For example, see the figure below.



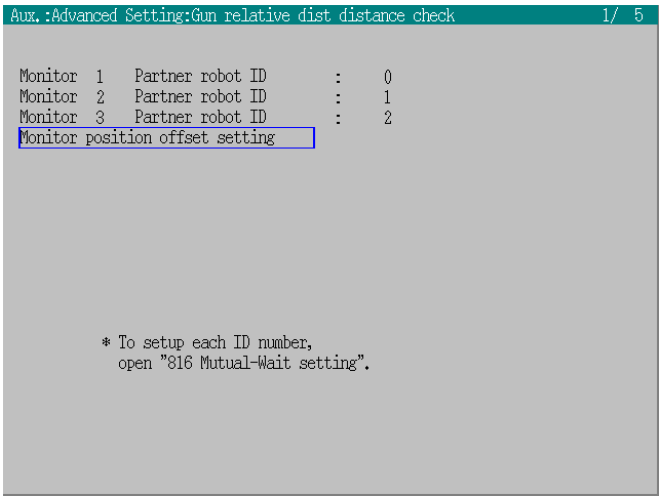
To avoid this, this function sets the offset value (Z_S in the figure above) to subtract the offset value from the Z value of the tool transformation value.

This setting will allow the distance check based on the point set back by the offset distance from the set TCP in the direction of the Z axis. This point should be the actual gun tip.

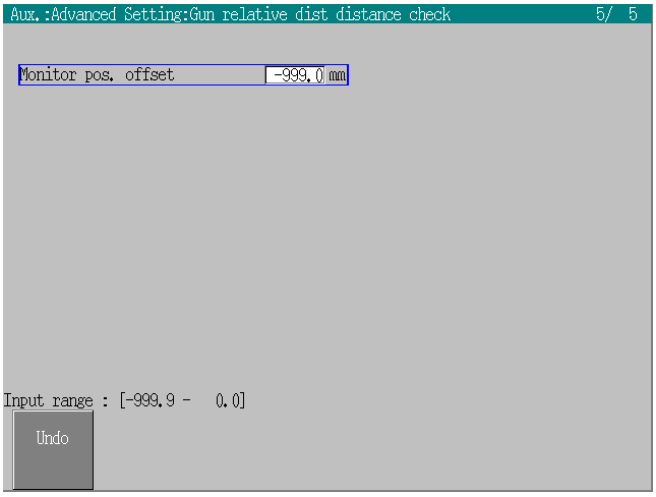
The offset value set here will apply on all Monitor 1 – Monitor 3. Also, the setting is valid and reflected to the check right after the setting is complete.

1. From the auxiliary function menu screen, select [5. Advanced settings] - [32. Gun relative distance check].

2. Select [Monitor position offset setting].



3. Enter the offset value.



[NOTE]

This offset value set in screen is effective only in the direction of the Z axis.
This is because the spray direction is supposedly limited to the Z direction of the tool coordinates.

H4.4 ERROR

Following errors may occur concerning the relative gun distance check function.

E6012 Relative distance between guns is too near

Cause:
The guns of the monitored robots approached each other exceeding the allowed limit of distance.

Countermeasures:
Change the operation mode to teach mode and move the robots away from each other until they are further away from than the allowed approach distance. The error can be reset as soon as the robots are apart from each other.

Status of robot and controller at time of error occurrence

Robot Motion	Stopped
Error signal	ON
Motor power	OFF
Master ON	OFF
Cycle Start	OFF
Error reset	Not available*

Note* Until the relative distance between the guns is greater than the allowed approach distance.

E6023 Communication error in Mutual-Wait.

Cause:
The communication error occurs when the relative gun distance check data are not received from the partner for 2 seconds. Communication among the connected robots is not normal.

Countermeasures:
Check the wiring or the mutual wait connection setting of the partner robots. However, the communication status is monitored while the error is occurring and as soon as gun distance check data from the partner robots are confirmed, the error can be reset.

Status of robot and controller at time of error occurrence

Robot Motion	Stopped
Error signal	ON
Motor power	ON
Master ON	ON
Cycle Start	OFF
Error reset	Not available*

Note* Until mutual-wait/ gun distance check data is confirmed as received.
(Communication status is monitored even when error is occuring.)

When the controller power in one of the robots connected to the network is not turned ON, error E6023 Communication error in Mutual-Wait occurs. Reset this error after the controller power in all the robots has been turned ON.

APPENDIX ERROR MESSAGE LIST

Code	Error Message
P0100	Illegal input data.
P0101	Too many arguments.
P0102	Input data is too big.
P0103	Illegal PC number.
P0104	Illegal Robot number.
P0105	Illegal program.
P0106	Illegal priority.
P0107	Invalid coordinate value.
P0108	Syntax error.
P0109	Invalid statement.
P0110	Specify full spelling of command.
P0111	Cannot use this command/instruction in current mode.
P0112	Cannot execute with DO command.
P0113	Not a program instruction.
P0114	Illegal expression.
P0115	Illegal function.
P0116	Illegal argument of function.
P0117	Invalid variable (or program) name.
P0118	Illegal variable type.
P0119	Incorrect array suffix.
P0120	Incongruent num. of parenthesis.
P0121	Expected to be a binary operator.
P0122	Illegal constant.
P0123	Illegal qualifier.
P0124	Invalid label.
P0125	Missing expected character.
P0126	Illegal switch name.
P0127	Specified switch name needs full spelling.
P0128	Illegal format specified.
P0129	Duplicate statement label.
P0130	Cannot define as array.
P0131	No. of dimensions in array exceeds 3.
P0132	Array variable already exists.
P0133	Non array variable exists.

P0134	Array variable expected.
P0135	Local variable expected.
P0136	Unexpected suffix.
P0137	Mismatch of arguments at subroutine call.
P0138	Mismatch of argument type at subroutine call.
P0139	Illegal control structure.
P0140	Step: XX Wrong END statement.
P0141	Step: XX Extra END statement.
P0142	Step: XX Cannot terminate DO with END.
P0143	Step: XX No VALUE statement after CASE.
P0144	Step: XX Preceding IF missing.
P0145	Step: XX Preceding CASE missing.
P0146	Step: XX Preceding DO missing.
P0147	Step XX Cannot find END of XX.
P0148	Step: XX Too many control structures.
P0149	Variable (or program) already exists.
P0150	Variable of different type already exists.
P0151	Internal buffer over due to complicated expression.
P0152	Undefined variable (or program).
P0153	Illegal clock value.
P0154	Missing '='.
P0155	Missing ')'.
P0156	Missing ']'.
P0157	Missing "TO".
P0158	Missing "BY".
P0159	Missing ':'.
P0160	Specify "ON" or "OFF".
P0161	Robot Num. must be specified.
P0162	Cannot modify position data in this instruction.
P0163	Name of program, variable, file, etc. misspecified.
P0164	Illegal Robot network ID.
P0165	Step: XX No SVALUE statement after SCASE.
P0166	Step: XX Preceding SCASE missing.
P1000	Cannot execute program because motor power is OFF.
P1001	Cannot execute program in TEACH mode.
P1002	Cannot execute program because teach lock is ON.
P1003	Cannot execute program because of EXT. HOLD input.

P1004	Cannot execute program being reset.
P1005	Cannot execute program because of EXT. START ENABLE.
P1006	Cannot execute program because of EXT. START DISABLE.
P1007	Start signal was not input at a RPS_END step.
P1008	Cannot execute program, HOLD sw. engaged.
P1009	Program is already running.
P1010	Robot control program is already running.
P1011	Cannot continue this program. Use EXECUTE.
P1012	Robot is moving now.
P1013	Cannot execute because in error now. Reset error.
P1014	Cannot execute because program already in use.
P1015	Cannot delete, in use by another command.
P1016	Cannot delete, used in program.
P1017	Cannot delete a program in Editor.
P1018	KILL or PCKILL to delete program.
P1019	PC program is running.
P1020	Cannot operate, teach pendant in operation.
P1021	Cannot execute with DO command.
P1022	Cannot execute with MC instruction.
P1023	Cannot execute in Robot program.
P1024	Statement cannot be executed.
P1025	Cannot be executed, function not set.
P1026	Cannot KILL program that is running.
P1027	Cannot edit program, teach lock is ON.
P1028	Cannot paste.
P1029	Program name not specified.
P1030	Program interlocked by other procedure.
P1031	No free memory.
P1032	No program step.
P1033	Program name already exists.
P1034	This program is not editable.
P1035	Record inhibited. Set [Record Accept] and operate again.
P1036	Program change inhibited. Set [Accept] and operate again.
P1037	Program name cannot be called "calib_load_".
P1038	Program does not exist.
P1039	Teach pendant is not connected.
P1040	Cannot execute this command in I/F panel.

P1041	Auto monitor command failure.
P1042	NUM program is running.
P1043	Cannot execute in REPEAT mode.
P1044	Cannot execute on because motor power is ON.
P1045	Set TEACH mode and teach lock ON.
P1046	Turn on trigger switch.
P1047	The disconnected robot cannot select the program/step.
P1048	Cannot operate during execution of brake check.
P1049	Program is locked.
P1050	Exist protected program.
P1051	Cannot unlock protection while program running.
P1052	Because the memory was full, could not copy the program.
P1053	Because the memory was full, the copy of program was suspended.
P1054	Turn off trigger switch.
P1055	Teach the axis lock instruction at the step of clamp ON.
P1056	Teach the axis unlocking instruction at the step of clamp ON.
P2000	Turn OFF motor power.
P2001	Turn HOLD/RUN sw. to HOLD.
P2002	There is no external axis.
P2003	Illegal positioner type.
P2004	Cannot change, user data already exists.
P2005	Graphic area error.
P2006	Option is OFF.
P2007	Cannot execute because executed by other device.
P2008	Device is not ready.
P2009	Illegal file name.
P2010	Disk is not ready.
P2011	Invalid disk format.
P2012	Disk is write-protected.
P2013	Disk full.
P2014	Too many files.
P2015	Cannot write on read-only file.
P2016	Cannot open the file.
P2017	Cannot close the file.
P2018	Storage data logging now.
P2019	ADC function already in use.
P2020	Illegal device number.

P2021	Cannot execute on this terminal.
P2022	Cannot use DOUBLE OX.
P2023	In cooperative mode.
P2024	Invalid coordinate value X.
P2025	Invalid coordinate value Y.
P2026	Invalid coordinate value Z.
P2027	Cannot use signal, already used in I/F panel.
P2028	Arm ID board is busy.
P2029	Axis setting data is incorrect.
P2030	Unknown Aux. function number.
P2031	Deleted step was destination step of Jump, Call instruction.
P2032	Incorrect number input as WHERE parameter.
P2033	Logging is running.
P2034	Undefined memory.
P2035	Non data.
P2036	Memory verify error.
P2037	Real time path modulation is already running.
P2038	Matrix calculation error.
P2039	Cannot start cycle from FN instruction.
P2040	Card is not ready.
P2041	Wrong card loaded.
P2042	Card is write-protected.
P2043	Card battery is low voltage.
P2044	Card is not formatted.
P2045	Cannot format this card.
P2046	Card initialization error.
P2047	File is already open.
P2048	File does not exist in card.
P2049	Attempted to open too many files.
P2050	Unexpected error during card access.
P2051	Illegal sequence numbers for file I/O data.
P2052	[LSEQ]Program includes unavailable instruction.
P2053	[LSEQ]Too many steps exist.
P2054	[LSEQ]Invalid type of signal variable.
P2055	[LSEQ]Program is already running.
P2056	[LSEQ]No.of signal is outside specifiable range.
P2057	[Serial Flash]Cannot open file.

P2058	[Serial Flash]Data read error.
P2059	[Serial Flash]Data write error.
P2060	[Serial Flash]File or directory doesn't exist.
P2061	File does not exist in floppy.
P2062	[FDD/PC_CARD]Failure in writing data per verify function.
P2063	[FDD/PC_CARD]Faulty response from verify function.
P2064	[FDD]No space available.
P2065	[Multi Disks] Invalid disk was loaded.
P2066	Boot flash state is write-disenable.
P2067	[Serial Flash] File directory error.
P2068	Cannot execute program being edited now.
P2069	[FDD/PC_CARD]Device already in use.
P2070	No more data can be registered.
P2071	C/S switch set to disable.
P2072	[LSEQ] Maximum cycles of execution.
P2073	[LSEQ] Other program is waiting execution.
P2074	Floppy disk is broken.
P2075	Channel number for Jt XX is incorrect.
P2076	SAVE/LOAD in progress.
P2077	[Serial Flash] Access error occurred.
P2078	[Serial Flash] Upload or Download was aborted.
P2079	Card full.
P2080	Can not execute because of the channel assigned joint No.
P2083	User log is not created.
P2084	The number of registration of a user log was changed.
P2085	Cannot register user log, no free memory.
P2086	User log data is not registered.
P2087	The kind of user log data and specified data is different.
P2088	Can not load the improper compensation parameter.
P2090	No servo data of the servo spec.
P2091	[Serial Flash] The file or directory already exists.
P2092	[Serial Flash] The directory is not yet empty.
P2093	[Serial Flash] There is no space to write.
P2094	[Serial Flash] Cannot access the file for read only.
P2095	No response from option CPU board.
P2096	Cannot execute cycle start after palletizing motion aborted.
P2097	Cannot change steps during palletizing motion.

P2098	The axis is not for endless rotation.
P2099	Cannot change palletizing state into ON.
P2100	Macro error.
P2101	Nesting is too deep in include file.
P2102	File or folder does not exist.
P2103	USB memory is not inserted.
P2104	Failed to download software.
P2105	Available USB memory is low.
P2106	Available compact flash memory is low.
P2107	System is now downloading the software.
P2108	There is no software in the USB memory.
P2109	Cannot execute program because of simultaneously operation sig. inputting.
P2110	[USB/CF]File write error.
P2111	Please return spin-axis to the original position.
P2112	File name is too long.
P2113	Cannot start operation cycle from KI instruction.
P4500	FIELD-BUS)Interface not enabled.
P4501	DEVNET)Node XX not in the scan list.
P4502	DEVNET)Already in that mode.
P4503	Duplicate signal number
P4504	FIELD-BUS)signals limit over.(max. XX)
P4505	CC-LINK)Version mismatch.
P4506	EN/IP-M)Already in specified mode.
P4507	FIELD-BUS)Cannot execute with old ANYBUS card firmware.
P4508	FIELD-BUS)Cannot communicate with interface card.
P4509	FIELD-BUS)Wrong interface card type error.
P4510	FIELD-BUS)Initialization of the card is not complete.
P5000	Waiting weld completion.
P5001	Waiting retract or extend pos. input signal.
P5002	Spot sequence is running.
P5003	External-axis type and Gun type data mismatch.
P6000	Shifted location of STEP XX is out of range.
P6001	STEP XX in source program is out of motion range.
P6002	Specified painting data bank does not exist.
P6003	Cannot execute program because of suspend playback.
P6004	Cannot execute because of the Air Purge sequence.
P6005	Cannot execute because robot is disconnected.

P6006	Cannot specify circular move to end point of spraying path
P6007	Number of taught points for spraying path exceeds the limit.
P6008	Number of instructions between points exceeds the limit.
P6009	Number of instructions between points exceeds the limit.
P6010	Shortage in number of taught points for spraying path.
P6011	Cannot move, change to joint interpolation or add points.
P6012	Cannot edit program, TEACH LOCK is OFF.
P6500	Cannot generate working line direction.
P6501	Illegal tool posture.
P6502	No weld database.
P6503	Cannot change weld condition.
P6504	Step: XX Preceding L.START missing.
P6505	The axis type is not set as the servo torch
P6506	Shift function can not be used in CIR interp.
P7000	Cannot program reset, because not at home position 1.
P7001	In force meas. mode, only NOP Interp. avail.
P7002	Cannot change stroke because clamp on now.
P7003	Servo parameter file is not found.
P7500	Turn motor power on.
P7501	Because of repeat mode, wait to teach mode.
P7502	Over the number which can be registered in interruption.
P7503	Cannot execute program in error masking.
P7504	ONC/ONCI channel has already received.
P7505	Cannot execute in saving.
P7506	Cannot accept a record because robot is moving.
P7507	Amount of the data change is too large in repeat operation.
P8400	Cannot execute program because of CLAMP MODE sig. inputting.
P8800	The controller number is duplicated.
P8801	The IL robot number is duplicated.
P8802	The IL server is being processed.
P8803	The connection with the IL server has not been permitted.
P8804	IL server IP address is a unsetting.
P8805	It is not teach mode.
P8806	Please do servo OFF.
P8807	ILL)Communication time out error.
P8808	ILL)PC server processing comp. waiting is time out error.
P8809	ILL)PC server processing demand completion waiting is time out error.

P8810	ILL)Inter lock less function system error.
P8811	ILL)Could not release operation lock for slave controller.
P8812	ILL)Could not communicate with the PC server.
P8813	The IL robot number is unregistered.
P9000	Unacceptable control-direction.
P9001	Unacceptable control-distance.
P9002	Same data are specified for some reference points.
P9003	Reference points1,2,3 are on a straight line.
P9004	Reference point 4 is out of allowed range.
P9005	Cannot manipulate because teach lock is ON.
W1000	Cannot move along straight line JTXX in this configuration.
W1001	Over maximum joint speed in check. Set low speed.
W1002	Operation log information was cleared.
W1003	Calibration failed. Retry after changing posture.
W1004	JTXX out of motion range. Check operational area.
W1005	Illegal center of gravity, default parameter is set.
W1006	Incorrect load moment. Default parameter is set.
W1007	Application setting changed. Turn OFF & ON the control power.
W1008	Parameter changed. Turn OFF & ON the control power.
W1009	Position envelope error of jt XX at last E-stop.
W1010	RAM battery low voltage.
W1011	PLC alarm. (XX)
W1012	Servo parameter changed. Turn OFF & ON the control power.
W1013	Encoder battery low voltage. [Servo(XX)]
W1014	Number of axes changed. Reinitialize.
W1015	Possibility of failure.
W1016	Torque of motor is over limit. JTXX
W1017	Encoder battery low voltage.[External axis(XX)]
W1018	Network parameter is changed. Turn OFF & ON the control power.
W1019	The registered value is beyond rated load.
W1020	Error sector was found.
W1021	The optimal posture can't be found at present location.
W1022	Not execute ZRPAADSET command.
W1023	Teach Plug Position wrong or P-N low voltage.[XX]
W1024	Deviation from last stop position exceeds the limit set.
W1025	(SSCNET) Excessive regenerative warning of Jt XX.(code XX)
W1026	(SSCNET) Motor overload warning of Jt XX.(code XX)

W1027	While lifter is locked, it can not move.
W1028	The center of gravity for payload is over limit. Reduction gears could be broken.
W1029	The center of gravity for payload is over limit. Use the JT5 at zero degree only.
W1030	Braking torque of Jt XX has decreased.
W1031	Cannot move along straight line unless JTXX value is 0 degree.
W1032	Cannot move straight - the flange faces direction of upper sphere.
W1033	Cannot change orientation.
W1034	Encoder power voltage is low. Jt XX
W1035	Encoder battery voltage is low. Check zeroing. Jt XX
W1036	Step data is different.
W1037	The axis is not for endless rotation.
W1038	Encoder rotation data is abnormal.(jt XX)
W1039	Encoder response error(JtXX).
W1040	Encoder communication error.(jtXX)
W1041	Speed error jt XX.
W1042	Encoder rotation speed exceeded limit (jt XX)
W1043	Encoder temperature exceeded limit (jt XX)
W1044	Velocity envelope error in endless rotation axis.(jt XX)
W1045	Abn. curr feedback Jt XX. (Amp fail, pwr harness disconnect)
W1046	Encoder ABS-track error.(jtXX)
W1047	Encoder INC-pulse error.(jtXX)
W1048	Encoder communication alarm jtXX.
W1049	RSC)TCP communication error occurred.(CODE:XX)
W1050	RSC)Command value output communication error occurred. (CODE:XX)
W1051	RSC)USB communication initialize error occurred.(CODE:XX)
W1052	RSC)RC parameter generation error occurred.(CODE:XX)
W1053	(FANXX-XX)Rotational speed of fan is below the limit. (ServoBoardXX)
W1054	Remaining lifetime of AVR is little.
W1055	Vision cycle timer over.
W1056	[Main CPU board]CPU temperature exceeded limit.(XX 1/1000 deg C)
W1057	Cannot move along straight line tool in this configuration.
W1058	Link3 interferes in ground.
W1059	Link5 interferes in base.
W1060	Link6 interferes in base.
W1061	TP changed. Confirm current pose, and operate the robot.

W1062	The TP backlight lighting time exceeded the limit.
W1063	The number of ON/OFF operations of MC relay exceeded the limit.(SrvB'd XX)(MC XX)
W1064	Exceeded the limit.(Parts:XX)
W1072	Deviation of JTXX is too large.
W2901	SLOGIC ERROR MESSAGE #1
W2902	SLOGIC ERROR MESSAGE #2
W2903	SLOGIC ERROR MESSAGE #3
W2904	SLOGIC ERROR MESSAGE #4
W2905	SLOGIC ERROR MESSAGE #5
W2906	SLOGIC ERROR MESSAGE #6
W2907	SLOGIC ERROR MESSAGE #7
W2908	SLOGIC ERROR MESSAGE #8
W2909	SLOGIC ERROR MESSAGE #9
W2910	SLOGIC ERROR MESSAGE #10
W2911	SLOGIC ERROR MESSAGE #11
W2912	SLOGIC ERROR MESSAGE #12
W2913	SLOGIC ERROR MESSAGE #13
W2914	SLOGIC ERROR MESSAGE #14
W2915	SLOGIC ERROR MESSAGE #15
W2916	SLOGIC ERROR MESSAGE #16
W2917	SLOGIC ERROR MESSAGE #17
W2918	SLOGIC ERROR MESSAGE #18
W2919	SLOGIC ERROR MESSAGE #19
W2920	SLOGIC ERROR MESSAGE #20
W2921	SLOGIC ERROR MESSAGE #21
W2922	SLOGIC ERROR MESSAGE #22
W2923	SLOGIC ERROR MESSAGE #23
W2924	SLOGIC ERROR MESSAGE #24
W2925	SLOGIC ERROR MESSAGE #25
W2926	SLOGIC ERROR MESSAGE #26
W2927	SLOGIC ERROR MESSAGE #27
W2928	SLOGIC ERROR MESSAGE #28
W2929	SLOGIC ERROR MESSAGE #29
W2930	SLOGIC ERROR MESSAGE #30
W2931	SLOGIC ERROR MESSAGE #31
W2932	SLOGIC ERROR MESSAGE #32

W2933	SLOGIC ERROR MESSAGE #33
W2934	SLOGIC ERROR MESSAGE #34
W2935	SLOGIC ERROR MESSAGE #35
W2936	SLOGIC ERROR MESSAGE #36
W2937	SLOGIC ERROR MESSAGE #37
W2938	SLOGIC ERROR MESSAGE #38
W2939	SLOGIC ERROR MESSAGE #39
W2940	SLOGIC ERROR MESSAGE #40
W2941	SLOGIC ERROR MESSAGE #41
W2942	SLOGIC ERROR MESSAGE #42
W2943	SLOGIC ERROR MESSAGE #43
W2944	SLOGIC ERROR MESSAGE #44
W2945	SLOGIC ERROR MESSAGE #45
W2946	SLOGIC ERROR MESSAGE #46
W2947	SLOGIC ERROR MESSAGE #47
W2948	SLOGIC ERROR MESSAGE #48
W2949	SLOGIC ERROR MESSAGE #49
W2950	SLOGIC ERROR MESSAGE #50
W2951	SLOGIC ERROR MESSAGE #51
W2952	SLOGIC ERROR MESSAGE #52
W2953	SLOGIC ERROR MESSAGE #53
W2954	SLOGIC ERROR MESSAGE #54
W2955	SLOGIC ERROR MESSAGE #55
W2956	SLOGIC ERROR MESSAGE #56
W2957	SLOGIC ERROR MESSAGE #57
W2958	SLOGIC ERROR MESSAGE #58
W2959	SLOGIC ERROR MESSAGE #59
W2960	SLOGIC ERROR MESSAGE #60
W2961	SLOGIC ERROR MESSAGE #61
W2962	SLOGIC ERROR MESSAGE #62
W2963	SLOGIC ERROR MESSAGE #63
W2964	SLOGIC ERROR MESSAGE #64
W2965	The max load is XX of a permissible torque.
W2966	Load exceeded permissible torque.
W2967	Load exceeded max torque.
W2968	Please set a group number as XX.
W3800	Encoder battery voltage decrease

W3801	Because the brake has been released, it is not possible to move.
W3802	Maint. period elapsed, maint. is required.
W3803	Total power ON time exceeded limit, maint. is required.
W3804	Total robot connection time exceeded limit, maint. is required.
W3805	Total servo ON time exceeded limit, maint. is required.
W3806	Total JtXX the total travel dist. exceeded limit, maint. is required.
W3807	Total times of MC ON exceeded limit, maint. is required.
W3808	Total times of servo ON exceeded limit, maint. is required.
W3809	Total times of E-stop exceeded limit, maint. is required.
W3810	JtXX total (curr)^3-motion dist. exceeded limit, maint. is required.
W3811	JtXX RMS value of current exceeded limit, maint. is required.
W3812	Power supply(1) for input to NO.XX I/O board is abnormal.
W3813	Power supply(2) for input to NO.XX I/O board is abnormal.
W3814	Power for output from NO.XX I/O board is abnormal or Fuse blown.
W4000	No response from PLC to Break down info writing.
W4001	Break down info cannot write on PLC[EC = XX].
W4002	Break down info writing cannot receive correct answer.
W4500	FIELD-BUS)Slave port OFFLINE.
W4501	FIELD-BUS)Master port OFFLINE.
W4502	CC-LINK)Data link error on Master board. XX
W5000	Release wait cond., in force measurement mode.
W5001	PLC communication error.
W5002	Weld controller XX not connected.
W5003	Weld controller XX no response.
W5004	Weld controller XX response error.
W5005	(Spot welding) No response from RWC XX.
W5006	(Spot welding) RWC response error XX.
W5007	(Spot welding) Weld fault XX.
W5008	(Spot welding) Cable disconnection error (welder XX).
W5009	(Spot welding) Internal leak XX.
W5010	(Spot welding) Main cable exchange alarm XX.
W5011	(Spot welding) No connection with RWC XX.
W5012	Cannot achieve set force.
W5013	Tip wear over the limit. (MOVING SIDE)
W5014	Tip wear over the limit. (FIXED SIDE)
W5015	(Spot welding) Welding current has decreased.
W5016	Weld warning has arisen.(code XX)

W6000	Grease reduction gears and motor bearings.
W6001	Replace the robot main cable.
W6002	Replace the cooling fans in the controller.
W6003	Replace the DC power supply in the controller.
W6004	Replace the servo power unit.
W6005	Replace the power amplifier for the robot arm.
W6006	Replace the power amplifier for the robot wrist.
W6007	Replace the power amplifier for the traveler.
W6008	Exp interlock is disabled by jumper wiring.
W6009	Not selected Internal pressure Explosion-proof.
W6010	Disable Gun Relative Distance Check (ID:XX).
W6011	Shutter release signal variable logging error.
W7000	Cannot operate excluding the servo welding gun axis. Because the pressure measurement mode.
W7001	Detected board gap quantity error.
W7002	Detected board gap quantity error.
W7003	The foreign body was detected in the Tip Dress.
W7004	Value of auto collect exceeds work abnormality level.
W7500	Can't continue check motion because separated from last pos.
W7501	Cannot execute a program because of LOW voltage.
W8400	Cannot achieve set force of JtXX.
W8800	Command value almost exceeds virtual safety fence.(Sphere XX, Line XX)
W8801	Command value almost exceeds virtual safety fence.(Sphere XX, Z Upper)
W8802	Command value almost exceeds virtual safety fence.(Sphere XX, Z Lower)
W8803	Command value almost invades restricted space.(Sphere XX, Part. XX Line XX)
W8804	Command value almost invades restricted space.(Sphere XX, Part. XX Z Upper)
W8805	Command value almost invades restricted space.(Sphere XX, Part .XX Z Lower)
W8806	Command value almost exceeds virtual safety fence.(Tool Box, Line XX)
W8807	Command value almost exceeds virtual safety fence.(Tool Box, Z Upper)
W8808	Command value almost exceeds virtual safety fence.(Tool Box, Z Upper)
W8809	Command value almost invades restricted space.(Tool Box, Part. XX)
W8810	Command value almost exceeds virtual safety fence.(Link XX, Line XX)
W8811	Command value almost exceeds virtual safety fence.(Link XX, Z Upper)
W8812	Command value almost exceeds virtual safety fence.(Link XX, Z Lower)

W8813	Command value almost invades restricted space.(Link XX, Part. XX Line XX)
W8814	Command value almost invades restricted space.(Link XX Part .XX Z Upper)
W8815	Command value almost invades restricted space.(Link XX, Part. XX Z Lower)
W8851	Detected area interference.
W8852	Detected arm interference.(XX, XX)
W8853	ILL)Detected arm interference.(XX, XX)
W8854	ILL)Communication time out error.
W8855	ILL)Sequence processing demand completion waiting is time out error.
W8856	ILL)Sequence processing completion waiting is time out error.
W8857	ILL)Sequence processing system error.
W8858	ILL)Create/Set processing completion waiting is time out error.
W8859	ILL)Inter lock less function system error.
W8860	[ARM CONTROL b'd]Data received from IL server is invalid.
W8900	Can not operate because motion limitation signal was input.
E0001	Unknown error.
E0002	[Servo board XX] CPU BUS error.
E0100	Abnormal comment statement exists.
E0101	Nonexistent label.
E0102	Variable is not defined.
E0103	Location data is not defined.
E0104	String variable is not defined.
E0105	Program or label is not defined.
E0106	Value is out of range.
E0107	No array suffix.
E0108	Divided by zero.
E0109	Floating point overflow.
E0110	String too long.
E0111	Attempted operation with neg. exponent.
E0112	Too complicated expression.
E0113	No expressions to evaluate.
E0114	SQRT parameter is negative.
E0115	Array suffix value outside range.
E0116	Faulty or missing argument value.
E0117	Incorrect joint number.
E0118	Too many subroutine calls.
E0119	Nonexistent subroutine.
E0120	No destination program.

E0121	Cannot specify the jump source program as jump destination.
E0900	Block step instruction check sum error.
E0901	Step data is broken.
E0902	Expression data is broken.
E0903	Check sum error of system data.
E1000	ADC channel error.
E1001	ADC input range error.
E1002	PLC interface error.
E1003	Built-in PLC is not installed.
E1004	INTER-bus board is not ready.
E1005	Spin axis encoder difference error.
E1006	Touch panel switch is short-circuited.
E1007	Power sequence board is not installed.
E1008	Second Power sequence board is not installed.
E1009	No. XX I/O board is not installed.
E1010	Power sequence detects error.
E1011	Built-in sequence board is not installed.
E1012	RI/O board or C-NET board is not installed.
E1013	INTER-BUS board is not installed.
E1014	Dual port memory for communication is not installed.
E1015	Amp Interface board is not installed.(code=XX)
E1016	No XX CC-LINK board is not installed.
E1017	PLC error. Error code is Hex. XX.
E1018	INTER-BUS status error.
E1019	Power sequence board for safety unit is not installed.
E1020	External equipment is abnormal.
E1021	Arm ID board error. (code XX)
E1022	Power sequence board error. (code XX)
E1023	Communication error in robot network.
E1024	EXT.AXIS release sequence error.(code XX)
E1025	EXT.AXIS connect sequence error.(code XX)
E1026	Main CPU ID mismatch.
E1027	Safety circuit was cut OFF.
E1028	Jt XX motor overloaded.
E1029	Encoder rotation data is abnormal.(jt XX)
E1030	Encoder data is abnormal.(jt XX)
E1031	Miscount of encoder data.(jt XX)

E1032	Mismatch ABS and INC encoder data(jt XX).
E1033	Encoder line error of (jt XX) .
E1034	Encoder initialize error (jt XX).
E1035	Encoder response error(Jt XX).
E1036	Encoder communication error.(jt XX)
E1037	Encoder data conversion error.(jt XX)
E1038	Encoder ABS-track error.(jt XX)
E1039	Encoder INC-pulse error.(jt XX)
E1040	Encoder MR-sensor error. (jt XX)
E1041	Limit switch (JTXX) is ON.
E1042	Limit switch signal line is disconnected.
E1043	Teach Plug is abnormal.
E1044	Destination position is out of the specified area.
E1045	(Spot welding) Gun-clamp mismatch.
E1046	Too short distance between start point and end point.
E1047	Axis number is not for conveyor follow mode.
E1048	Offset data of zeroing is illegal value.
E1049	Current position is out of the specified area.
E1050	Encoder and brake power off signal not dedicated.
E1051	Incorrect double OX output.
E1052	Work sensing signal is not dedicated.
E1053	Work sensing signal already input.
E1054	Cannot execute motion instruction.
E1055	Start point position error for circle.
E1056	MASTER robot already exists.
E1057	Check to which robot MASTER/ALONE were instructed.
E1058	SLAVE robot already exists.
E1059	Not an instruction for cooperative motion.
E1060	Cannot execute in check back mode.
E1061	Cannot execute in ONE program.
E1062	JT2 and JT3 interfere during motion to start pose.
E1063	JT2 and JT3 interfere during motion to end pose.
E1064	Illegal pallet number.
E1065	Illegal work number.
E1066	Illegal pattern number.
E1067	Illegal pattern type.
E1068	Illegal work data.

E1069	Illegal pallet data.
E1070	ON/ONI signal is already input.
E1071	XMOVE signal is already input.
E1072	Home position data is not defined.
E1073	Illegal timer number.
E1074	Over maximum signal number.
E1075	Illegal clamp number.
E1076	Cannot use negative time value.
E1077	No value set.
E1078	Illegal signal number.
E1079	Cannot use dedicated signal.
E1080	Not RPS mode.
E1081	Cannot use negative value.
E1082	Out of absolute lower motion range limit.
E1083	Out of absolute upper motion range limit.
E1084	Out of set lower motion range limit.
E1085	Out of set upper motion range limit.
E1086	Start point for Jt XX beyond motion range.
E1087	End point for Jt XX beyond motion range.
E1088	Destination is out of motion range.
E1089	Cannot do linear motion in current configuration.
E1090	External modulation data is not input.
E1091	External modulation data is abnormal.
E1092	Modulation data is over limit.
E1093	Incorrect motion instruction to execute modulate motion.
E1094	Illegal joint number.
E1095	Cannot execute motion instruction in PC program.
E1096	Incorrect auxiliary data settings.
E1097	Missing C1MOVE or C2MOVE instruction.
E1098	C1MOVE(CIR1) instruction required before C2MOVE.
E1099	Unable to create arc path, check positions of the 3 points.
E1100	Cannot execute in sealing specification.
E1101	Can only execute in sealing specification.
E1102	Option is not set, cannot execute.
E1103	Over conveyer position.
E1104	Too many SPINMOVE instructions.
E1105	Start/Destination point is in protected space.

E1106	Cannot execute in this robot.
E1107	Cannot use SEPARATE CONTROL.
E1108	Duplicate robot network IDs.
E1109	Conveyor I/F board is not installed.
E1110	GROUP is not primed.
E1111	Due to motion restriction, JT XX cannot move.
E1113	Work sensing signal is not detected.
E1114	Interruption in cooperative control.
E1115	Forced termination of cooperative control.
E1116	Spin axis is not stopped on every 360 degrees.
E1117	Process time over.
E1118	Command value for Jt XX suddenly changed.
E1119	Command value for Jt XX beyond motion range.
E1120	Current command causes interference betw Jt2 and Jt3.
E1121	Other robot is already in the interference area.
E1122	Unexpected motor power OFF.
E1123	Speed error jt XX.
E1124	Deviation error of Jt XX.
E1125	Velocity envelope error jt XX.
E1126	Command speed error of jt XX.
E1127	Command acceleration error of jt XX.
E1128	Uncoincidence error betw destination and current jt XX pos.
E1129	External axis Jt XX moved while holding them.
E1130	Jt XX collision was detected.
E1131	Jt XX unexpected shock is detected.
E1132	Motor power OFF. Measurement stopped.
E1133	Conveyor has reached max. value position.
E1134	Abnormal work transfer pitch of conveyor.
E1135	Motor power OFF.
E1136	Standard terminal is not connected.
E1137	Cannot input/output to teach pendant.
E1138	Aux. terminal is not connected.
E1139	DA board is not installed.
E1140	No conveyor axis.
E1141	Conveyor transfers beyond sync. zone.
E1142	No traverse axis.
E1143	Conveyor axis number is not set.

E1144	No Arm control board.
E1145	Cannot use specified channel, already in use.
E1146	[LSEQ]Aborted by processing time over.
E1147	Cannot open setting file, so cannot set to shipment state.
E1148	Cannot read setting file, so cannot set to shipment state.
E1149	Cannot open setting data, so cannot set to shipment state.
E1150	Cannot read setting data, so cannot set to shipment state.
E1151	Too much data for setting to the shipment state.
E1152	Name of setting data for shipment state is too long.
E1153	Power sequence board detected error.(Code=XX)
E1154	Option SIO port not installed.
E1155	A/D converter is not installed.
E1156	[ARM CONTROL BOARD] Processing time over.
E1157	Arm ID I/F board error. (code XX)
E1158	(SSCNET) Servo error in jt XX.
E1159	(SSCNET) Error code for servo is (XX).
E1160	(SSCNET) Servo error and monitor setting error of jt XX.
E1161	Automatic Tool Registration not supported by robot model.
E1162	Buffer overflow occurred in the gravity comp. value channel XX.
E1163	Robot stopped in checking operational area.
E1164	[LSEQ]Program execution error at control power ON.(code XX)
E1165	Unable to download ext. axis parameter.(Jt-A)
E1166	Num. not assigned to specified channel.(Jt-A)
E1167	Unable to download ext. axis parameter.(Jt-B)
E1168	Num. not assigned to specified channel.(Jt-B)
E1169	Error in servo parameter change sequence.(code XX)
E1170	Slave is not ready.
E1171	CC-LINK communication board is not installed.
E1172	Weld communication board is not installed.
E1173	Servo communication error Jt XX.
E1174	AD board No.0 is not installed.
E1175	Offset data of zeroing is illegal value.(Robot XX)
E1176	(SSCNET) Download error of external axis parameter.
E1177	(SSCNET) Joint number is not assigned to the channel.
E1178	Communication error between Arm Control and Arm I/F board.
E1179	The current under bending compensation is too large.(jt XX)
E1180	Download error of external axis parameter.(Jt XX)

E1181	Encoder battery low voltage.[Servo(XX)]
E1182	Encoder battery low voltage.[External axis(XX)]
E1183	Because JT5 is not zero degree, cannot move along straight line.
E1184	Illegal configuration for motion.
E1185	JT1 and JT2 is interfered at start location.
E1186	JT1 and JT2 is interfered at end location.
E1187	Current command between Jt1 and Jt2 is interfered.
E1188	(SSCNET) Error in servo parameter change sequence.(code XX)
E1189	(SSCNET) Regenerative error of Jt XX.(code XX)
E1190	(SSCNET) Speed error of Jt XX.(code XX)
E1191	(SSCNET) Motor overload of Jt XX.(code XX)
E1192	(SSCNET) Deviation error of Jt XX.(code XX)
E1193	(SSCNET) Encoder battery of Jt XX is low voltage.(code XX)
E1194	(SSCNET) Parameter warning of Jt XX.(code XX)
E1195	(Dual servo) Deviation error between master joint and slave joint.
E1196	While lifter is locked, it can not move.
E1197	Compensation LS signal is not dedicated.
E1198	Brake check sequence error.
E1199	Brake check function is not supported by servo software ver.
E1200	(Dual servo) Cannot compensate current error (deviation XX).
E1201	Interference check board is not installed.
E1202	Voice recorder cannot stop.
E1203	LS location is not registered.
E1204	Current stretch over the limit.
E1205	Total stretch over the limit.
E1207	The type of I/O board on arm ID board is wrong.
E1208	Download error of servo parameter.(Jt XX)
E1209	Upload error of servo parameter.(Jt XX)
E1210	Cannot execute program because unprotected.
E1211	Because the memory was full, could not copy the program.
E1212	Because the memory was full, the copy of program was suspended.
E1213	JT4 and robot arm interfere during motion to start pose.
E1214	JT4 and robot arm interfere during motion to end pose.
E1215	Current command causes interference between JT4 and robot arm.
E1216	JT5 and JT6 interfere during motion to start pose.
E1217	JT5 and JT6 interfere during motion to end pose.
E1218	Current command causes interference between JT5 and JT6.

E1219	Exceeds allowable No. of output instructions for the path.
E1220	Signal output point is out of the path.
E1221	Too many signal numbers are specified.
E1222	Motion instruction to start/end point of path not set.
E1223	No pose data in last/next motion instruction.
E1224	Several signal output points detected at the same point.
E1225	Correction end instruction is missing.
E1228	JT4 value in the start point is not 0 degree.
E1229	JT4 value in the target point is not 0 degree.
E1230	Flange faces direction of upper sphere in start point.
E1231	Flange faces direction of upper sphere in target point.
E1232	Option CPU board is not installed.
E1233	IJoint/ILinear signal not specified.
E1234	IJoint/ILinear signal not detected.
E1235	Separate control I/O board is not installed.
E1236	Distance is too long to correct.
E1237	Vision recognition error.
E1238	Vision communication error.
E1239	Cannot use this instruction in frame correction mode.
E1240	BASE FRAME is not sent from vision unit.
E1241	Improper parameter for FN481.
E1242	Cannot create more than 99 BASE FRAME.
E1243	Cannot execute because camera XX is disconnected.
E1244	JT1 and JT2 and floor interfere during motion to start pose.
E1245	JT1 and JT2 and floor interfere during motion to end pose.
E1246	Current command causes interference between JT1, JT2 and floor.
E1247	Calculation of encoder absolute data is not completed.(jt XX)
E1248	EEPROM access flag in encoder is busy.(jt XX)
E1249	Temperature in encoder is over the limit.(jt XX)
E1250	Rotation speed of encoder is over the limit.(jt XX)
E1251	EEPROM access error occurred in encoder.(jt XX)
E1252	Encoder rotation data (internal) is abnormal.(jt XX)
E1253	Uncoincidence error between request and response in encoder.(jt XX)
E1254	MC of a group XX is OFF, it cannot operate.
E1255	The motor power of unchosen robot was turned on.
E1256	Internal valve, sensor and error reset I/F board missing.
E1257	MC of group XX turned off during individual repeat operation.

E1258	MC turned off during operation.
E1259	Invalid Structure of palletizing instruction.
E1260	Cannot execute instruction during palletizing motion.
E1261	Palletizing motion aborted.
E1262	Encoder rotation speed exceeded limit (jt XX)
E1263	Encoder temperature exceeded limit (jt XX)
E1264	Velocity envelope error in endless rotation axis.(jt XX)
E1267	The initial setting of Encoder is abnormal. (jt XX)
E1268	Breakage in the encoder line or faulty setting of encoder baud rate. (jt XX)
E1269	The program is for other robot.
E1270	The pose variable is for other robot.
E1271	Interference between arm and floor at start pose.
E1272	Interference between arm and floor at end pose.
E1273	Command causes interference between arm and floor.
E1274	JTXX Over speed in heavy load mode.
E1275	JTXX Beyond the motion range in heavy load mode.
E1276	Start point JTXX is beyond the motion range in heavy load mode.
E1277	End point JTXX is beyond the motion range in heavy load mode.
E1278	Can't slant wrist any more.
E1279	Wrist does not face vertically down at start point.
E1280	Wrist does not face vertically down at end point.
E1281	Command to JT4 over limit.
E1282	Cannot operate because a MC of a group XX(JTXX) is off.
E1283	analysis) The E1035 error occurs frequently. JTXX
E1284	analysis) The E1035 and E1029 error occur at the same time. JT XX
E1285	analysis) The E1035 and E1036 error occur at the same time. JT XX
E1286	analysis) The E1035 and E1032 error occur at the same time. JT XX
E1287	Power module error Jt XX (UP).
E1288	Power module error Jt XX (LOW).
E1289	[Servo boardXX] Synchronous error.(Servo FPGA)
E1290	Jt XX The voltage of the current sensor exceeded the upper bound value.
E1291	Jt XX Current sensor is disconnected or out of order.(U)
E1292	[Servo board XX] Input abnormal signal from MCXX.
E1293	[Servo board XX]FB current setting gain data is abnormal.
E1294	[Servo board XX] I/O 24V is low.
E1295	[Servo board XX] 24V for internal valve is low.
E1296	[Servo board XX]Mismatch in safety circuit LS conditions.

E1297	[Servo board XX]Mismatch in jumper wiring of internal pressure.
E1298	[Servo board XX]Mismatch in LS override switch.
E1299	[Servo board XX]Jumper wiring of internal pressure is disconnected.
E1300	[Servo board XX] DC 24V is abnormal.
E1301	[Servo board XX]Soft or servo is not compatible with encoder type.
E1302	[MCXX] OFF check is abnormal.(Servo board XX)
E1303	[MCXX]OFF check of safety relay is abnormal.(Servo board XX)
E1304	[MCXX]Incorrect operation of K1.(Servo board XX)
E1305	[MCXX]Incorrect operation of K2.(Servo board XX)
E1306	[MCXX]Incorrect operation of rush control relay.(Servo board XX)
E1307	[MCXX]Incorrect operation of safety relay KS1.(Servo board XX)
E1308	[MCXX]Incorrect operation of safety relay KS2.(Servo board XX)
E1309	[MCXX]Incorrect operation of safety relay KS3.(Servo board XX)
E1310	[MCXX]Incorrect operation of motor power ON relay.(Servo board XX)
E1311	[MCXX]Incorrect operation of safety circuit motor OFF relay.(Servo board XX)
E1312	[MCXX]Mismatch in safety circuit motor OFF relay.(Servo board XX)
E1313	[MCXX]Mismatch in MC control of safety circuit.(Servo board XX)
E1314	[MCXX]Thyristor Thermal is abnormal.(Servo board XX)
E1315	[I/O board(No. XX)]Watch dog timeout error.
E1316	[I/O board(No. XX)]Access Error.[Address: XX]
E1317	[Servo Board(No. XX)]Response from monitor is abnormal. [code: XX]
E1318	[MCXX]DC 20V is abnormal.(Servo board XX)
E1319	Internal valve , sensor and error reset I/F board No.2 is not installed.
E1321	[Main CPU board]Servo board(XX) communication error.(code XX)
E1322	Mismatch in setting of safety circuit between Power Seq B'd and MC XX. (Srv B'd XX)
E1323	Mismatch in setting of safety circuit between Servo board XX and MCXX.
E1324	Safe circuit disconnected between Power sequence board and Servo board XX.
E1325	Safe circuit disconnected between Servo board XX and MCXX.
E1326	Safety fence is open.
E1327	[Power sequence board]Mismatch in motor off relay condition on safety circuit.
E1328	[Power sequence board]Error of motor off relay on safety circuit.
E1329	[Power sequence board] Error in TEACH/REPEAT switch condition on safety circuit.

E1330	[Power sequence board]IO 24V is low.
E1331	[Power sequence board]Thermal error.
E1332	[Power sequence board]Servo board XX power error signal was detected.
E1333	Unexpected OFF of motor power status signal.(Servo board XX) (MC XX)
E1334	Mismatch of TEACH/REPEAT switch condition between safety circuit and monitor.
E1335	Unexpected motor power OFF.(Servo board XX)(MC XX)
E1336	[Servo board XX]Communication error with Main CPU board .
E1337	[MC XX]Brake power is abnormal.(Servo board XX)
E1338	[MC XX]P-N low voltage.(Servo board XX)
E1339	[MC XX]P-N high voltage.(Servo board XX)
E1340	[MC XX]Regenerative time over.(Servo board XX)
E1341	[MC XX]Regenerative resistor overheat.(Servo board XX)
E1342	Motor harness disconnected or robot temperature exceeded limit. (MC XX)
E1343	Mismatch in wiring brake and software setting.(Jt XX)
E1344	Jt XX Current sensor is disconnected or out of order.(V)
E1345	[Servo board XX]Limit switch signal line is disconnected.
E1346	Jt XX Fail to get encoder full data.
E1347	[MC XX]Destination spec is incorrect.(Servo board XX)
E1348	[MC XX]Controlled target is incorrect.(Servo board XX)
E1349	[MC XX]Explosion proof setting is mismatch.(Servo board XX)
E1350	[MC XX]MC specification error.[code XX](Servo boardXX)
E1351	[MC XX]MC OFF delay specification is incorrect.(Servo board XX)
E1352	Mismatch in setting of code between software and power block. (Jt XX)
E1353	[Main CPU board]CPU temperature is abnormal.
E1354	[Main CPU board]Temperature in CPU board exceeded limit.(XX 1/1000 deg C)
E1355	Error in servo I/F command communication.(code: XX)
E1356	The tool shape is not set.
E1357	Failed to download ext. axis parameter data.(Jt-C)
E1358	Axis No. is not assigned to the specified channel.(Jt-C)
E1359	JT XX axis U, phase overcurrent.
E1360	JT XX axis V, phase overcurrent.
E1361	JT XX axis W, phase overcurrent.
E1362	[Servo boar XX]Speed of tool center point exceeded safety speed.
E1363	[Servo board XX]Speed of flange center point exceeded safety speed.
E1364	[ARM CONTROL BOARD] Out of command synch, between IF and SV.

E1365	TEACH KEY SWITCH is ON in two or more places.
E1366	Watchdog error in No XX ANYBUS interface board.
E1367	Improper parameter value for KI481.
E1377	[Main CPU board]Speed of tool center point exceeded safety speed.
E1378	[Main CPU board]Speed of flange center point exceeded safety speed.
E1379	[Main CPU board]Deviation error of JTXX.
E1382	[Servo board%d]Valve , sensor I/F board missing.
E1392	Servo software does not support deviation alarm function.
E1396	PLC stopped.
E1397	PLC has not started.
E1398	The Teach enabling signal turned off.
E1399	The specifications of a power sequence board differ.
E1401	[Power sequence board]The state of safety unit and relay(line XX) is inharmonious.(code:XX)
E1402	[Power sequence board]The safety circuit (line XX) of a power sequence board is disconnected.
E1403	[Power sequence board] 24V for I/F low voltage.
E3800	JT XX axis amp servo amp heating
E3801	JT XX axis amp main circuit power supply decrease
E3802	Encoder harness disconnected jt XX
E3803	JT XX axis amp speed control error
E3804	JT XX axis amp velocity feedback error
E3805	Jt XX axis amp position envelope error
E3806	JT XX axis amp servo ready does not turn on
E3807	JT XX axis amp IPM overheated.
E3808	Motor power OFF (EXT_EMG).
E3809	Brake release signal error
E3810	Power sequence ready off
E3811	JT XX axis amp command value suddenly changed.
E3900	Mismatch moving tool data and selected tool data.
E4000	Data communication error.
E4001	Data reading error.
E4002	Data write error.
E4003	Unexpected error in file access.
E4004	Communication retry error.
E4005	Communication process was stopped.
E4006	Receive no data after request.

E4007	Receiving data is too long(MAX=255 characters).
E4008	Abnormal data (EOT) received in communication.
E4009	Communication time out error.
E4010	Terminal already in use.
E4011	Communication port already in use.
E4012	Waiting for input of PROMPT. Connect input device.
E4013	TELNET) SEND error. CODE=XX
E4014	TELNET) RECV error. CODE=XX
E4015	TELNET) IAC receive error. CODE=XX
E4016	TELNET) Close failure. CODE=XX
E4017	TELNET) Main socket close failure. CODE=XX
E4018	TELNET) System error. CODE=XX
E4019	TCPIP) Socket open failure. CODE= XX Dst.IP=XX.XX.XX.XX
E4020	TCPIP) Socket close failure. CODE= XX Dst.IP=XX.XX.XX.XX
E4021	TCPIP)Communication Error. CODE= XX Dst.IP=XX.XX.XX.XX
E4022	TCPIP)Message is too long.
E4023	TCPIP)Cannot reach the Host.
E4024	TCPIP)Communication Time Out. Dst.IP=XX.XX.XX.XX
E4025	TCPIP)Connection aborted.
E4026	TCPIP)No Buffer Space.
E4027	TCPIP)Bad Socket.
E4028	FTP)Data receive error.(code=XX)
E4029	FTP)Data send error.(code=XX)
E4030	FTP)Server does not recognize command.(code=XX)
E4031	FTP)Failed to disconnect with FTP server.(code=XX)
E4032	FTP)Unregistered OS detected.
E4033	FTP)Failed to connect with server.(code=XX)
E4034	FTP)Failed to receive HOST OS information.(code=XX)
E4035	FTP)TCP/IP not initialized.
E4036	FTP)FTP service busy now.
E4037	FTP)Failed AUTO-SAVING.
E4050	No response from the FDD/PC_CARD driver board.
E4051	No communication with FDD/PC_CARD driver board.
E4052	[FDD/PC_CARD]Failed to set verify function. Please set again.
E4053	Channel error.
E4054	TCPIP)Cannot execute because Ethernet board not installed.
E4055	TCP)Cannot create a socket.

E4056	TCP)This port is not in LISTEN (SOCK).
E4057	TCP)Illegal Socket ID.
E4058	Failed download to FDD/PC_CARD driver board.
E4059	ASCYCLE communication receive error(CODE:XX)
E4060	[ARM CONTROL BOARD] ASCYCLE communication receive error(CODE:XX)
E4061	Received gauge hole data exceeds allowable range.
E4062	Master/slave data is not registered.
E4063	Reference point data is not registered.
E4064	3D calibration/measurement modes are both ON.
E4065	Unregistered variable specified to receive data.
E4066	Variable specified to receive data is broken.
E4067	Received data is broken.
E4068	Start code is not correct.
E4069	End code is not correct.
E4070	3D camera group No. not specified.
E4071	Incorrect 3D camera group No.
E4072	Communication beginning wait time out error.
E4073	No servo off signal from ARM I/F board.
E4074	[Servo board XX]No response from MCXX.(code: XX)
E4075	[Servo board XX]MCXX communication error.(code: XX)
E4076	[MCXX]Servo board XX communication error.(code: XX)
E4077	[Servo board XX]Communication error with AS.(code: XX)
E4078	[Servo board XX]Error in command communication with the main CPU board.(code: XX)
E4082	[Servo board%d]Error is communication with Cubic-S.(code:%04X)
E4500	ANYBUS)IN-AREA request timeout. XX
E4501	ANYBUS)OUT/FB.CTRL release timeout. XX
E4510	DN)Master status. XX
E4511	DN)Node status. XX
E4512	ABM-DN)Mailbox error.
E4520	ABMA-PDP)Status STOP. XX
E4521	ABMA-PDP)Status OFFLINE. XX
E4522	ABMA-PDP)I/O data Communication error. XX
E4523	ABMA-PDP)Sending of timed out I/O data. XX
E4524	ABMA-PDP)Timeout of receiving I/O data. XX
E4525	ABMA-PDP)Timeout of sending message. XX

E4526	ABMA-PDP)Timeout of receiving message. XX
E4527	ABMA-PDP)Check configuration data. XX
E4528	PROFIBUS)Slave Diag-error response detected. XX
E4529	PROFIBUS)Statistic counter-error response detected. XX
E4530	DN)DeviceNet cable is disconnected.
E4531	CC-LINK)Communication has been disconnected. XX
E4532	CC-LINK)Initial condition setting is incorrect.
E4533	CC-LINK)Watch dog timeout error.
E4534	CC-LINK)Parameter setting error. XX
E4535	CC-LINK)Time out on setting parameter.
E4536	CC-LINK)Master board is abnormal. XX
E4537	CC-LINK)Initialization error on master board . XX
E4538	CANopen)Network is disconnected.
E5000	Connected permission signal has not been turned ON.
E5001	RWC type is not process control type.
E5002	1GS board is not process control type.
E5003	Illegal extend (retract) output signal.
E5004	Weld completion signal already input.
E5005	(Spot welding) Welding schedule setting data is abnormal.
E5006	CLAMP SPEC is not set as PULSE.
E5007	Servo weld gun not connected or wrong gun connected.
E5008	Tip wear measurement (STAGE1) was not executed.
E5009	Work sensing signal(gun tip touch signal) is not set.
E5010	Servo weld gun mechanical parameter is not set.
E5011	This clamp number already set for servo weld gun axis.
E5012	Cannot change the gun because offset data is abnormal.
E5013	Cannot change multiple guns at the same step.
E5014	Cannot execute, gun connected to another joint.
E5015	Gun status data disagrees with clamp condition.
E5016	Data of SRVPRESS is wrong.
E5017	Wear base data is not registered.
E5018	Weld completion signal has not been detected.
E5019	Weld fault signal is detected.
E5020	Retract pos. monitor error.
E5021	Extend pos. monitor error.
E5022	Current gun retract position differs from a destination.
E5023	Wear is abnormal, cannot take measurement.

E5024	Pressurization comp. signal has not been detected.
E5025	Gun opening comp. signal has not been detected.
E5026	(Spot welding) RWC error. XX
E5027	Robot stopped in welding.
E5028	Cannot achieve set force.
E5029	Gun tip stuck.
E5030	Copper plate wear exceeds limit. step=XX
E5031	Weld completion signal is not turned OFF.
E5032	Calibration did not end normally.
E5033	Cannot weld because of abnormal thickness.
E5034	Tip wear exceeds limit. (MOVING SIDE)
E5035	Tip wear exceeds limit. (FIXED SIDE)
E5036	Incorrect gun status data.
E5037	Tip wear exceeds limit. XX:
E5038	Arc detection signal did not turn OFF.
E5039	No response from RWC communication I/F board.
E5040	Cannot connect gun because gun is already connected.
E5041	Cannot disconnect gun because gun is already disconnected.
E5042	Gun No is not defined or Gun type is not servo gun.
E5043	Communication error in welder. (code XX)
E5044	Failed to get weld data. (timer XX)
E5045	Failed to change weld data. (timer XX)
E5046	Weld error has arisen.
E5047	Receiving weld items now, wait till completion.
E5048	Weld controller is unconnected or weld items are not received. (timer XX)
E5049	Serial number signal error.
E5050	This welder is without Traceability.
E5051	Cannot calibrate because tool change axis is disconnected.
E5052	The pressurizing power measurement value is abnormal.
E5053	The pressurizing power sensor is disconnected or it breaks down.
E5054	The selector switch on TP is set to manual operation.
E5055	The selector switch on TP is set to automatic operation.
E5056	No Initialization Weld board.
E5057	Initialization failure in Initialization Weld board.
E5058	Welder (DENGEN COMPANY) not connected. (welder XX)
E5059	Welder (DENGEN COMPANY) response error. (welder XX)
E5060	Initialization Weld board protected. (welder XX)

E5061	Welder (DENGEN COMPANY) data process not execute. (welder XX)
E5062	Welder (DENGEN COMPANY) data process error. (welder XX)
E5063	Weld error has arisen. (code XX)
E5064	Welder (DENGEN COMPANY) of weld was aborted. (welder XX)
E5065	Welder (DENGEN COMPANY) error has arisen. (welder XX)
E5066	Waiting weld completion time out.(welder XX)
E5067	Magnet control is abnormal.(welder XX)
E5500	Vision board is not installed.
E5501	(Vision) Camera not connected.
E5502	(Vision) Incorrect parameter.
E5503	(Vision) Incorrect Symbol.
E5504	(Vision) Incorrect name.
E5505	(Vision) Incorrect image memory.
E5506	(Vision) Incorrect histogram data.
E5507	(Vision) Incorrect mode.
E5508	(Vision) Incorrect density(/color).
E5509	(Vision) Incorrect camera input assignment.
E5510	(Vision) Incorrect camera ch. number.
E5511	(Vision) Incorrect Window No.
E5512	(Vision) Incorrect coordinates data.
E5513	(Vision) Incorrect number.
E5514	(Vision) Incorrect image code(binary/multi).
E5515	(Vision) Incorrect threshold.
E5516	(Vision)PROTO(/TEMPLATE) not registered or already exists.
E5517	(Vision) Cal. data not registered.
E5518	(Vision) Graphic cursor is not initialized.
E5519	(Vision) Too many samples from PROTO object.
E5520	(Vision) Too many targets detected.
E5521	(Vision)Vision command not initiated.
E5522	(Vision) System registered with abnormal data.
E5523	(Vision) Error in processing image(s).
E5524	(Vision) Sound port assigned another function.
E5525	(Vision) Lack of data storage area.
E5526	(Vision) Incorrect synch. mode.
E5527	(Vision)Vision processing now.
E5528	(Vision) Image capture error.
E5529	(Vision) Time out or Buffer overflow.

E5530	(Vision) Failed to write on flash memory.
E5531	(Vision) Proto data abnormal, so initialized.
E5532	(Vision) Work detection failure.
E5533	(Vision) Initialization error. Code = XX
E5534	(Vision) Vision system error.
E5535	(Vision) Specified motion mode is incorrect.
E5536	(Vision) Inappropriate camera/projector parameters.
E5537	(Vision) Incorrect camera switch assignment.
E5538	(Vision) This plane is assigned to another camera.
E5539	(Vision) Edge was not found.
E5540	(Vision) Inappropriate HSI data.
E5541	(Vision) H data range width is over 128.
E5542	(Vision) Distance image input unit not set for camera.
E5543	(Vision) Cannot calculate the set edge points.
E5544	(Vision) Check color conversion table type in set config.
E5545	(Vision) Incorrect area size.
E5546	(Vision) Slit image does not exist.
E5547	(Vision) Incorrect no. of correlation vectors.
E5548	(Vision) Inappropriate vector data.
E5549	(Vision) X-Fit environment was not set.
E5550	(Vision) Mouse is not initialized.
E5551	(Vision)Camera switcher board is not installed.
E6000	Explosion proof teach pendant is not connected.
E6001	Step after XD(2)START must be LMOVE or HMOVE.
E6002	Signal condition already input.
E6003	Door open detect signal is not dedicated.
E6004	Location data was not detected.
E6005	Incorrect setting of barrier unit.
E6006	Signal not detected.
E6007	Wrist can't be straightened any more (Singular point 1).
E6008	Wrist can't be bent any more (Singular point 2).
E6009	Purge air flow is insufficient.
E6010	Out of motion area XYZ.
E6011	Pressure within enclosure is low.
E6012	Relative distance between guns is too near.
E6013	No free memory in program queue.
E6014	No free memory in delayed start queue.

E6015	Special signal is not specialized.
E6016	Robot arm stretching out (Singular Point 3).
E6017	Out of mechanical XYZ motion limits.
E6018	Painting equipment control board error. (code XX)
E6019	Painting equipment control board is not installed.
E6020	Monitoring Robot ID is duplicate..
E6021	Robots do not specify each other's ID.
E6022	Duplicate Mutual-Wait IDs.
E6023	(Mutual-Wait) Communication error in Mutual-Wait.
E6024	Wrist can't bend any further left/right (Singular Point 1).
E6025	(conveyer synchronous communications)It is a conveyer position reception error.
E6026	Guns are too near in X direction (ID:XX).
E6027	Guns are too near in Y direction (ID:XX).
E6028	Guns are too near in Z direction (ID:XX).
E6029	[Servo board XX]Mismatch in internal pressure of safety relay.
E6030	[Servo board XX]Pressure within enclosure is low.
E6031	Monitoring Robot ID is invalid.
E6032	[Purge control board] Pressure within enclosure is low.(during purging)
E6033	Painting equipment error. (code XX)
E6034	Cartridge table rotate command is abnormal.
E6500	No welding Interface board.
E6501	No.2 welding Interface board not found.
E6502	Arc failure.
E6503	Wire stuck.
E6504	Arc start failure.
E6505	Arc weld insulation defect.
E6506	Torch interference.
E6507	Illegal interpolation data.
E6508	No D/A board for polarity ratio control.
E6509	No work detected.
E6510	Undefined sensing direction.
E6511	Insufficient num. of sensing points.
E6512	Undefined mother or daughter work.
E6513	Too many sensing points.
E6514	Work specification incorrect.
E6515	Incorrect sensing point specified.

E6516	Wire check failure.
E6517	Incorrect weld condition number.
E6518	No weld condition data set.
E6519	Weld condition data is out of range.
E6520	Laser sensor tracking value exceeded.
E6521	Beyond Laser sensor tracking ability.
E6522	Laser sensor cannot detect welding joint.
E6523	Calibration data between torch and camera is not ready.
E6524	Error in data calculated using Laser sensor.
E6525	Cannot detect weld joint, Laser sensor tracking set already.
E6526	No response from Laser sensor controller.
E6527	Laser sensor communication error. Code is XX.
E6528	Start point not found by Laser sensor.
E6529	Finish point not found by Laser sensor.
E6530	Cannot use circular interp. with Laser sensor function.
E6531	Cannot turn Laser ON because motor power is OFF.
E6532	No communication board to Laser sensor.
E6533	No RTPM board.
E6534	Too many taught points for RTPM.
E6535	RTPM arc sensor error.
E6536	RTPM current deviation error.
E6537	RTPM tracking value is out of range.
E6538	Beyond RTPM tracking ability.
E6539	AVC tracking value is out of range.
E6540	Beyond AVC tracking ability.
E6541	No AVC board.
E6542	AVC voltage deviation error.
E6543	Too many taught points for AVC.
E6544	Hyper Arc tracking value is out of range.
E6545	Beyond Hyper Arc tracking ability.
E6546	Bead end is not found.
E6547	Finish end is not found.
E6548	Hyper Arc revolution beyond normal deviation.
E6549	Hyper Arc torch calibration error.
E6550	Hyper Arc Z phase index error.
E6551	No Hyper Arc board.
E6552	Hyper Arc board error. Code is XX.

E6553	Hyper Arc current sensor error.
E6554	Hyper Arc voltage sensor error.
E6555	Hyper Arc current deviation error.
E6556	Hyper Arc amplifier error. Code is XX.
E6557	No Wire feeding Control board.
E6558	Wire feeding control error, code is XX.
E6559	Wire feeding speed deviation error.
E6560	Cannot re-calibrate weld in progress.
E6561	Cannot weld, re-calibration in progress.
E6562	Electric pole stuck.
E6563	KHITS tracking system error. (code = XX)
E6564	The arc weld instruction sequence is incorrect.
E6565	Arc welding Interface board(1LN) is not installed.(robot XX
E6566	FN instructions not executed in the correct order.
E6567	KLS tracking system error.(code= XX)
E6568	Failed in executing command to tracking system.(cmd= XX)
E6569	Taught data exceeds inclination limit for compensation.
E6570	Can not execute because welding now.
E6571	Can not execute because wire inching/retracting now.
E6572	Teach point for circular motion is missing.
E6573	The welding machine is abnormal.(code= XX)
E6574	Sensing of groove: cannot detect edge.
E6575	Sensing of groove: gap error.
E6576	Welder is not ready for operation. (code=XX)
E6577	Deviation is too large. Reset allows non-correction movement.
E6578	Sensing was interrupted due to power OFF. Restore step and retry.
E6579	KI instructions not programmed in the correct order.
E7000	Servo weld gun disconnected.
E7001	Location data includes released gun status data.
E7002	Destination is far from target point.
E7003	The clearance distance of gun XX is set to 0mm.
E7004	Gun tip wear change over the limit. (MOVING SIDE)
E7005	Gun tip wear change over the limit. (FIXED SIDE)
E7006	Clamp number or gun number is not servo weld gun.
E7007	Cannot change tip base data in 1 Stg. because tip wear rate is not set.
E7008	Independent Gun control is not completed.
E7009	Current limit for servo welding gun is abnormal.

E7500	Jt XX Collision is detected.
E7501	Jt XX Unexpected shock is detected.
E7502	AC Fail Process Error = XX
E7503	POWER SEQUENCE setting data incorrect.
E7504	Angle between JT XX is out of range at start location.
E7505	Angle between JT XX is out of range at end location.
E7506	Angle between JT XX is out of range.
E7507	SC1MOVE or SC2MOVE instruction is required after SC1MOVE.
E7508	SC1MOVE instruction is required before SC2MOVE.
E7509	Cannot execute, interpolation conditions are not fulfilled.
E7510	Cannot move with current posture.
E7511	Brake control bit number is duplicated.
E7512	L3C1MOVE or L3C2MOVE instruction is required after L3C1MOVE.
E7513	L3C1MOVE instruction is required before L3C2MOVE.
E7514	Specified parameter is not consistent.
E8200	Not in cooperative mode.
E8201	Unmatch the total of motion instruction in cooperative mode.
E8202	Unmatch step of motion instruction in cooperative mode.
E8203	Cannot use this instruction in cooperative mode.
E8204	Invalid cooperative group No.
E8205	No JMASTER robot.
E8206	Touch Sensing in Cooperative mode is no supported.
E8207	JMASTER robot already exists.
E8208	WSLAVE robot already exists.
E8209	Fixed Point Motion in Cooperative mode is no supported.
E8210	No WSLAVE robot.
E8211	Out of sync.
E8212	Cannot continue non-cooperative instruction in cooperative mode.
E8213	No MASTER robot.
E8214	No SLAVE robot.
E8400	Servo hand opened in clamp ON step.(CLAMP=XX)
E8401	Clamping position of servo Hand is error.(CLAMP=XX)
E8402	Cannot achieve set force of Jt XX.
E8403	NC Joints lock signal not off.
E8404	Interpolation other than joint int. is unavailable.
E8405	It tries to move the Matehan axis with the axis locked.
E8600	(FSJ)Processing condition error. XX

E8601	Gap was over the lower pos. limit.
E8602	Reached the Penetration depth within min.processing time.
E8603	It could not reach the set Penetration depth within the appointed period.
E8604	Pressure cable disconnected.
E8605	Please input two set pressure or more.
E8606	Please input data in ascending order.
E8607	FSJ COUNTER ALARM. XX
E8608	(FSJ) FSJ schedule setting data is abnormal.
E8609	Setting tip force is over limit.
E8610	Setting rotation speed is over limit.
E8611	FSW Logging buffer is full.
E8800	Command value almost exceeds virtual safety fence.(Sphere XX, Line XX)
E8801	Command value almost exceeds virtual safety fence.(Sphere XX, Z Upper)
E8802	Command value almost exceeds virtual safety fence.(Sphere XX, Z Lower)
E8803	Command value almost invades restricted space.(Sphere XX, Part. XX Line XX)
E8804	Command value almost invades restricted space.(Sphere XX, Part XX Z Upper)
E8805	Command value almost invades restricted space.(Sphere XX, Part. XX Z Lower)
E8806	Command value almost exceeds virtual safety fence.(Tool Box, Line XX)
E8807	Command value almost exceeds virtual safety fence.(Tool Box, Z Upper)
E8808	Command value almost exceeds virtual safety fence.(Tool Box, Z Upper)
E8809	Command value almost invades restricted space.(Tool Box, Part. XX)
E8810	Command value almost exceeds virtual safety fence.(Link XX, Line XX)
E8811	Command value almost exceeds virtual safety fence.(Link XX, Z Upper)
E8812	Command value almost exceeds virtual safety fence.(Link XX, Z Lower)
E8813	Command value almost invades restricted space.(Link XX, Part. XX Line XX)
E8814	Command value almost invades restricted space.(Link XX, Part. XX Z Upper)
E8815	Command value almost invades restricted space.(Link XX, Part. XX Z Lower)
E8820	Current value exceeded virtual safety fence.(Sphere XX, Line XX)
E8821	Current value exceeded virtual safety fence.(Sphere XX, Z Upper)
E8822	Current value exceeded virtual safety fence.(Sphere XX, Z Lower)
E8823	Current value invaded restricted space.(Sphere XX, Part. XX Line XX)
E8824	Current value invaded restricted space.(Sphere XX, Part. XX Z Upper)
E8825	Current value invaded restricted space.(Sphere X X, Part. XX Z Lower)
E8826	Current value exceeded virtual safety fence.(Tool Box, Line XX)

E8827	Current value exceeded virtual safety fence.(Tool Box, Z Upper)
E8828	Current value exceeded virtual safety fence.(Tool Box, Z Lower)
E8829	Current value invaded restricted space.(Tool Box, Part. XX)
E8830	Current value exceeded virtual safety fence.(Link XX, Line XX)
E8831	Current value exceeded virtual safety fence.(Link XX, Z Upper)
E8832	Current value exceeded virtual safety fence.(Link XX, Z Lower)
E8833	Current value invaded restricted space.(Link XX, Part. XX Line XX)
E8834	Current value invaded restricted space.(Link XX, Part. XX Z Upper)
E8835	Current value invaded restricted space.(Link XX, Part .XX Z Lower)
E8850	Disabled robot motion.
E8851	Detected area interference.
E8852	Detected arm interference.
E8853	Failed to predict trajectory.
E8854	Detected deadlock.
E8855	No response from interference check board.
E8856	Communication error between interference check board and ARM CONTROL board.
E8857	The number of robots is too many.
E8858	[INTERFERENCE CHECK BOARD] Processing time over.
E8859	[INTERFERENCE CHECK BOARD] Can not receive data from ARM CTRL BOARD.
E8860	[ARM CTRL BOARD] Can not receive data from INTERFERENCE CHECK BOARD.
E8861	Communication error between IL server and ARM CONTROL board.
E8862	Cable disconnected between IL server and ARM CONTROL board.
E8900	Detected torque for load presence is abnormal.
E8901	Detected torque for load absence is abnormal.
E8902	Stopped because motion limitation signal was input.
E9000	Joystick of JTXX is disconnected.
E9100	RSC)Watchdog timer overflow.
E9101	RSC)Overvoltage error. (3.3V)
E9102	RSC)Overvoltage error. (5V)
E9103	RSC)Internal processing time time-out.
E9104	RSC)RSC error occurred.(code:54)
E9105	RSC)Robot number transmission, interprocessor communication error.
E9106	RSC)RSC operation status, interprocessor communication error.
E9107	RSC)I/O output, interprocessor communication error.

E9108	RSC)I/O check, interprocessor communication error.
E9109	RSC)Schedule management, timer synchronization error.
E9110	RSC)Main module, interprocessor communication error.
E9111	RSC)Operation part, interprocessor communication error.
E9112	RSC)Tool number input, interprocessor communication error.
E9113	RSC)I/O Port filtering, interprocessor communication error.
E9114	RSC)Robot diagnosis, interprocessor communication error.
E9115	RSC)RSC error occurred.(code:5F)
E9116	RSC)Ethernet chip writing error.
E9117	RSC)Ethernet chip System. Open failure.
E9118	RSC)RSC error occurred.(code:62)
E9119	RSC)RSC error occurred.(code:63)
E9120	RSC)RSC error occurred.(code:64)
E9121	RSC)Error log addition error.
E9122	RSC)Error log acquisition error.
E9123	RSC)Error log overwrite error.
E9124	RSC)RSC error occurred.(code:68)
E9125	RSC)RSC error occurred.(code:69)
E9126	RSC)Current time initialization error.
E9127	RSC)Current time acquisition error.
E9128	RSC)Current time set point error.
E9129	RSC)RSC error occurred.(code:6D)
E9130	RSC)RSC error occurred.(code:6E)
E9131	RSC)RSC error occurred.(code:6F)
E9132	RSC)CPU error.
E9133	RSC)Memory error.
E9134	RSC)CPU status exchange failure.
E9135	RSC)Firmware CRC error.
E9136	RSC)RSC parameter CRC error.
E9137	RSC)RSC error occurred.(code:75)
E9138	RSC)Mac address CRC error.
E9139	RSC)Initialization failure in "power down backup".
E9140	RSC)RSC error occurred.(code:78)
E9141	RSC)RSC error occurred.(code:79)
E9142	RSC)Power-source monitoring process error.
E9143	RSC)Pulse check error.
E9144	RSC)Readback error.

E9145	RSC)Relay contact check error.
E9146	RSC)Crosscheck error.
E9147	RSC)Input mismatching check error.
E9148	RSC)First-time encoder data receiving time-out.
E9149	RSC)FPGA operation error.
E9150	RSC)RSC error occurred.(code:82)
E9151	RSC)RSC error occurred.(code:83)
E9152	RSC)RSC error occurred.(code:84)
E9153	RSC)RSC error occurred.(code:85)
E9154	RSC)RSC error occurred.(code:86)
E9155	RSC)Command value axes number error.
E9156	RSC)parameter error.(axes number / tool number)
E9157	RSC)"Command value input section" CRC error.
E9158	RSC)Robot number transmitting failure.
E9159	RSC)First command value receive time out.
E9160	RSC)USB communication impossible.
E9161	RSC)command value byte-number corruption.
E9162	RSC)USB Device recognition time-out.
E9163	RSC)command value receive time out.
E9164	RSC)RSC error occurred.(code:90)
E9165	RSC)RSC error occurred.(code:91)
E9166	RSC)RSC parameter read failure.
E9167	RSC)Robot number error.
E9168	RSC)Encoder data movement error.
E9169	RSC)Parameter and RC zeroing data mismatch.
E9170	RSC)TCP Communication Retry count over.
E9171	RSC)Rotary switch number error.
E9172	RSC)RSC error occurred.(code:98)
E9173	RSC)RSC error occurred.(code:99)
E9174	RSC)Parameter setting range over error.
E9175	RSC)Monitoring area parameter setting error.
E9176	RSC)Parameter error at TOOL monitoring invalid.
E9177	RSC)Operation part internal error.
E9178	RSC)RSC error occurred.(code:9E)
E9179	RSC)RSC error occurred.(code:9F)
E9180	RSC)Safety speed over.(TCP)
E9181	RSC)Speed over.(flange point)

E9182	RSC)Axis upper limit over.
E9183	RSC)Axis lower limit over.
E9184	RSC)Outside of a SSL area limit.(partial restricted area)
E9185	RSC)Outside of a SSL area limit.(restriction area)
E9186	RSC)Outside of a SSF area limit.
E9187	RSC)Positioning confirmation processing error.
E9188	RSC)TOOL verification error.
E9189	RSC)Distance error between flanges.
E9190	RSC)RSC error occurred.(code: EA)
E9191	RSC)RSC error occurred.(code: EB)
E9192	RSC)RSC error occurred.(code: EC)
E9193	RSC)RSC error occurred.(code: EE)
E9194	RSC)RSC error occurred.(code: EE)
E9195	RSC)RSC error occurred.(code: EF)
E9196	RSC)RSC error occurred.(code: F0)
E9197	RSC)RSC error occurred.(code: F1)
E9198	RSC)RSC error occurred.(code: F2)
E9199	RSC)RSC error occurred.(code: F3)
E9200	RSC)RSC error occurred.(code: F4)
E9201	RSC)RSC error occurred.(code :F5)
E9202	RSC)RSC error occurred.(code: F6)
E9203	RSC)RSC error occurred.(code :F7)
E9204	RSC)RSC error occurred.(code: F8)
E9205	RSC)RSC error occurred.(code: F9)
E9206	RSC)Encoder receiving timeout error.
E9207	RSC)Encoder receiving timeout error 2.
E9208	RSC)Encoder status error.
E9209	RSC)Encoder data reading Retry count over.
E9210	RSC)RSC error occurred.(code: FE)
E9211	RSC)RSC error occurred.(code:FF)
E9300	Cannot rotate JT XX. Because disconnected axis.
E9301	Cannot rotate JT XX. Because invalid axis.
E9302	Rotation speed setting for JT XX is abnormal.
E9400	[Cubic-S(XX)]Cubic-S is not installed.
E9401	[Cubic-S(XX)]Initialization error.
E9402	[Cubic-S(XX)]Mismatch in XX between robot controller and Cubic-S.(XX)
E9403	[Cubic-S(XX)]System error.(Code:XX)

E9404	[Cubic-S]Parameter may be changed. Turn OFF & ON the control power for verify.
E9405	[Cubic-S]Cannot use with Cubic-S.
E9406	[Cubic-S(XX)]XX (XX) is out of always allowed space.(code XX)
E9407	[Cubic-S(XX)]XX (XX) is in always prohibited space(XX).(code XX)
E9408	[Cubic-S(XX)]XX(XX) is out of selectively allowed space (XX). (code XX)
E9409	[Cubic-S(XX)]XX (XX) is in selectively prohibited space (XX). (code XX)
E9410	[Cubic-S(XX)] JTXX is out of always monitored range of axis. (code XX)
E9411	[Cubic-S(XX)] JTXX is out of selectively monitored range of axis(XX).(code XX)
E9412	[Cubic-S(XX)]XX(XX) speed exceeded 250mm/s.(code XX)
E9413	[Cubic-S(XX)]XX(XX) exceeded the setting speed. (code XX)
E9414	[Cubic-S(XX)]JTXX has moved during monitor for stoppage.(code XX)
E9415	[Cubic-S(XX)]X orientation is out of the tool orientation range(XX).(code XX)
E9416	[Cubic-S(XX)] Deceleration monitor error (JTXX)at protection stop. (code XX)
E9417	[Cubic-S(XX)] Deceleration monitor error (JTXX)at emergency stop. (code XX)
E9418	[Cubic-S(XX)] Deviation error in JTXX(code XX). !!!!Ckeck zeroing data, home pose etc in teach mode.!!!!
E9419	[Cubic-S(XXX)] Encoder value error in JTXX(code XX). !!!!Check zeroing data,home pose etc in teach mode.!!!!
E9420	[Cubic-S(XX)] Command error in JTXX(code XX) at power ON. !!!!Check zeroing, home pose in teach mode.!!!!
E9421	[Cubic-S(XX)] Sudden change of enc. value in JTXX(code XX). !!!!Check zeroing, home pose in teach mode.!!!!
E9422	[Cubic-S(XX)] Software processing error in safety unit.(code XX)
E9423	[Cubic-S(XX)] Safety unit error(code XX)
E9424	[Cubic-S(XX)]Tool numbers do not coincide.(Command XX Current XX) (code XX)
E9425	[Cubic-S(XX)] Relay for internal emergency stop is welded.(code XX)
E9426	[Cubic-S(XX)] Relay for external emergency stop is welded.(code XX)
E9427	[Cubic-S(XX)] Failure in circuit for relay weld detection or in wiring.(code XX)
E9428	[Cubic-S(XX)] External safety relay(user output XX) is welded.(code XX)
E9430	[Cubic-S(XX)] Failure in circuit for driving e-stop relay or in wiring.(code

	XX)
E9431	[Cubic-S(XX)] Failure in circuit for safety output(user XX) or in wiring. (code XX)
E9433	[Cubic-S(XX)] Failure in circuit for safety input (user XX) or in wiring. (code XX)
E9435	[Cubic-S(XX)] Power has dropped. (code XX)
E9436	[Cubic-S(XX)] Error in communication with servo board XX.(code XX)(type:XX)
E9437	[Cubic-S(XX)] Encoder communication error in JTXX.(code XX)
E9439	[Cubic-S(XX)] Encoder failure in JTXX.(code XX)
E9440	[Cubic-S(XX)] Override switch is kept ON.(code XX)
E9442	[Cubic-S(XX)] Parameter values are rewritten in PC for setting parameters.(code XX)
E9444	[Cubic-S(XX)]Coincidence error of safety inputs(user inputsXX) state.(code XX)
E9448	[Cubic-S(XX)]No response from Cubic-S.
E9449	[Cubic-S(XX)]JTXX speed exceeded 250mm/s.(code XX)
E9450	[Cubic-S(XX)]JTXX exceeded the setting speed. (code XX)
E9451	[Cubic-S(XX)] Parameter No.XX is out of range.(code XX)
E9452	[Cubic-S(XX)] External safety relay(fixed output of Teach/FastCheck mode) is welded.(code XX)
E9453	[Cubic-S(XX)] External safety relay(fixed output of teach speed monitor) is welded.(code XX)
E9454	[Cubic-S(XX)] External safety relay(fixed output of override) is welded.(code XX)
E9455	[Cubic-S(XX)] External safety relay(fixed output of emergency stop) is welded.(code XX)
E9456	[Cubic-S(XX)] Failure in circuit for fixed safety output(Teach/FastCheck mode) or in wiring.(code XX)
E9457	[Cubic-S(XX)] Failure in circuit for fixed safety output(teach speed monitor) or in wiring.(code XX)
E9458	[Cubic-S(XX)] Failure in circuit for fixed safety output(override) or in wiring.(code XX)
E9459	[Cubic-S(XX)] Failure in circuit for fixed safety output(emergency stop) or in wiring.(code XX)
E9460	[Cubic-S(XX)] Failure in circuit for fixed safety input (Teach/FastCheck mode) or in wiring. (code XX)

E9461	[Cubic-S(XX)] Failure in circuit for fixed safety input (teach speed monitor) or in wiring. (code XX)
E9462	[Cubic-S(XX)] Failure in circuit for fixed safety input (override) or in wiring. (code XX)
E9463	[Cubic-S(XX)] Failure in circuit for fixed safety input (emergency stop) or in wiring. (code XX)
E9464	[Cubic-S(XX)] Coincidence error of fixed safety input (Teach/FastCheck mode) state.(code XX)
E9465	[Cubic-S(XX)] Coincidence error of fixed safety input (teach speed monitor) state.(code XX)
E9466	[Cubic-S(XX)] Coincidence error of fixed safety input (override) state.(code XX)
E9467	[Cubic-S(XX)] Coincidence error of fixed safety input (emergency stop) state.(code XX)
E9470	[Cubic-S(XX)] Failure in circuit for fixed safety input (enable switch) or in wiring. (code XX)
E9471	[Cubic-S(XX)] Coincidence error of fixed safety input (enable switch) state.(code XX)
E9474	[Cubic-S(XX)] Failure in circuit for fixed safety input (external emergency) or in wiring. (code XX)
E9475	[Cubic-S(XX)] Coincidence error of fixed safety input (external emergency) state.(code XX)
E9478	[Cubic-S(XX)] Failure in circuit for fixed safety input (safety stop) or in wiring. (code XX)
E9479	[Cubic-S(XX)] Coincidence error of fixed safety input (safety stop) state.(code XX)
D0001	CPU error.(PC=XX)
D0002	Main CPU BUS error.(PC=XX
D0003	VME BUS error.(PC=XX)
D0004	[ARM CONTROL BOARD] CPU error.(PC=XX)
D0005	[ARM CONTROL BOARD] CPU BUS error.(PC=XX)
D0006	[ARM CONTROL BOARD] Servo control software CPU error. (PC=XX code XX)
D0007	[Servo boardXX]CPU error. (code XX)
D0008	P-N low voltage. [XX]
D0009	P-N high voltage. [XX]
D0900	Teach data is broken.

D0901	AS Flash memory sum check error.
D0902	Servo Flash memory sum check error.
D0903	IP board memory error (XX).
D0904	Memory is locked due to AC_FAIL.
D1000	Read error of servo control software.
D1001	Download error of servo control software.
D1002	Init. error of servo software.
D1003	Init. error of servo control software.
D1004	[ARM CTRL BOARD] Watch dog error of Servo control software.
D1005	Servo board command error. (XX)
D1006	Servo system error.
D1007	Regenerative time over. [XX]
D1008	P-N low voltage. [XX]
D1009	P-N high voltage. [XX]
D1010	Regenerative resistor overheat. [XX]
D1011	As or servo software is not compatible with the robot model.
D1012	Servo type mismatch. Check the settings.
D1013	P-N capacitor is not discharged.
D1014	Servo system error.(Code= XX)
D1015	The servo data file does not exist.
D1016	Data applicable to the robot model not in servo data file.
D1017	Error of download of servo data.
D1018	Servo software version mismatch.
D1019	[ARM CONTROL BOARD] Watchdog error in timer built-in CPU for servo control.
D1020	[ARM CONTROL BOARD] Synchronous error between CPUs.
D1021	Servo FPGA configuration data not found.
D1022	Configuration error in servo FPGA.(code XX)
D1023	Current mismatch betw. m-plexer & software Jt XX
D1024	[ARM CONTROL BOARD] Servo FPGA detected Watch dog error on ARMSC Software.
D1025	[Servo board XX] Detected Watch dog error.(Servo FPGA)
D1026	[Servo board XX] Input abnormal signal from power sequence board.
D1027	[MCXX] Detected Watch dog error.
D1028	[Servo board XX] DC is abnormal.(Servo FPGA)
D1029	[Servo board XX] AC primary power is abnormal.(Servo FPGA)
D1030	Cannot start communication with the servo board XX.

D1031	Read error of servo software.
D1032	[Servo board XX] Download error of servo software.(code XX)
D1033	Connection Port No(XX) differs from servo board No(XX).
D1034	The servo data file is missing or not acceptable.(code XX)
D1035	[Servo board XX] Init. error of servo software.(code XX)
D1036	[Servo board XX] Download error of servo data.(code XX)
D1037	[Servo board XX] Configuration error in servo FPGA.(code XX)
D1038	[Servo board XX] Upload error of servo software initial data.(code XX)
D1039	[Servo board XX] Download error of servo software initial data.(code XX)
D1040	[Servo board XX] Device check error. (code XX)
D1041	JtXX axis brake release circuit is abnormal.
D1500	Encoder misread error Jt XX.
D1501	Defective gun changer connection or encoder comm. error.
D1502	Amp overcurrent Jt XX.
D1503	Current detector type (XX) mismatch!
D1504	Abn. curr feedback XX. (Amp fail, pwr harness disconnect)
D1505	Motor harness disconnected or amplifier overheated.(XX)
D1506	Power module error Jt XX.
D1507	AC primary power OFF.
D1508	24VDC power source is too low.
D1509	Primary power source is too high.
D1510	Primary power source is too low.
D1511	+12VDC or -12VDC is abnormal.
D1512	Brake line error for jt XX.
D1513	Brake power is abnormal.(XX)
D1514	I/O 24V fuse is open.
D1515	Mismatch in setting of safety circuit as single/double.
D1516	Mismatch betw hard/software settings for HOLD backup time.
D1517	Blown fuse on safety circuit emergency line.
D1518	Mismatch in the Emer. Stop condition on safety circuit.
D1519	Mismatch in safety circuit LS conditions.
D1520	Mismatch in safety circuit TEACH/REPEAT condition.
D1521	Mismatch in safety circuit safety-fence condition.
D1522	Mismatch in cond. of safety circuit enabling device.
D1523	Mismatch in cond. of safety circuit ext.enabling device.
D1524	Incorrect operation of the safety relay.
D1525	Incorrect operation of MC(K1).

D1526	Incorrect operation of MC(K2).
D1527	Incorrect operation of MC(K3).
D1528	Controller temperature is out of range.
D1529	Signal harness disconnected or Encoder power error.
D1530	Abnormal current limit of Jt XX.
D1531	Heat sink on power block overheated.
D1532	(SSCNET) Encoder communication error.(JtXX)(code XX
D1533	(SSCNET) Absolute position of Jt XX is erased.(code XX)
D1534	(SSCNET) Parameter error of Jt XX.(code XX)
D1535	(SSCNET) Alarm of Jt XX.(code XX)
D1536	Jt XX does not move normally.
D1537	[Small Amp] Brake rectifier relay failure.
D1538	[Small Amp] DC 24V is abnormal.
D1539	Power supply circuit for PWM signal output malfunctioned.
D1540	Amplifier overheats.(XX)
D1541	Encoder type set in software and Arm control board mismatch.
D1542	No Rotation data from multidrop encoder at initialize.
D1543	[Servo board XX]DC 5V is abnormal.
D1544	[Servo board XX]DC 3.3V is abnormal.
D1545	[Servo board XX]DC 12V is abnormal.
D1546	[Servo board XX]DC 2.5V is abnormal.
D1547	[Servo board XX]DC 1.2V is abnormal.
D1548	[Servo board XX]DC 1.0V is abnormal.
D1549	[Servo board XX]Primary power source is too low.
D1550	[Servo board XX]Primary power source is too high.
D1551	[Servo board XX]AC primary power OFF.
D1552	[MCXX]DC 3.3V is abnormal.
D1553	[MCXX]DC 5V is abnormal.
D1554	Brake power in servo amplifier is abnormal.
D1555	Amplifier temperature is out of range or regenerative resistor overheats.
D1556	Control power in servo amplifier is abnormal.
D1557	[Power sequence board]DC 3.3V is abnormal.
D1558	[Power sequence board]DC 5V is abnormal.
D1559	[Power sequence board]DC 12V is abnormal.
D1560	[Power sequence board]DC 24V is abnormal.
D1561	[Power sequence board]AC primary power OFF.
D1562	[Power sequence board]AC primary power voltage is too high.

D1563	[Power sequence board]AC primary power voltage is too low.
D1564	[Power sequence board]Remote power off signal was detected.
D1565	Cannot access Power sequence board.
D1566	P-N capacitor is not discharged.(Servo board XX)(MCXX)
D1567	[Servo board XX]Primary Power source is error.
D1568	[Servo board XX] Power supply circuit for PWM signal output malfunctioned.
D1569	Servo amplifier is abnormal.(XX)
D2000	No response from Comm. board for Laser sensor.
D2001	RI/O or C-NET board initialize error.
D2002	No response from the Arm ID board.
D2003	No data in the Arm ID board.
D2004	Mismatch data in the Arm ID board.
D2005	CC-LINK software version mismatch.
D2006	Watch dog error on communication board for Explosion proof TP.
D2007	No response from the built-in sequence board.
D2008	Magnet is Contactor of group XX is stuck.
D2009	Sensor for detecting pressure in enclosure is abnormal.
D2010	Sync. error between User I/F and Arm control board.
D2011	Parameter download error betw User I/F & Arm control boards.
D2012	Soft Absorber error. Turn OFF & ON the control power.
D2013	Change gain error. Turn OFF & ON the control power.
D2014	Robot network initialize error.
D2016	No response from the Arm control board.
D2017	No response from User I/F board.
D2018	[ARM CTRL BOARD] no response.
D2019	[ARM CTRL BOARD] servo software no response.
D2020	[ARM CTRL BOARD] servo control software no response.
D2021	Arm data file is not found.
D2022	Arm data is not found.
D2023	Failed to load arm data.
D2024	[ARM CTRL BOARD] Robot type setting failed.
D2025	Robot codes set in software and Arm ctrl board do not match.
D2026	Codes set in software & curr. sensor I/F b'd do not match.
D2027	Codes set in software and power block do not match.
D2028	(SSCNET) Initialization error. (code XX)
D2029	Motor codes in software & Arm control b'd mismatch.(Jt-A)
D2030	Codes set in software & curr. sensor I/F b'd mismatch.(Jt-A)

D2031	Codes set in software and on add'l pwr block mismatch.(Jt-A)
D2032	Motor codes set in software and Arm ctrl b'd mismatch.(Jt-B)
D2033	Codes set in software & curr. sensor I/F b'd mismatch.(Jt-B)
D2034	Codes set in software and on add'l pwr block mismatch.(Jt-B)
D2035	Program execution error.
D2036	(SSCNET) System error occurred in 1LP I/F board. (code XX)
D2037	Safety unit circuit is abnormal.
D2038	(SSCNET) Interface board is not installed.
D2039	(SSCNET) Communication error of Jt XX on initialization.
D2040	(SSCNET) Initialization error of Jt XX.(code XX)
D2041	Connection of the signal harness is wrong.
D2042	Servo amp and robot arm are mismatched.
D2043	Arm I/F board detects AC-Fail.
D2044	[ARM CONTROL BOARD] No response from Servo FPGA software.
D2045	[ARM CONTROL BOARD] Device check error. (code XX)
D2046	Relay error on purge control board. (relay XX)
D2047	Jumper setting error or Safety relay failure on Servo CPU board.
D2048	DC 12V Voltage source error on purge control board.
D2049	Over current error in interlock relay drive circuit(1) for purge control board.
D2050	Over current error in interlock relay drive circuit(2) for purge control board.
D2051	Communication error on purge control board.
D2052	Hardware setting for the external axis amplifier has discrepancy. robot=n
D2053	(FANXX-XX)Rotational speed of fan is abnormal.(Servo Board XX)
D2054	Codes set in software and power block do not match.(code: XX)
D2055	[Power sequence board]Watchdog error was detected.
D2056	[I/O board(No. XX)]Several boards have same address ID.
D2057	[Servo boardXX]No response from Servo FPGA.
D2058	[Main CPU board]DC is abnormal.(XX mV)
D2059	1SP board is abnormal.(XX)
D2060	Safety unit is abnormal.(XX)
D2061	Mother board is abnormal.(XX)
D2062	1QL board is abnormal.(XX)
D2063	MC unit is abnormal.(XX)
D2064	[Purge control board] Pressure within enclosure is low.
D2065	Safety relay is abnormal which cut off brake power when inner pressure is low.
D2066	[Purge control board] DC is abnormal (12V).

D2067	[Main CPU board] Communication with purge control board is abnormal.
D2068	[IO board No. XX]Device check failure.(code %d)
D2069	[ANYBUS interface board(No. XX)]Several boards have the same ID address.
D3800	Communication board memory error. (XX)
D3801	JT XX axis amp interface error 1
D3802	JT XX axis amp interface error 2
D3803	JT XX axis amp interface error 3
D3804	JT XX axis amp power element error
D3805	JT XX axis amp current detector error
D3806	JT XX axis amp main circuit voltage unmatch
D3807	JT XX axis amp memory error(EEPROM error)
D3808	JT XX axis amp inside RAM error
D3809	JT XX axis amp servo processor error
D3810	JT XX axis amp parameter error
D3811	JT XX axis amp initial processing error
D3812	JT XX axis amp undefinition error1
D3813	Amp communication I/F board initialed check error(XX)
D3814	Amp communication I/F board undefinition error(XX)
D3815	It is not possible to communicate with JTXX axis amp
D3816	JT XX axis amp communication frame reception error
D3817	JT XX axis amp communication frame reception timeout
D3818	JT XX axis amp communication bank data error
D3819	JT XX axis amp init timeout
D3820	JT XX axis amp communication undefinition error
D3821	Motor harness connection point is error.
D3822	Motor parameter is not consistent with controller. JT XX
D3823	FAN NO. XX in Controller is out of order.
D3824	Fuse NO. XX on IO board NO.1 is open.
D3825	Fuse NO. XX on IO board NO.2 is open.
D3826	Robot DC voltage error.
D3828	Controller type error.
D3829	K1 and/or K2 works wrong.
D3830	PN high voltage error
D3831	PN low voltage error
D3832	Register over time error
D3833	Discharge resistor overheated.
D3834	Power board switching circuit is abnormal.

D3835	Power board inrush current limiting circuit is abnormal.
D3836	DC Power voltage is abnormal.(code XX)
D3837	JTXX axis amp control power supply error
D3838	Power board is abnormal.
D3839	Servo control line error.
D3840	FAN NO. XX on power board is out of order.
D3841	Robot XX servo amp is missing.
D3842	Control power supply for a power device is abnormal.
D3843	Brake release setting is abnormal.
D4000	[DIAG]Error is detected in RS232C.(Code: XX)
D4001	[DIAG]Error is detected in Ethernet.(Code: XX)
D4500	Fieldbus interface board is not detected.
D4501	ABMA-PDP)I/F module error. XX XX
D4502	FIELD-BUS-INIT)Error reply. XX
D4503	FIELD-BUS-INIT)Reply timeout. XX
D4504	ANYBUS)OUT/FB.CTRL request timeout. XX
D6000	Over temperature error in Barrier unit.
D6001	Mutual-Wait initialize error.

KAWASAKI ROBOT CONTROLLER T Series
OPERATION MANUAL

Nov 2012 : 1st Edition
Sep 2015 : 3rd Edition

Publication : KAWASAKI HEAVY INDUSTRIES, LTD.

90203-1111DEC

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