FANUC Robot series

R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus/
R-30*i*B Mini Plus CONTROLLER

OPERATOR'S MANUAL(Collaborative Robot Function)

B-83744EN/05

- **Original Instructions**

Thank you very much for purchasing FANUC Collaborative Robot.
Before using the Collaborative robot, be sure to read MECHANICAL UNIT OPERATOR'S MANUAL and understand the content.

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In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

SAFETY PRECAUTIONS

Before using the FANUC collaborative robot, be sure to read MECHANICAL UNIT OPERATOR'S MANUAL (Refer to RELATED MANUALS in PREFACE chapter) to become familiar with those contents.

DEFINITION OF SAFETY NOTATIONS

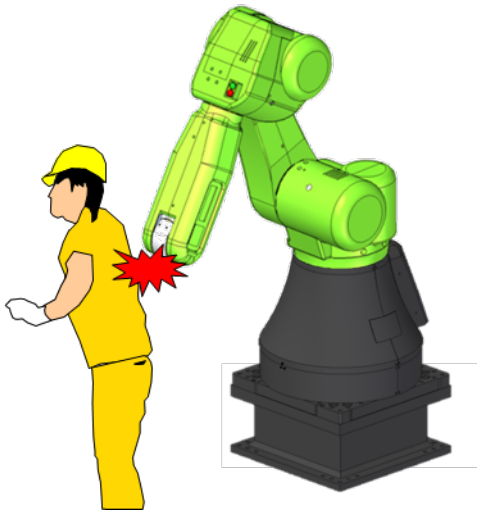
To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Supplementary information is indicated by "**NOTE**". Read the contents of each "**WARNING**", "**CAUTION**" and "**NOTE**" before using the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

PREFACE

The coexistence of human and robot will make a difference in production site from the point of view of productivity, efficiency and so on. However, for coexistence of human and robot, adequate risk assessment for the whole the robot system is necessary to verify the human safety.

Collaborative robot is befitted for this purpose, because the collaborative robot has the contact stop function to stop when the external force exceeds the limit. This function is useful for design of the robot system.



The collaborative robot is certified to meet the requirements of International Standard ISO 10218-1 by an internationally accredited certification body.
The contact stop function is certified to meet the requirements of International ISO 13849-1 for Category 3, PL (Performance Level) d by an internationally accredited certification body.

In order to design the collaborative robot system, it is necessary to understand the collaborative robot function. This manual describes the collaborative robot function use.

RELATED MANUALS

For the FANUC Robot series, the following manuals are available:

R-30*i*B, R-30*i*B Mate, R-30*i*B Plus, R-30*i*B Mate Plus controller	OPERATOR'S MANUAL Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2** Dual Check Safety Function **B-83184EN**	Intended readers : Operator, programmer, maintenance technician, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL **B-83525EN**	Intended readers : Maintenance technician, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance
FANUC Robot CR-4*i*A, CR-7*i*A, CR-7*i*A/L CR-14*i*A/L Mechanical unit	OPERATOR'S MANUAL **B-83774EN**	Intended readers: System designer, Maintenance technician Topics: Installation, connection to controller, maintenance Use: Installation, start-up, connection, maintenance
FANUC Robot CR-35*i*A Mechanical unit	OPERATOR'S MANUAL **B-83734EN**	Intended readers: System designer, Maintenance technician Topics: Installation, connection to controller, maintenance Use: Installation, start-up, connection, maintenance
FANUC Robot CR-15*i*A Mechanical unit	OPERATOR'S MANUAL **B-84054EN**	Intended readers: System designer, Maintenance technician Topics: Installation, connection to controller, maintenance Use: Installation, start-up, connection, maintenance
FANUC Robot CRX-10*i*A, CRX-10*i*A/L Mechanical unit	OPERATOR'S MANUAL **B-84194EN**	Intended readers: System designer, Maintenance technician Topics: Installation, connection to controller, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

Name	Terms in this manual
Robot mechanical unit	Mechanical unit
CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L, CR-15*i*A, CR-35*i*A	CR series
CRX-10*i*A, CRX-10*i*A/L	CRX series

TABLE OF CONTENTS

1 ABSTRACT

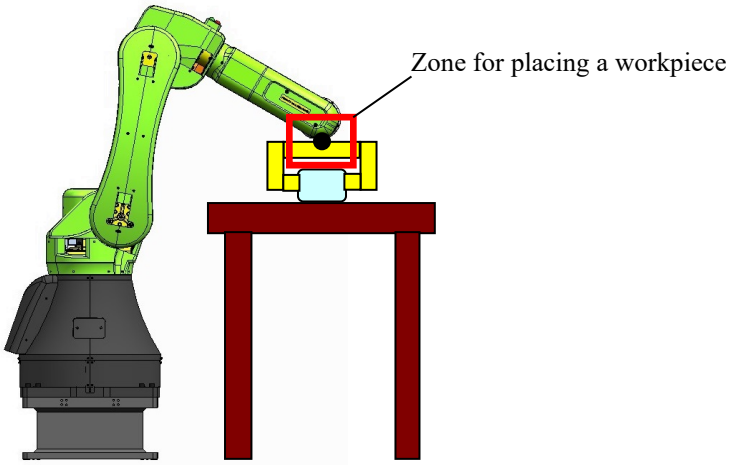
1.1 RESTRICTION OF COLLABORATIVE ROBOT

- Constant path function is needed for the collaborative robot function. So you can NOT use any option unsupported by Constant path function.
- Speed clamping function to reduce speed to the collaborative speed automatically does not works for Jogging, Circular motion, Circle arc motion, Spline motion and Remote tool motion. When the robot moves at over collaborative speed, “SYST-323 Collaborative speed limit (TCP)” or “SYST-359 Collaborative speed limit (Elbow)” is posted, and the robot stops.

1.2 SOFTWARE OPTION FOR COLLABORATIVE ROBOT

Robot library software of Collaborative robot is sufficient for the simple collaborative system.
For more advanced system as followings, DCS function is required. Refer to Chapter 5.

- Limit the area for picking or placing a workpiece
- Disable the contact stop function in specified area



Recommended DCS functions

J567 DCS Position/Speed check function
J568 DCS Safe I/O connection function

(CR series) DCS Joint Position Check function is installed as standard.
(CRX series) DCS Basic Position Check function and DCS Safe I/O connection function are installed as standard.
Refer to Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN) for detail of this function.

1.3 SETUP STEPS

To use the collaborative robot, you must do the followings. You can use the other functions except for the collaborative robot function as same manner as the standard FANUC robot. Refer to each function manual.

1 Set up the collaborative robot function. Refer to Chapter 2. For more detail information of the collaborative robot function, refer to Chapter 4.
2 Perform the payload confirmation operation after every power on. Refer to Chapter 3.
3 Teach production programs. Refer to Chapter 5 of this manual and OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Chapter of PROGRAMMING.
4 (CR series) Make periodical check program of force sensor. Refer to Chapter 6.
5 Run production with above programs. Refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Chapter of EXECUTING A PROGRAM.
6 Set up the special functions of the collaborative robot. Refer to Chapter 7.

If you have any problem of the collaborative robot, refer to Appendix A.

1.4 NOTES

- In the software version 7DF1/10 or later, “Enable UI signals” is disabled by default. When you use UI signals, enable “Enable UI signals”. Refer to OPERATOR’S MANUAL (Basic Operation) (B-83284EN), Section of SYSTEM CONFIG MENU.
- In the software version 7DF1/10 or later, payload setting no.1 is set to 0kg and selected by default. When you attach an end effector to the robot, set the payload setting correctly. When you move the robot with fault payload setting, “SYST-325 Payload error is detected” might occur. Refer to OPERATOR’S MANUAL (Basic Operation) (B-83284EN), Section of PAYLOAD SETTING.
- On CRX series, cartesian motions become WJNT motion when wrist configures differ between start and destination positions if Singularity Avoidance function is disabled. Therefore, wrist joints’ behavior can change when Offset option is used like below. If you want to disable this function, make the item “Wjnt when config changes:” FALSE on the System/Config screen.
  - The turn numbers performed are not always the same to taught position’s on linear motion because the robot tool moves toward the target point while adopting an attitude very similar to that at the start point
  - If Offset option on the line 2 is removed from the TP program below, J6 goes to not -175 degrees but 185 degrees.
  - With Offset option, J5 is fixed and wrist configure changes so line 2 is added WJNT option. With WJNT option, taught position’s joint angles are performed so J6 goes to -175 degrees on line 2.

```
    1:J P[1] 100% FINE      ;
    2:L P[2] 1000mm/sec FINE Offset,PR[1]      ;

P[1]{
    GP1:
            UF : 0, UT : 1,
            J1=       0.000000 deg,       J2=       0.000000 deg,       J3=       0.000000 deg,
            J4=       0.000000 deg,       J5=      -5.000000 deg,       J6=     175.000000 deg
};
P[2]{
    GP1:
            UF : 0, UT : 1,
            J1=       0.000000 deg,       J2=       0.000000 deg,       J3=       0.000000 deg,
            J4=       0.000000 deg,       J5=      -5.000000 deg,       J6=    -175.000000 deg
PR[1]{
    GP1:
            UF : 0, UT : 1,
            J1=       0.000000 deg,       J2=       0.000000 deg,       J3=       0.000000 deg,
            J4=       0.000000 deg,       J5=      10.000000 deg,       J6=       0.000000 deg
```

2 SETTING UP

This chapter describes how to set up the collaborative robot. By default, SAFE I/O device is set correctly. Set up after Section 2.2.

2.1 SETTING SAFE I/O DEVICE

Collaborative robot has a built sensor, and this sensor detects a external force to realize the contact stop function. By default, the sensors are assigned to SAFE I/O DEVICE. These devices are needed for the collaborative robot function. If the safe I/O device configuration is changed, the following operation is needed.

Initialize Safe I/O device

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS. If neither DCS top screen nor Safe I/O device screen, press [PREV] key, and select Safe I/O device.
5 Press F2, [INIT]. The message “Do you want to change setting?” is displayed.
6 Press F4, [YES].
7 Press F2, [INIT] again. The message “Initialize device configuration?” is displayed.
8 Press F4, [YES].
9 Make sure that the types of Device 2 to 5 are “Force Sensor” (CR series) or the types of Device 2 to 12 are “Torque Sensor” (CRX series). The following screen will be displayed.

```
DCS
     Safe I/O device
       1 Safe  I/O device: I/O connect    OK
       2 SFDO Pulse check: ENABLE(PL e)   OK
     Configuration                       status
         --- Device 1 ----------------
       3 Type: E-stop board               OK
       4 Robot number: 1                  OK
       5 Input:   SPI[  1 -   8](PL e)    OK
       6 Output:  SPO[  1 -   8](PL e)    OK
         --- Device 2 ----------------
       7 Type: Force Sensor              CHGD
       8 Robot number: 0                  OK
       9 Input:   SPI[  0 -   0](PL e)    OK
      10 Output:  SPO[  0 -   0](PL e)    OK
         --- Device 3 ----------------
      11 Type: Force Sensor              CHGD
      12 Robot number: 0                  OK
      13 Input:   SPI[  0 -   0](PL e)    OK
      14 Output:  SPO[  0 -   0](PL e)    OK
         --- Device 4 ----------------
      15 Type: Force Sensor              CHGD
      16 Robot number: 0                  OK
      17 Input:   SPI[  0 -   0](PL e)    OK
      18 Output:  SPO[  0 -   0](PL e)    OK
         --- Device 5 ----------------
      19 Type: Force Sensor              CHGD
      20 Robot number: 0                  OK
      21 Input:   SPI[  0 -   0](PL e)    OK
      22 Output:  SPO[  0 -   0](PL e)    OK

 [TYPE]  INIT                      UNDO
```

10 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

2.2 SETTING COLLABORATIVE ROBOT FUNCTION

This section introduces the setting of the collaborative robot function. In the collaborative robot screen, you can set up the collaborative robot function.

Collaborative robot screen

1 Press the [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Collaborative robot screen, press the [PREV] key, and select Collaborative robot. The following screen will be displayed. Some items is not displayed depending on the software version.

```
DCS
     Collaborative robot

     Contact stop status    STOP
     Enable/Disable         ENABLE          OK
     Force sensor
        Serial number:             0        OK
     Group:                        1         OK
     Payload setup:         <DETAIL>         OK
     Active Payload number: No. 1 [**********]
     External force Limit / Disabling input
       Current:       0.0
       Limit 1:    150.00[N] ---[  0]         OK
       Limit 2:      0.00[N] ---[  0]         OK
       Limit 3:      0.00[N] ---[  0]         OK
       Limit 4:      0.00[N] ---[  0]         OK
       Escape:     300.00[N]                  OK

[TYPE] | CONFIRM | PEAKCLR |  | UNDO
```

You can set up the collaborative function in this screen.
For configurable items, OK/CHGD/PEND is displayed in the right.
OK : Setting parameter and DCS parameter are the same.
CHGD : Setting parameter is changed, but not applied to DCS parameter.
PEND : Setting parameter is changed and applied to DCS parameter, but controller power has not been cycled.

When you change DCS parameter setting, “Apply to the DCS parameter” is necessary. Refer to Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

```
DCS
     Collaborative robot

     Contact stop status    STOP
     Enable/Disable         ENABLE          OK
     Force sensor
        Serial number:             0        OK
     Group:                        1         OK
     Payload setup:         <DETAIL>         OK
     Active Payload number: No. 1 [**********]
     External force Limit / Disabling input
       Current:       0.0
       Limit 1:    150.00[N] ---[  0]         OK
       Limit 2:      0.00[N] ---[  0]         OK
       Limit 3:      0.00[N] ---[  0]         OK
       Limit 4:      0.00[N] ---[  0]         OK
       Escape:     300.00[N]                  OK

[TYPE] | CONFIRM | PEAKCLR |  | UNDO
```

Contact stop status

The status of the contact stop function is displayed. Refer to Section 2.3.

Enable/Disable (configurable)

Enabling or disabling the contact stop function.

DISABLE

The contact stop function is disabled. In this setting, the robot is same as a standard robot. You can move the robot only in T1 mode. In T2 or AUTO mode, “SYST-343 Enable Contact Stop function” occurs, and you cannot move the robot.

ENABLE

The contact stop function is enabled.

ENBL (Shift+Reset)

Contact stop is always enabled in AUTO mode. When you hold down the [SHIFT] key and press the [RESET] key in T1 or T2 mode and the contact stop status is STOP (Refer to Section 2.3), the contact stop function is disabled until the [SHIFT] key is released or the safety is confirmed.

Refer to Subsection 4.1.1 for the detail of the difference between ENABLE and ENBL(Shift+Reset).

> ⚠ **CAUTION**
> When “ENBL (Shift+Reset)” is selected, the contact stop function might be disabled when you hold down the [SHIFT] key and press the [RESET] key in T1 or T2 mode. If “ENBL (Shift+Reset)” is used, adequate risk assessment for the whole the robot system is necessary to verify that the contact stop can be disabled while Shift+Reset is pressed in T1 or T2 mode.

Force Sensor Serial number (CR series)

The serial number of the force sensor is displayed.

Group (configurable)

Set the group number of the collaborative robot.

Payload setup

You can see current payload setup. Refer to Subsection 2.2.1.

Active payload number

Current payload number is displayed and not configurable in this screen. You can select the payload number in “SYSTEM > Motion” screen or by PAYLOAD instruction in program. Refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN).

External force (N)

Current (CR series)

You can see the current external force. This item moved to Force monitor in the software version 7DC3/30 or later.

Limit 1 to 4 (configurable)

Set the external force limit 1 to 4 between 0[N] and 150[N], inclusive. 0[N] means disable and you cannot set the limit 1 to 0[N].
When the contact stop function is enabled, "@" is displayed as following.

```
      Limit 1:    150.00[N] ---[  0]        OK
     @Limit 2:     90.00[N] ---[  0]        OK
      Limit 3:      0.00[N] ---[  0]        OK
      Limit 4:      0.00[N] ---[  0]        OK
```

This means the active force limit. The active force limit is minimum limit in available limits. When the external force exceeds the active force limit, the robot will stop. To disable the force limit, set the limit to 0[N] or the corresponding disabling input to ON. You can disable the force limit to change the active force limit dynamically in a program. In the example of this screen, the limit 1 and 2 are enabled, then @ is attached to the minimum limit 2. The limit 3 and 4 is set 0[N], then they are disabled.

For CRX series, the external force is calculated by the torque acting on each axis. Therefore, when the robot contacts at the point near the each axis, the robot may not stop even if the external force is more than the external force limit. On the other hand, when the robot contacts at the point far from the each axis, the robot may stop even if the external force is smaller than the external force limit.
※External force：Force to act on the robot at the time of contact by the robot motion.

When you push [NEXT] key and F5[DETAIL] on each limit item, detail setting screen is displayed.

```
      Limit 1:              150.00[N]       OK
      Disabling input       ---[  0]        OK
      Payload Error Margin   60.00[N]       OK
```

Payload Error Margin (configurable)

Set Payload Error Margin. When steady load applied to the robot exceeds Payload Error Margin, SYST-325 "Payload error is detected" will be posted, and the robot will stop.

Escape (configurable)

Set the external force limit for Push To Escape between 0[N] and 300[N], inclusive. In Push To Escape, if the external force exceeds this limit, the robot is stopped. This means that the robot does not escape when you push with a force more than the force limit.

Disabling input (configurable)

Set the Safe I/O to disable each force limit. When the disabling input is ON, the corresponding force limit is disabled. When the all limits are disabled, the contact stop function is disabled.

```
     @Limit 1:    150.00[N] SIR[  1]        OK
      Limit 2:     90.00[N] SIR[  2]        OK
      Limit 3:      0.00[N] ---[  0]        OK
      Limit 4:      0.00[N] ---[  0]        OK
```

In the example of this screen, SIR[2] is ON to disable the limit 2. The limit 1 is only enabled, then @ is attached to the limit 1.

> ⚠ **WARNING**
> When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and a serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

```
DCS
    Collaborative robot

    Force Monitor:
             Resultant     X       Y       Z
      Curr:      0.00[N]
                   0%       0%       0%       0%
      Peak:        0%       0%       0%       0%
      Output:
        Curr:   GO[  0] GO[  0] GO[  0] GO[  0]
      Warning:      0%
    Payload Monitor:
     FORCE    Resultant     X       Y       Z
      Curr:        0%       0%       0%       0%
      Comp:                 0%       0%       0%
      Peak:        0%       0%       0%       0%
      Output:
        Curr:    GO[  0] GO[  0] GO[  0] GO[  0]
        Comp:             GO[  0] GO[  0] GO[  0]
      Warning:     50%
     MOMENT    Resultant     X       Y       Z
      Curr:        0%       0%       0%       0%
      Comp:                 0%       0%       0%
      Peak:        0%       0%       0%       0%
      Output:
        Curr:    GO[  0] GO[  0] GO[  0] GO[  0]
        Comp:             GO[  0] GO[  0] GO[  0]
      Warning:     50%
     Warning in DSBL:           DISABLE

    [TYPE]  CONFIRM  PEAKCLR          UNDO
```

Force Monitor/Payload Monitor

These items is displayed in the software version 7DC3/30 or later. An external force and a load applied to the robot is displayed. You can configure the warning posted when the monitored value exceeds specified value, and output monitored value. Refer to Subsection 4.2.3.

```
DCS
    Collaborative robot

    Payload change distance (mm)
            Current   +Limit   -Limit
      X:       0.00     0.00     0.00       OK
      Y:       0.00     0.00     0.00       OK
      Z:       0.00     0.00     0.00       OK
      Rotation:  Current     Limit
                  0.00[deg]   0.20[deg]      OK
      Enabling input:      ON [  0]          OK
    Password for CONFIRM:    ENABLE         OK
    CONFIRM by DI:           DISABLE        OK
      CONFIRM input:         DI[  0]
      Payload No. output:    GO[  0]

    [TYPE]  CONFIRM  PEAKCLR          UNDO
```

Payload change distance

Current

You can see the current distance and the rotation angle of the posture from a payload change position. The rotation angle of the posture is displayed in the software version 7DC3/30 or later. When the payload changing output is OFF (Refer to Section 2.3), this value is 0.

+Limit, -Limit, Rotation Limit (configurable)

When the payload change distance is enabled, the active payload number is changed, then the contact stop function will switch to disable. If the face plate position is changed more than the payload change distance, the contact stop function switches to enable immediately. The payload change distance can be

set for each direction individually, +X, -X, +Y, -Y, +Z and –Z of the world coordinate system. Rotation Limit is displayed in the software version 7DC3/30 or later. Rotation Limit is one value without distinction of direction. This is useful for the collaborative robot to pick or place a workpiece. Refer to Chapter 5.

Enabling input (configurable)

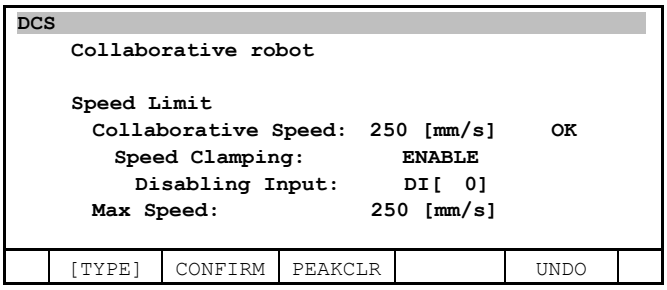
Set the Safe I/O to enable the payload change distance. When the enabling input is ON, the payload change distance is enabled. When the Safe I/O is OFF, the payload change distance is disabled, and STOP state (Refer to Section 2.3) will be initiated immediately when the actual payload number is changed. Default setting is ON[0]. It means the payload change distance is always enabled.

Password for CONFIRM (configurable)

After power on the controller, the payload confirmation operation must be performed to clear the alarm. The collaborative robot does not move until the payload confirmation is performed. When Password for CONFIRM is ENABLE, DCS password is required for the payload confirmation operation. Default setting is ENABLE. Refer to Chapter 3.

CONFIRM by DI (configurable)

This item is displayed in the software version 7DC3/30 or later. You can perform the payload confirmation operation with some kind of terminal without other than the teach pendant. Refer to Chapter 3.



Speed limit

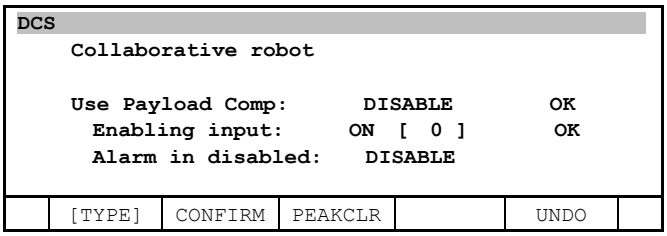
Collaborative Speed (configurable)

This item is displayed the software version 7DC3/28. When the contact stop is enable, the TCP speed or the elbow (joint position between J2 arm and J3 arm) speed of the collaborative robot exceeds the speed limit, “SYST-323 Collaborative speed limit(TCP)” or “SYST-359 Collaborative speed limit(elbow)” will be posted, and the robot will stop.

⚠ WARNING
If the speed limit is set to inappropriate value, the force at the time of contact increases, and a serious personal injury could result. Risk assessment for the whole robot system is required to determine appropriate speed limit. Refer to followings about the risk according to the speed.
CR-35*i*A:
MECHANICAL UNIT OPERATOR'S MANUAL(B-83734EN), Section 3.6 THE CHARACTERISTIC OF COLLABORATIVE ROBOT AND LIMITATIONS AND USAGE NOTES
CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L:
MECHANICAL UNIT OPERATOR'S MANUAL(B-83774EN), Section 3.6 THE CHARACTERISTIC OF COLLABORATIVE ROBOT AND LIMITATIONS AND USAGE NOTES
CR-15*i*A:
MECHANICAL UNIT OPERATOR'S MANUAL(B-84054EN), Section 3.6 THE CHARACTERISTIC OF COLLABORATIVE ROBOT AND LIMITATIONS AND USAGE NOTES
CRX-10*i*A, CRX-10*i*A/L:
MECHANICAL UNIT OPERATOR'S MANUAL(B-84194EN), Section 3.6 THE CHARACTERISTIC OF COLLABORATIVE ROBOT AND LIMITATIONS AND USAGE NOTES

Speed Clamping, Disabling input (configurable)
Speed Clamping is the function to slow down such that the speed of the TCP and the elbow are less than Collaborative Speed. It is ENABLE by default. When you set Disabling input and turn signal to ON, it will turn to DISABLE.

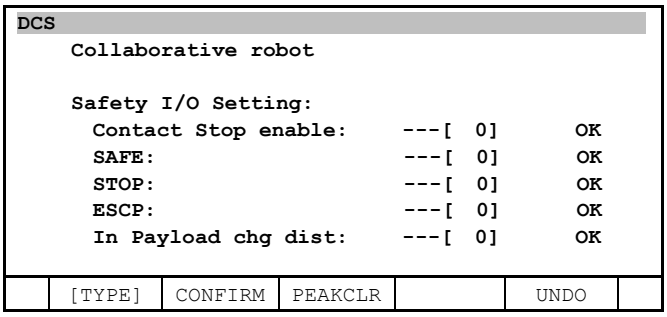
Max Speed (configurable)
When you want to teach higher speed more than default, set this item to the maximum speed. Refer to Section 7.2 about procedure to switch the speed according to the conditions.



Use Payload Comp (configurable)
This item is displayed in the software version 7DC3/33 or later. Use when same payload acts on the robot every time during robot move. Refer to Section 7.5.

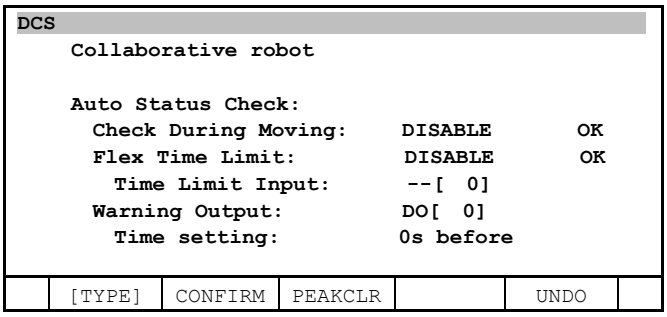
Enabling input (configurable)
When the set signal is ON, the compensation value is used, and when it is OFF, the compensation value is not used.

Alarm in disabled (configurable)
When this item is enabled, you use the KAREL programs for compensation with Use Payload Comp" disabled or Enabling input OFF, the robot will stop with alarm.



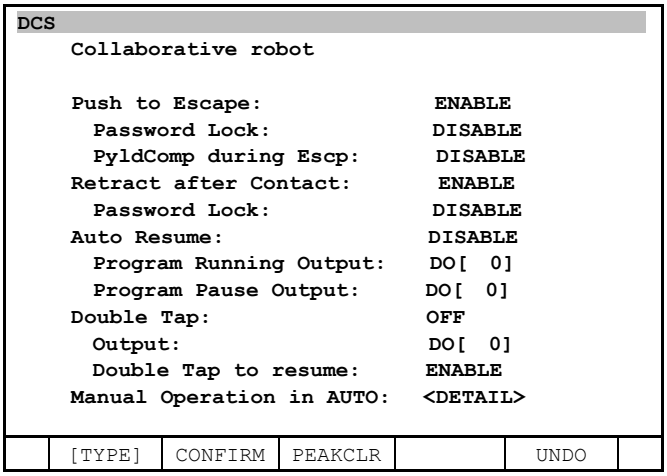
Safety I/O Setting (configurable)

This item is displayed in the software version 7DC3/37, 7DF1/08 or later. You can output the collaborative robot status to safety signals. Refer to Subsection 2.3.1.



Auto Status Check (configurable)

This item is displayed in the software version 7DC3/42, 7DF1/10 or later. You can change setting of Auto Status Check. Refer to Subsection 4.2.1.



Push to Escape (configurable)

You can enable/disable for Push to Escape. Refer to Section 4.4 for details.

Password Lock (configurable)

When this item is enabled, password is required to change Push to Escape item.

PyldComp during Escp (configurable)

When this item is enabled and Push to Escape is done while the payload compensation working, the compensation keeps when Push to Escape is performed. When this item is disabled and Push to Escape is

done while the payload compensation working, the compensation value becomes 0. After restarting program, the compensation value will be back when the robot returns on original path.

Retract after Contact (configurable)

You can enable/disable for Retract after Contact. Refer to Section 4.3 for details.

Password Lock (configurable)

When this item is enabled, password is required to change Retract after Contact item.

Auto Resume (configurable)

You can enable/disable for Auto Resume function. Refer to Section 7.1 for details.

Program Running Output (configurable)

It is ON when the program is running or the auto resume function is waiting to resume. This keeps ON when the program is resumed by Auto resume function.

Program Pause Output (configurable)

It is ON when the program is paused and the auto resume function is not waiting to resume.

Double Tap (configurable)

It is ON when the double tap is detected. Refer to Section 7.6 for details.

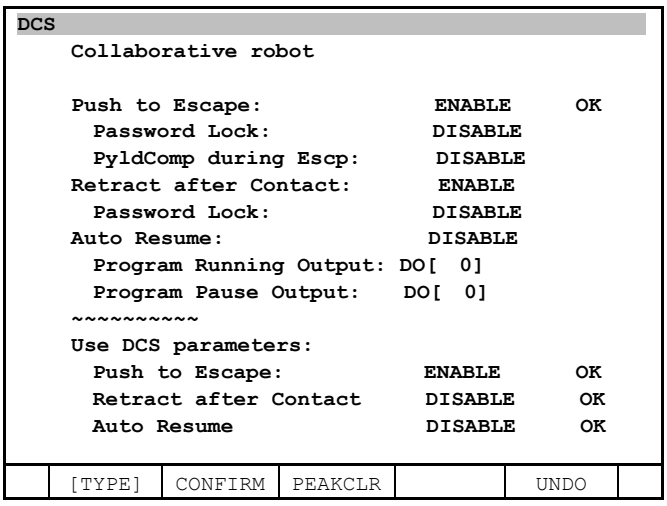
Double Tap to resume (configurable)

This item is displayed in the software version 7DF5/05 or later.

When this is enabled, you can restart the TP program after contact stop by Double Tap. Refer to Section 7.6 for details.

Manual Operation in AUTO (configurable, only for CRX series)

When this is DISABLE, JOG and Manual Guided Teaching during AUTO mode is forbidden.



Use DCS parameters (configurable)

This item is displayed in the software version 7DC3/58, 7DF5/17 or later.

You can change whether the specified settings are applied to DCS parameters or not. DCS parameters are used to calculate DCS signature number. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN) for details.

If this setting is ENABLE, the corresponding setting is applied to the DCS parameter and the applying status is displayed at the right side of the setting.

If this setting is DISABLE, the corresponding setting is not applied to the DCS parameters.

NOTE

DCS parameters are always checked as DCS signature number. So, this operation below can change DCS signature even if the settings on the collaborative robot screen are not changed.

1. Set “Use DCS parameters” to ENABLE.
2. Change the corresponding setting and apply.
3. Set “Use DCS parameters” to DISABLE.
4. Restore the corresponding setting.

F2 [CONFIRM]

Pressing the F2 [CONFIRM] and the payload confirmation starts. The payload confirmation operation must be performed at least once after power on. The collaborative robot does not move until the payload confirmation is performed. Refer to Chapter 3.

⚠ WARNING

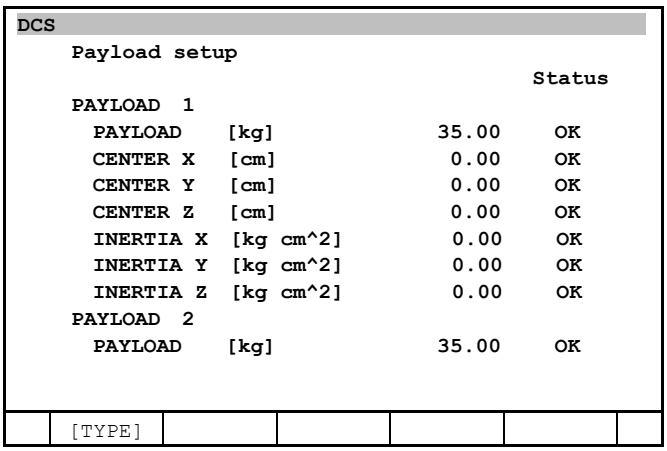
1 If the collaborative robot settings are incorrectly, the safety function will not work, and a serious personal injury could result. When the collaborative robot settings are changed, the values must be verified and the function must be tested again.

2 When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and a serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

3 If “Password for CONFIRM” is set to DISABLE, anybody can perform the payload confirmation operation. If the payload confirmation operation is performed incorrectly, the external force is not detected correctly and safety function will not work, and a personal injury could result. When “Password for CONFIRM” is set to DISABLE, everybody who can operate the teach pendant must be authorized to perform the payload confirmation operation.

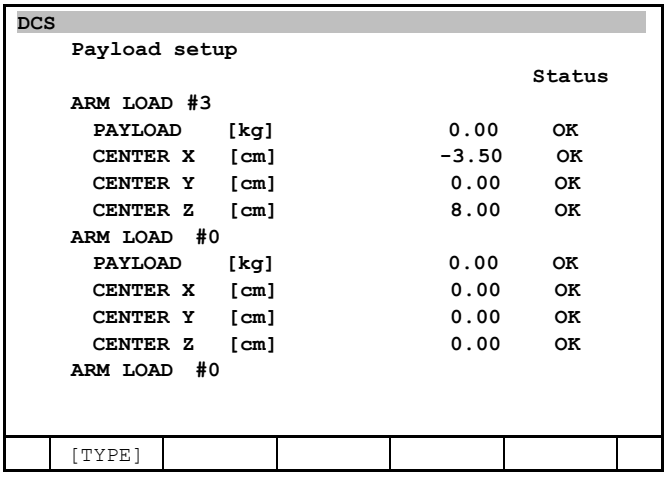
2.2.1 Verify Payload Setup

In the collaborative robot screen, select Payload setup: <DETAIL>, then the payload setup screen is displayed. In this screen, current parameters for the contact stop are displayed as followings. In this screen, you cannot change their parameters. Refer to Section 7.7 and each MECHANICAL UNIT OPERATER’S MANUAL, Section of “LOAD SETTING” for procedure to set payload.



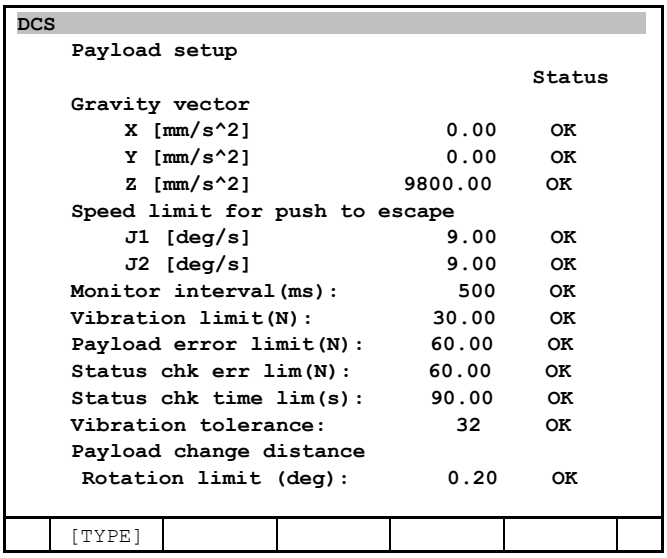
PAYLOAD 1 to 9

Payload settings are displayed. In “SYSTEM > Motion” screen, you can change the payload settings.



ARM LOAD #axis_number

Arm load settings are displayed. In “SYSTEM > Motion” screen, you can change the payload settings.



Gravity vector

Gravity vector is displayed. The gravity vector is changed by the mount angle of the robot.

Speed limit for push to escape

Speed limit in Push To Escape is displayed.

Monitor interval

Sampling time of the external force monitor is displayed. Refer to the section 4.2.

Vibration limit

The force limit by vibration is displayed.

Payload error limit

Payload error limit is displayed. When the error of the payload setting exceeds the payload error limit, the robot can not move. Refer to the subsection 4.2.2.

Status chk error lim
This is “Status check error limit”, internal parameter for the auto status check.

Status chk time lim
This is “Status check time limit”, the limit of time interval for the auto status check.

Vibration tolerance
Tolerance of floor vibration

Payload change distance Rotation limit (deg)
The orient rotation limit of the payload change distance. This item is displayed in the software version before 7DC3/29.

> ⚠ **WARNING**
> If the payload setting is incorrect, the safety function will not work correctly, and a personal injury could result. When payload settings are changed, the values must be verified and the function must be tested again.

2.3 OUTPUT SIGNAL OF COLLABORATIVE ROBOT STATUS

The state of the collaborative robot could be output as the digital output (DO, RO, Flag) by set the system variables. This is useful for programming and visual indicator.

SAFE state output
SETTING
$DCSS_CLLB[1].$DOTYP_SAFE: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_SAFE: Set the index of output
SPECIFICATION
ON: The contact stop function is enabled and the safety is confirmed. In this case, the robot can move as usual.

STOP state output
SETTING
$DCSS_CLLB[1].$DOTYP_STOP: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_STOP: Set the index of output
SPECIFICATION
ON: The contact stop function is enabled and the safety is not confirmed. In this case, the robot cannot move. The signal is ON in the following cases.
- The payload number is changed, but the payload change distance is disabled.
- The intensity of the external force is high.
- The auto status check has not been performed for Status check time limit. Refer to the subsection 4.2.1.

DSBL state output
SETTING
$DCSS_CLLB[1].$DOTYP_DSBL: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_DSBL: Set the index of output
SPECIFICATION
ON: The contact stop function is disabled.
This signal is useful for a visual indication when the robot is in collaborative operation.

ESCP state output

SETTING

$DCSS_CLLB[1].$DOTYP_ESCP: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_ESCP: Set the index of output

SPECIFICATION

ON: In Push To Escape.

Payload changing output

SETTING

$DCSS_CLLB[1].$DOTYP_PLCHG: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_PLCHG: Set the index of output

SPECIFICATION

ON: The contact stop function is disabled and the safety is not confirmed. In this case, if the contact stop is changed to enabling, the state would transition to STOP state, and the robot would stop. The signal is ON in the following cases.
- The payload number is changed when the payload change distance is enabled.
- The intensity of the external force is high.
- The auto status check has not been performed for Status check time limit. Refer to the subsection 4.2.1.

Auto status check Time Out output

SETTING

$DCSS_CLLB[1].$DOTYP_TMOUT: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_TMOUT: Set the index of output

SPECIFICATION

ON: The auto status check has not been performed for Status check time limit. Refer to the subsection 4.2.1.

Program Running output

SETTING

$DCSS_CLLB[1].$DOTYP_RUN: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_RUN: Set the index of output

SPECIFICATION

ON: The program is running or the auto resume function is waiting to resume. This keeps ON when the program is resumed by Auto resume function. Refer to Section 7.1.

Program Paused output

SETTING

$DCSS_CLLB[1].$DOTYP_PAUSE: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_PAUSE: Set the index of output

SPECIFICATION

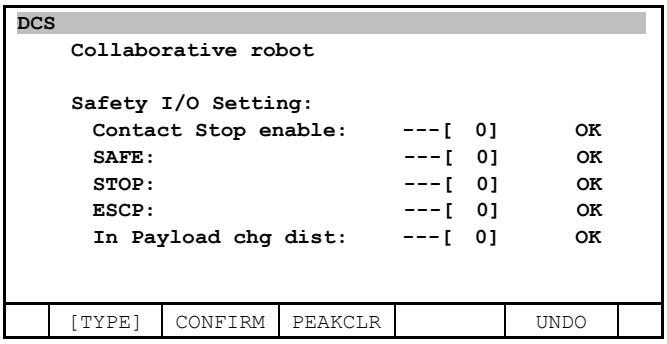
ON: The program is paused and the auto resume function is not waiting to resume. Refer to Section 7.1.

> ⚠ **WARNING**
> Collaborative status output is not a Safe I/O. If you assign it to Safe I/O used by the safety function, the safety function will not work under some fault conditions and serious personal injury could result. Do not use the collaborative status output for safety purposes.

2.3.1 Output Safety Signal of Collaborative Robot Status

This function is available in the software version 7DC3/37, 7DF1/08 or later.

You can output the collaborative robot status to safety signals.
Assign the collaborative robot status to safety signal at items of “Safety I/O setting” in the collaborative robot screen.



NOTE
Don’t specify CSO because this function doesn’t support output to CSO.

Contact Stop enable

When contact stop enable, the signal turns on.

SAFE

When the contact stop function is enabled and the safety is confirmed, the signal turns on. In this case, the robot can move as usual.

STOP

When the contact stop function is enabled and the safety is not confirmed, the signal turns on. In this case, the robot cannot move. The signal turns on in the following cases.

- The payload number is changed, but the payload change distance is disabled.
- The intensity of the external force is high.
- The auto status check has not been performed for Status check time limit. Refer to the subsection 4.2.1.

ESCP

In Push To Escape, the signal turns on.

In Payload chg dist

When the payload change distance is enabled and payload number is changed, the signal turns on. The robot moves more than payload change distance, or the payload change distance turns disabled, the signal turns off.

3 PAYLOAD CONFIRMATION OPERATION AFTER POWER ON

You must confirm that the payload setting is consistent with the actual payload at least once after power on the controller. This operation is called as Payload confirmation. The robot cannot move before Payload confirmation. In the collaborative robot screen, pressing F2[CONFIRM] and the payload confirmation process starts.

> ⚠ **WARNING**
> If the payload confirmation operation is performed incorrectly, the external force is not detected correctly and the safety function will not work, and a personal injury could result. When the payload confirmation operation is performed, the actual payload of the robot must be confirmed correctly, and anybody must not contact the robot.

Payload confirmation Operation

1 If the message “Code number (master)” is displayed, enter the master code number for DCS. If the code number is not correct, the payload confirmation operation is failed. (Default code number is "1111".)
If the “Password for CONFIRM” is DISABLE in the collaborative robot screen, it is not necessary to enter code number.

2 First question “Actual payload is No. X?” is displayed.
Confirm the actual payload of the robot hand/tool/workpiece is surely equal to payload No. X.
- If No. X is correct, press F4 [YES] and next question will be displayed.
- Else, press F5 [NO] and the payload confirmation operation is failed. Change the payload setting and try again.

3 Second question “Nobody contacts with the robot?” is displayed.
Confirm nobody contacts the robot, no foreign material is on the robot, and there is no external force to the actual robot.
- If nobody contacts with the robot, press F4 [YES] and the result of the payload confirmation will be displayed.
- Else, press F5 [NO] and the payload confirmation is failed. Remove the external force to the robot and try again.

The result of the payload confirmation

“Payload confirmation success”

Payload confirmation operation is completed. You can use the collaborative robot after this.

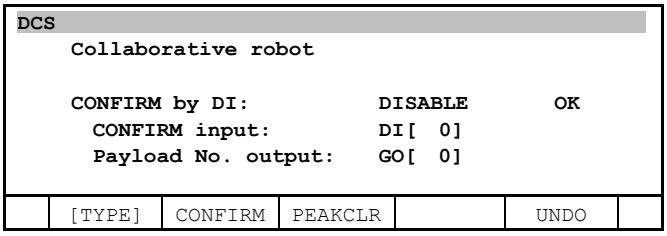
“Payload confirmation failed”

Remove the external force to the robot and try again. For example, a floor vibration may cause the external force.
Wait few seconds and try again. Payload confirmation can fail soon after power up

> ⚠ **WARNING**
> If “Password for CONFIRM” is set to DISABLE, anybody can perform the payload confirmation operation. If the payload confirmation operation is performed incorrectly, the external force is not detected correctly and safety function will not work, and a personal injury could result. When “Password for CONFIRM” is set to DISABLE, everybody who can operate the teach pendant must be authorized to perform the payload confirmation operation.

3.1 PAYLOAD CONFIRMATION WITHOUT TEACH PENDANT

When you would like to perform the payload confirmation operation with some kind of terminal other than the teach pendant, configure “CONFIRM by DI” in the collaborative robot screen. This configuration is displayed in the software version 7DC3/30 or later.



CONFIRM by DI (configurable)

When this item is set to ENABLE, you can perform the payload confirmation operation with an external signal. If it is ENABLE, you can also perform the payload confirmation operation with the teach pendant.

CONFIRM input (configurable)

When “CONFIRM by DI” is ENABLE and you change CONFIRM from OFF to ON, the payload confirmation will be performed. When the CONFIRM input changes from OFF to ON, you need to confirm that the actual payload of the robot hand/tool/workpiece is surely equal to current payload setting and nobody contacts with the robot. When CONFIRM input switches over and over in a short time, the payload confirmation may be performed incorrectly. CONFIRM input should be ON state more than 1 second. If CONFIRM input is ON at the power-up, “SRVO-473 DCS CLLB CC_EXTF alarm” might be occur.

Payload No. output (configurable)

Current payload setting number is output to a group output signal or a register set in this item. When you perform the payload confirmation operation with some kind of terminal other than the teach pendant, you can confirm the actual payload of the robot hand/tool/workpiece is surely equal to current payload setting by display of current payload setting number on the terminal.

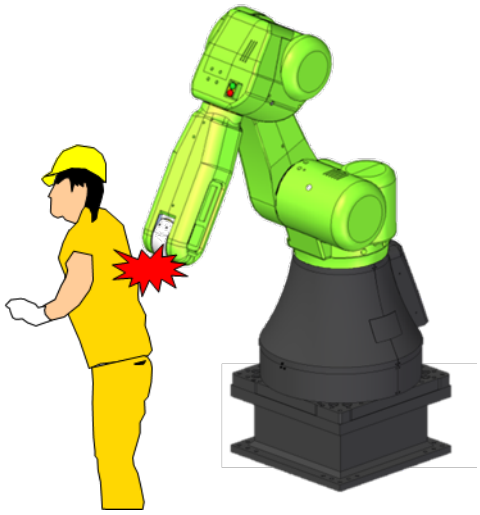
> ⚠ **WARNING**
> If “CONFIRM by DI” is set to ENABLE, you set CONFIRM input to ON, it is necessary to confirm that the actual payload of the robot matches current payload setting and anybody does not contact the robot. Measure is necessary to prevent putting CONFIRM input by unauthorized person such as locking. If the payload confirmation operation is performed incorrectly, the external force is not detected correctly and safety function will not work, and a personal injury could be result.

4 SPECIFICATION OF COLLABORATIVE FUNCTION

This chapter introduces functions of the collaborative robot.

4.1 CONTACT STOP FUNCTION

When the external force exceeds the active force limit, the robot will stop.



After a contact stop, the robot cannot moves until the intensity of the external force becomes low.

When multiple programs are executed by multitasking function, all programs pause by the contact stop function. If you don't want to stop a program by the contact stop, set Interruption Disable in the program detail screen. Refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Chapter of PROGRAM STRUCTURE.

> ⚠ **WARNING**
> Motion groups other than Collaborative robot are outside of the scope of the contact stop function. If a person comes into contact with the motion group other than Collaborative robot, a serious personal injury could result. If the robot system is designed to include the motion group other than Collaborative robot, adequate risk assessment for the whole robot system is necessary to verify that the motion group other than Collaborative robot are outside of the scope of the contact stop function.

4.1.1 Contact Stop in Teach Mode

The contact stop function is also enabled in T1/T2 mode. When the contact stop occurs, you cannot jog the robot in the usual manner until the intensity of the external force becomes low. This section provides the way to escape the robot by jogging in the contact stop situation. If the intensity of the external force does not become low, for example the robot contacts fixed object, you cannot jog in the usual manner. To recover this STOP situation, there are different manners between “ENABLE” and “ENBL(Shift+Reset)” set in the collaborative robot screen.

ENABLE

To recover from the STOP situation, you can jog the robot to the direction to go back to before contact. Hold down SHIFT key, press RESET key, and jog the robot without releasing SHIFT key. If the robot moves to the other direction, the robot stops immediately.

ENBL(Shift+Reset)

To recover from the STOP situation, hold down SHIFT key and press RESET key, then the contact stop function is disabled, and you can jog the robot. If the SHIFT key is released, or the intensity of the external force becomes low, the contact stop function is enabled again.

> ⚠ **CAUTION**
> 1 In ENBL (Shift+Reset) case, when the contact stop is disabled by holding SHIFT key and pressing RESET key, even if an operator moves the robot to a dangerous direction by jogging, the robot will not stop.
> 2 When “ENBL (Shift+Reset)” is selected, the contact stop might be disabled when you hold down SHIFT key and press RESET key in T1 or T2 mode. If “ENBL (Shift+Reset)” is used, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled when you hold down SHIFT key and press RESET key in T1 or T2 mode.

4.2 COLLABORATIVE ROBOT MONITOR

To verify that the contact stop function works correctly, the status of Collaborative robot is monitored periodically. If the status is possibly-abnormal, the robot stops until the external force data is confirmed normal status.

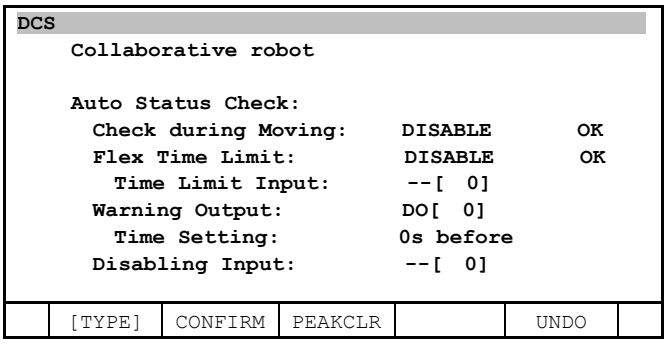
4.2.1 Auto Status Check

For the safety confirmation of Collaborative robot function, Auto Status Check is performed periodically.

- While the robot moving, the auto status check will not be performed by default. That is, when all motors of the robot stops, the auto status check is performed, even if the program is running.
- When the external force is large, the auto status check is not performed.
- When the elapsed time from a previous auto status check is longer than the status check time limit, the robot stops until the auto status check is performed. About Status check time limit, refer to the subsection 2.2.1.

By default, Collaborative robot cannot move continuously more than Status check time limit. It is necessary to program that the robot stops in a state that does not receive any external force. Or you can use the auto resume function to avoid the program continues to be paused. Refer to Section 7.1.

You can change setting of Auto Status Check in the software version 7DC3/42, 7DF1/10 or later. Setting is available in the collaborative robot screen.



Check during Moving

- When you set it to enable, the auto status check is also performed during the robot moving.
- When it is enable, Push to Escape function is disabled.

Flex Time Limit

- When you set it to enable, you can extend the status check time limit from the default value.
- When you extend the status check time limit, the robot might tend to stop with “SYST-320 Program paused by contact stop” or “SYST-325 Payload error is detected”.
- You can change the time limit dynamically.
- Range of the time limit is from Default value of the status check time limit to 10000s. You can see the default value of time limit is in the payload setup screen. Refer to subsection 2.2.1. When you input a value outside the range, the default value is used.

Time Limit Input

You can input the status check time limit by using following types. The unit is seconds.

GI: Group input

R: Numeric Register (Please input integer value. If real value is input, the default value is used as status check time limit.)

Warning Output

The elapsed time from a previous auto status check exceeds specified time before the time limit, signal turns to ON.

Time Setting

Specify the timing of warning output. The unit is seconds.

Disabling input

Set the I/O to disable the auto status check. Even when it’s disabled, the robot stops when the elapsed time from a previous auto status check is longer than the status check time limit.

4.2.2 Payload Monitor

If the payload setting is inconsistent with the actual payload, the sensor cannot detect the external force correctly. In this case, the robot stops until the intensity of the external force becomes low. For example, when the robot drops a workpiece unexpectedly, the robot cannot move.

When the robot picks or places a workpiece, an actual payload would be inconsistent with the payload setting temporarily. Then the sensor cannot also detect the external force correctly. In this case, the payload change distance is useful. Please refer to Chapter 5.

4.2.3 Collaborative Robot Monitor Screen

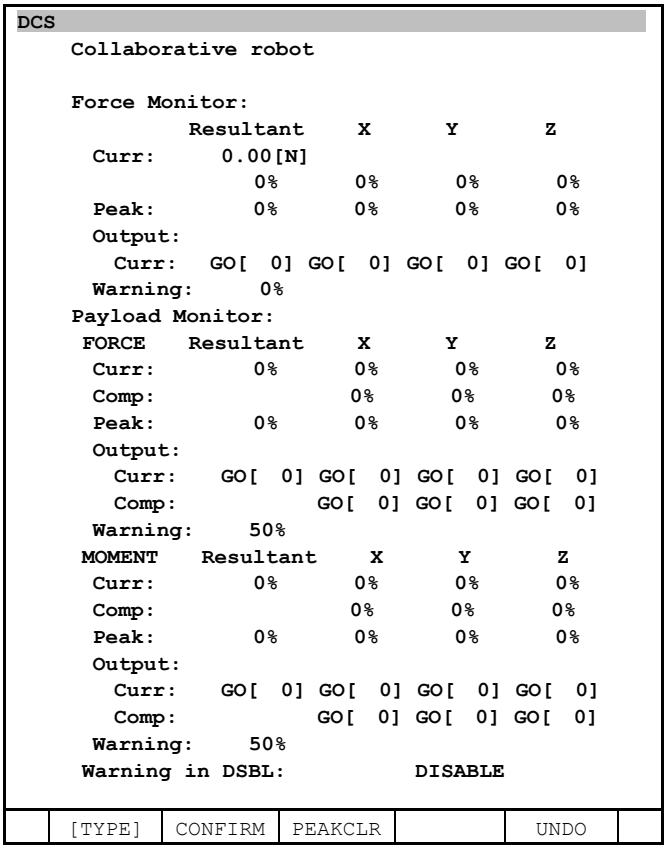
"Force Monitor" and "Payload Monitor" are displayed in the collaborative robot screen in the software version 7DC3/30 or later. You can monitor an external force and a load applied to the robot.

```
DCS
     Collaborative robot

     Force Monitor:    Current    Peak
                0.00[N] (    0%)     0%
      Settings  :      Warning    Output
                                0%     GO[  0]
     Payload Monitor: Current    Peak
       Force     :            0%      0%
       Moment    :            0%      0%
       Settings  :      Warning    Output
          Force  :           50%     GO[  0]
          Moment :           50%     GO[  0]
          Warning in DSBL:           DISABLE

 | [TYPE] | CONFIRM | PEAKCLR |  | UNDO |
```

In the software version 7DC3/31 or later, direction components based on the robot world frame is displayed.

```
DCS
     Collaborative robot

     Force Monitor:
              Resultant     X       Y       Z
       Curr:      0.00[N]
                    0%      0%      0%      0%
       Peak:        0%      0%      0%      0%
       Output: GO[  0] GO[  0] GO[  0] GO[  0]
       Warning:     0%
     Payload Monitor:
      FORCE    Resultant     X       Y       Z
       Curr:        0%      0%      0%      0%
       Peak:        0%      0%      0%      0%
       Output: GO[  0] GO[  0] GO[  0] GO[  0]
       Warning:    50%
      MOMENT    Resultant     X       Y       Z
       Curr:        0%      0%      0%      0%
       Peak:        0%      0%      0%      0%
       Output: GO[  0] GO[  0] GO[  0] GO[  0]
       Warning:    50%
      Warning in DSBL:           DISABLE

 | [TYPE] | CONFIRM | PEAKCLR |  | UNDO |
```

In the software version 7DC3/33 or later, the compensation value of Variable Payload Compensation function is also displayed. Refer to Section 7.5.



For CRX series, each joint direction components of the force is displayed.

```
DCS
    Collaborative robot

    Force Monitor:
             Resultant     J1      J2      J3
      Curr:         0%      0%      0%      0%
      Peak:         0%      0%      0%      0%
      Output:  GO[  0] GO[  0] GO[  0] GO[  0]
      Warning:      0%
                           J4      J5      J6
      Curr:                0%      0%      0%
      Peak:                0%      0%      0%
      Output:           GO[  0] GO[  0] GO[  0]
    Payload Monitor:
             Resultant     J1      J2      J3
      Curr:         0%      0%      0%      0%
      Comp:                0%      0%      0%
      Peak:         0%      0%      0%      0%
      Output:
        Curr:   GO[  0] GO[  0] GO[  0] GO[  0]
        Comp:           GO[  0] GO[  0] GO[  0]
      Warning:      0%
                           J4      J5      J6
      Curr:                0%      0%      0%
      Comp:                0%      0%      0%
      Peak:                0%      0%      0%
      Output:
        Curr:           GO[  0] GO[  0] GO[  0]
        Comp:           GO[  0] GO[  0] GO[  0]
     Warning in DSBL:           DISABLE

|  | [TYPE] | CONFIRM | PEAKCLR |  | UNDO |  |
```

Force Monitor

External force applied to the robot is displayed and output to external signals. You can monitor instant force such that a human contact.

Curr[N] (CR series)

Current external force applied to the robot is displayed.

Curr[%]

Current force / Active Force Limit x 100 (When the contact stop function is disabled, the value is 0 %.)
When the value is 100 %, a contact stop occurs. (SYST-320 “Contact force exceeds limit” is posted.)

Payload Monitor

Steady load applied to the robot is displayed and output to external signals. When the payload setting does not match the actual payload, this value will be large.

Force: Curr [%]

Averaged force / Payload Error Margin x 100 (During the payload change, the value is 0 %.)
When the value is 100 %, payload error occurs. (SYST-325 “Payload error is detected” is posted.)

Force: Comp [%]

Force Compensation value during playback of Variable Payload Compensation function. Refer to Section 7.5.

Moment: Curr [%] (CR series)

Averaged moment / tolerance x 100 (During the payload change, the value is 0 %.)
When the value is 100 %, payload error occurs. (SYST-325 “Payload error is detected” is posted.)

Moment: Comp [%] (CR series)

Moment Compensation value during playback of Variable Payload Compensation function. Refer to Section 7.5.

Peak

Peak hold value of each item is displayed. Press F3[PEAK CLR] to clear the value.

Warning

When the current value[%] exceeds each warning value[%], following warning occurs.

- SYST-350 Force Monitor warning
- SYST-348 Payload Monitor (Force) warning
- SYST-349 Payload Monitor (Moment) warning

Set integer value from 0 to 100. When the value is 0, warning does not occur.

Warning in DSBL

DISABLE: No warning occurs when the contact stop function is disabled.
ENABLE: Warnings also occur when the contact stop function is disabled.

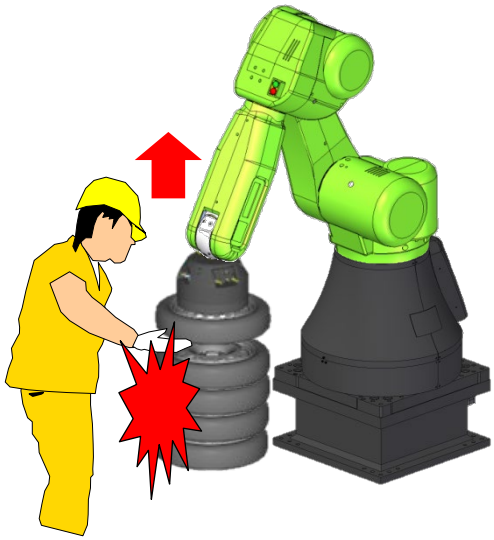
Output

Each item can be output to signals etc. Following signal types can be set.

GO: Current value is output to Group output.
R: Current value is output to Numeric Register.
DO/RO: When the current value exceeds the set warning value, signal is set to ON.

4.3 RETREAT AFTER CONTACT STOP

When the robot was stopped by the contact stop and if strong force remained, the robot will retreat slightly.



Condition

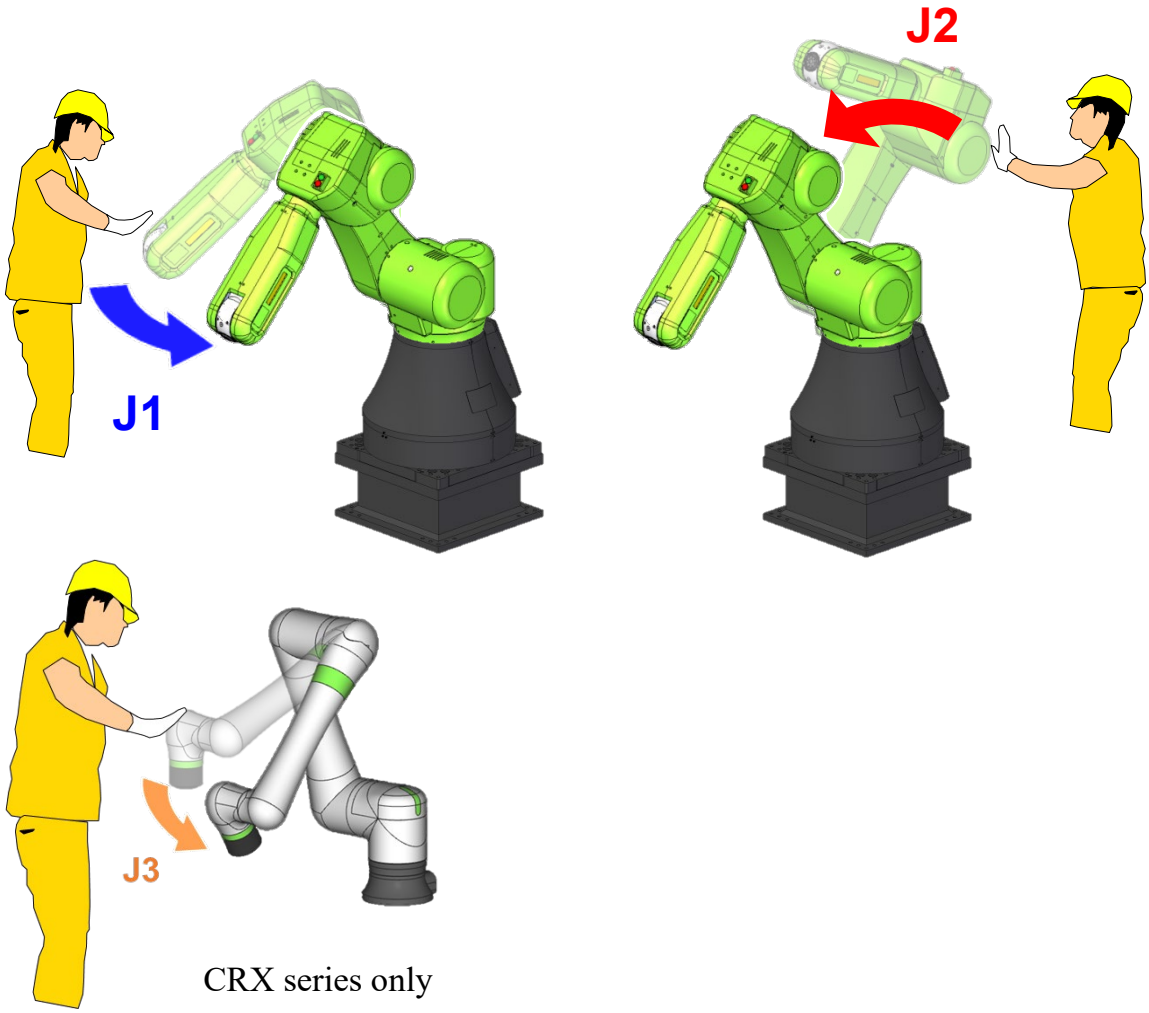
Only at the contact stop in execution of the program (not in jogging)

How to disable the function

In the software version 7DC3/44, 7DF1/17 or later, set in the collaborative screen. In earlier software version, set the system variable “$DCSS_CLLB[1].$REV_ENB” to FALSE.

4.4 PUSH TO ESCAPE

When an operator pushes the robot, the robot moves to pushed direction. Only J1 and J2 (CR series) or J1, J2 and J3 (CRX series) can respectively escape by pushing. In Push To Escape, TCP orientation is not kept.



CRX series only

Condition

- AUTO mode
- Any alarm is not posted.
- The robot stops.
- The contact stop function is enabled.
- The external force is less than the force limit for Push To Escape.
- The teach pendant is disabled.

How to disable the function

In the software version 7DC3/44, 7DF1/17 or later, set in the collaborative screen. In earlier software version, set the system variable “$DCSS_CLLB[1].$PTE_ENABLE” to FALSE.

Tips for pushing

- When you push the robot too strongly, the robot cannot escape.
- Farther and farther from the rotation axis, it is easy to push.
- If the robot does not escape, release your hand for a moment and try again.

4.5 Manual guided teaching

The manual guided teaching function enables operators to move the robot by pushing it directly.

The manual guided teaching is enabled when the enabling device (deadman switch) is pressed.
The correct operation is shown in Fig.4.5 (a). The tablet TP (or iPendant) and the robot must be held by the same person.

Correct Operation

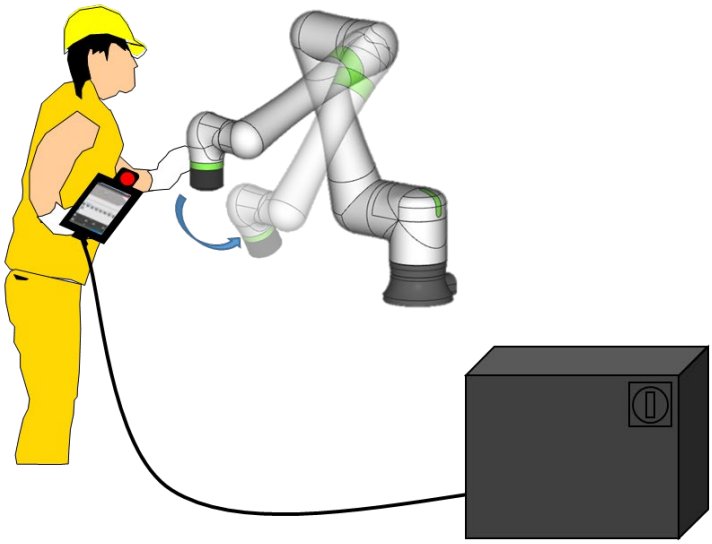


Fig. 4.5(a) Correct operation of manual guided teaching

The wrong operation is shown in the Fig.4.5 (b). The tablet TP (or *i*Pendant) and the robot are held by two persons.

Wrong Operation

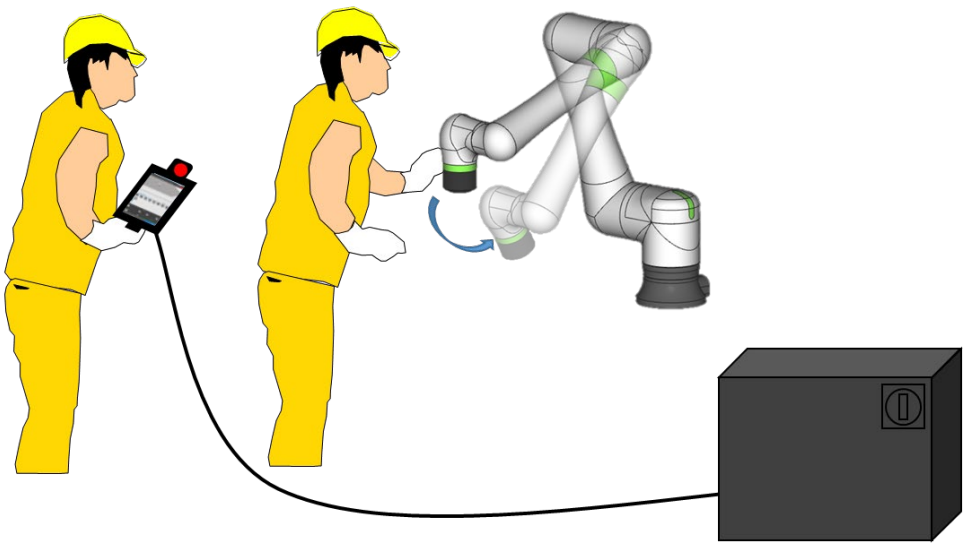


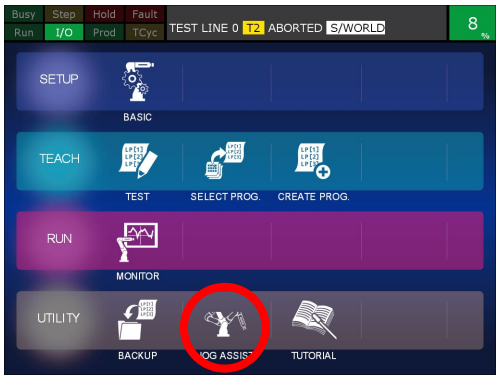
Fig. 4.5(b) Wrong operation of manual guided teaching

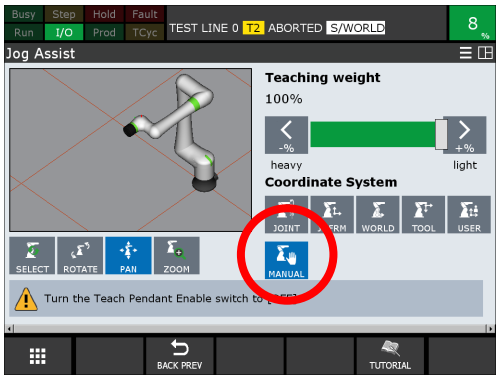
⚠ WARNING

- If payload setting is not appropriate, the robot can move unexpectedly in the manual guided teaching operation. Please confirm before operation that the payload setting is correct, and release the enabling device immediately if unexpected movement occurs.
- The contact stop function is disabled during the manual guided teaching operation. If you feel danger, for example, there is a risk that the work piece collides yourself or the stand etc., please release the enabling device immediately.

4.5.1 Usage

1. Enable the manual guided teaching function.
   - On the tablet TP, open the Robot Operation tab on the bottom of the screen and push the 『manual guided teaching』 button.
   - On *i*Pendant, open JOG ASSIST screen, and push the 『MANUAL』 button.





2. Press the enabling device in AUTO mode.
3. When all conditions are fulfilled, the green LED on the robot starts flashing and you can start moving the robot.

4.5.2 Mode

You can change the behavior of Manual Guided Teaching by selecting the modes.
The behavior of these modes except Free mode depends on Tool Frame setting.

Free

You can operate all joints freely.

Translation

This mode is available on the software version 7DF5/06 or later
You can operate the TCP position keeping its posture.

Rotation

This mode is available on the software version 7DF5/06 or later
You can operate the TCP posture keeping its position.

Custom

This mode is available on the software version 7DF5/17 or later
You can operate the TCP to the selected directions (XYZ of translation or rotation) in the selected frame (World, UTool, and UFrame).

4.5.3 Notice

- When TCP or the elbow speed exceeds 1000 [mm/s] during manual guided teaching, the robot stops.
- If manual guided teaching doesn't start, please check these conditions.
  - The controller is in AUTO mode.
  - All alarms are removed.
  - The robot axes are inside of joint limits.
  - Payload confirmation is done.
  - The robot stops.
- If external force is detected at pressing the enabling device, "SYST-367 Contact force limit for Manual Guided teaching" occurs and the manual guided teaching stops after moving certain distance. Repress the enabling device to restart manual guided teaching.

5 PROGRAMMING

You can teach a program of the collaborative robot in much the same way as other FANUC robots except for situations such that the collaborative robot is subjected to external force.

For example, while the robot picks or places a workpiece, the robot is subjected to external force. The payload number is changed by PAYLOAD instruction in program. The timing of PAYLOAD instruction execution is not the same as the timing of the actual workpiece picking/placing. Therefore a contact stop may occur by mismatch between the payload setting and the actual payload. To avoid the unnecessary contact stop during the payload change, the contact stop function can be disabled.

In this situation, to prevent a program from being paused by the contact stop, you should set the contact stop function to disable in limited area. There are following ways to disable the contact stop function.

- To set all disabling I/O of force limits to ON
- To change payload number when the payload change distance enabling input

The disabling I/O of force limits and the payload change distance enabling could be assigned with the safety I/O (e.g. Cartesian position check, Joint speed check, etc.). The safety I/O is helpful to teach a safety program.

⚠ WARNING

1 When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.
2 Opening and closing of a robot hand could do a human serious personal injury. When you design a robot hand, adequate risk assessment for the robot hand is necessary to verify that the robot hand do a human no injury.

This chapter provides some examples of programming the collaborative robot.

5.1 PICKING WORKPIECE

5.1.1 Simple Picking Program

This section provides a setting to pick a workpiece. In following way, the contact stop is disabled just after payload number change. If the robot moves more than the payload change distance, the contact stop is enabled.

⚠ WARNING

When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

SETTING

Payload change distance

1 Press the [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Collaborative robot screen, press [PREV] key, and select Collaborative robot.
6 Scroll down. You will see a screen similar to the following.

```
DCS
    Collaborative robot
      Limit 1:    105.00    ---[  0]        OK
      Limit 2:      0.00    ---[  0]        OK
      Limit 3:      0.00    ---[  0]        OK
      Limit 4:      0.00    ---[  0]        OK
      Escape:     300.00                    OK
    Payload change distance (mm)
            Current   +Limit   -Limit
      X:        0.00     0.00     0.00       OK
      Y:        0.00     0.00     0.00       OK
      Z:        0.00     0.00     0.00       OK
      Enabling input:      ON [  0]          OK

 |  [TYPE]  |  CONFIRM  |  |  |  UNDO  |  |
```

7 Set Payload change distance +Limit and –Limit of each direction(X, Y, Z). In this example, +Limit of Z = 3.0mm, and the limit of other directions is 1.0mm.

```
DCS
    Collaborative robot
      Limit 1:    105.00    ---[  0]        OK
      Limit 2:      0.00    ---[  0]        OK
      Limit 3:      0.00    ---[  0]        OK
      Limit 4:      0.00    ---[  0]        OK
      Escape:     300.00                    OK
    Payload change distance (mm)
            Current   +Limit   -Limit
      X:        0.00     1.00     1.00      CHGD
      Y:        0.00     1.00     1.00      CHGD
      Z:        0.00     3.00     1.00      CHGD
      Enabling input:      ON [  0]          OK

 |  [TYPE]  |  CONFIRM  |  |  |  UNDO  |  |
```

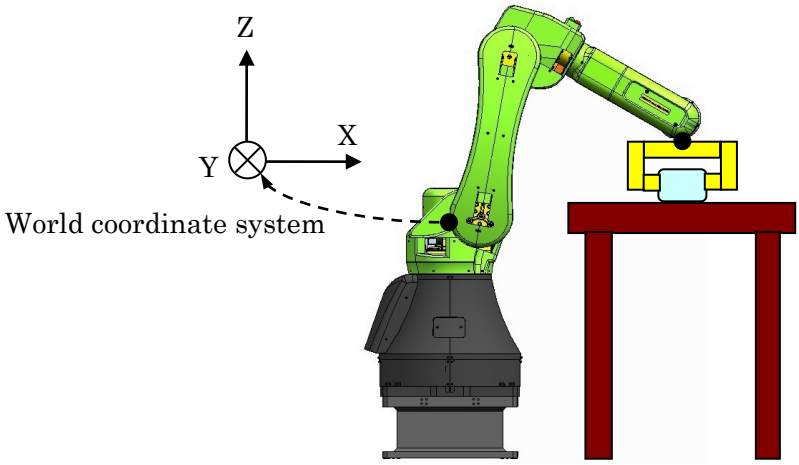
8 Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

In above setting, when the payload number is changed, the contact stop is disabled. When the flange position of the robot moves to +Z direction of the world coordinate system more than 3mm or other direction more than 1mm from the position the payload number is changed, the contact stop returns to enabled.

SAMPLE PROGRAM

Example of workpiece picking

1: L P[1] 200mm/s FINE	Position for picking workpiece
2: PAYLOAD[2]	Change payload for gripper and workpiece, Contact stop is disabled.
3: L P[2] 50mm/s FINE	In payload change distance, workpiece leaves the placing stand
4: WAIT 1.0sec	Payload monitor confirms no external force.
5: L P[3] 200mm/s CNT100	When the robot goes out of payload change distance, Contact stop is enabled.



If the contact stop returns to enabled before the external force is sufficiently small, the program will be paused. Adjust the setting as followings, and prevent the program from being paused.

- Reduce the speed of the movement the robot lift up a workpiece.
- Wait a little after lifting up a workpiece.
- Set the payload change distance to sufficient distance to the external force is small.

⚠ CAUTION

The payload change distance is 0 by default. If you change the payload change distance, adequate risk assessment for the whole robot system is necessary to verify that the payload change distance does not cause any dangerous situation.

⚠ WARNING

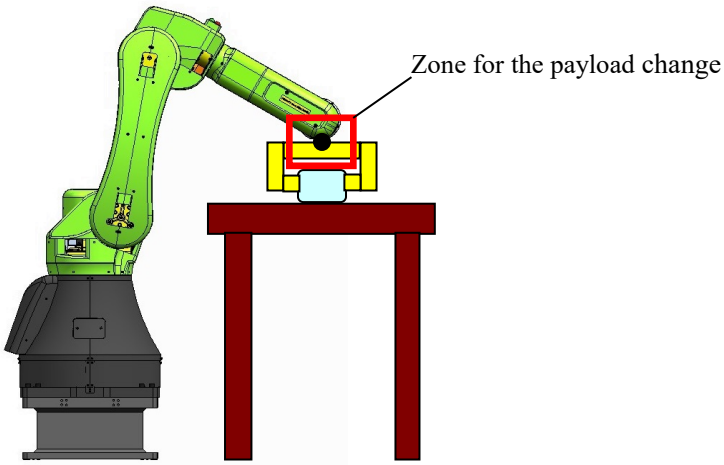
1 When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

2 In this setting, when the payload number is changed, the contact stop function is disabled anywhere in the envelope of the robot. This indicates the contact stop function is disabled unexpectedly, if any mistakes.

5.1.2 Limiting Picking Area

In previous sample program, when the payload number is changed, the contact stop function is disabled anywhere in the envelope of the robot. This indicates the contact stop function is disabled unexpectedly, if any mistakes. For example, the payload number is changed by a mistake of programming.
This section provides additional setting to specify the area to payload change. In this setting, even if the payload number is changed out of the zone, the contact stop function still is enabled. You can program as below.

- Set the DCS tool model for the payload change.
- Set the zone for the payload change to the DCS Cartesian Position Check.
- Set Safe I/O connect
- Set Safe I/O of the zone as the payload change distance enabling input.



SOFTWARE OPTION

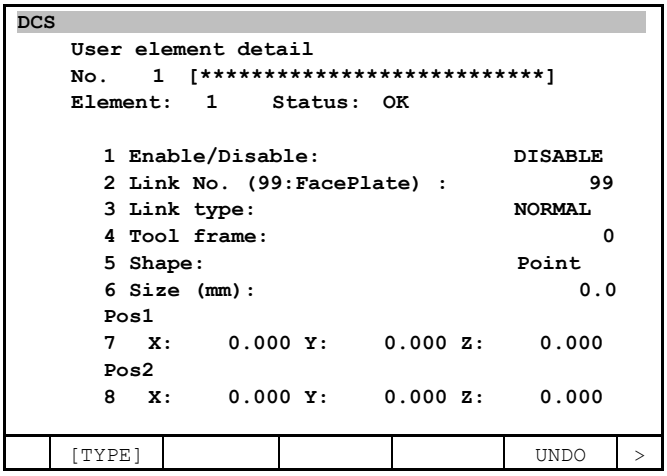
The following options are necessary for below setting.
J567 DCS Position/Speed check function
J568 DCS Safe I/O connection function (Standard with CRX series)

Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN) for more detail information about these options. Below setting is one example.

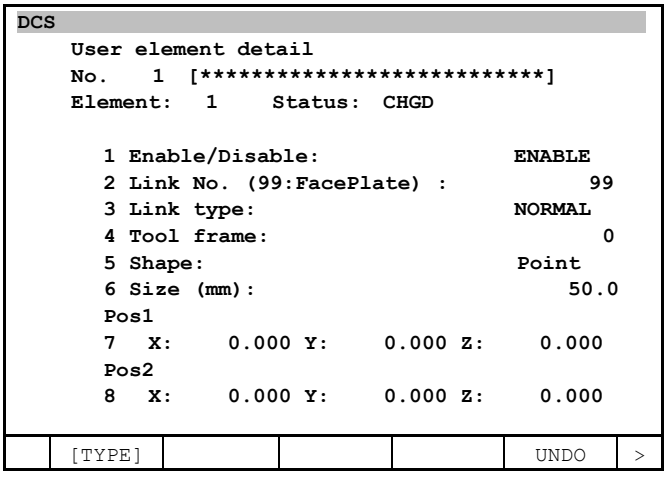
SETTING

DCS Tool model setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor User model, press [PREV] key several times, and select User model.
6 Select No.1 and press F3, [DETAIL]. You will see a screen similar to the following.



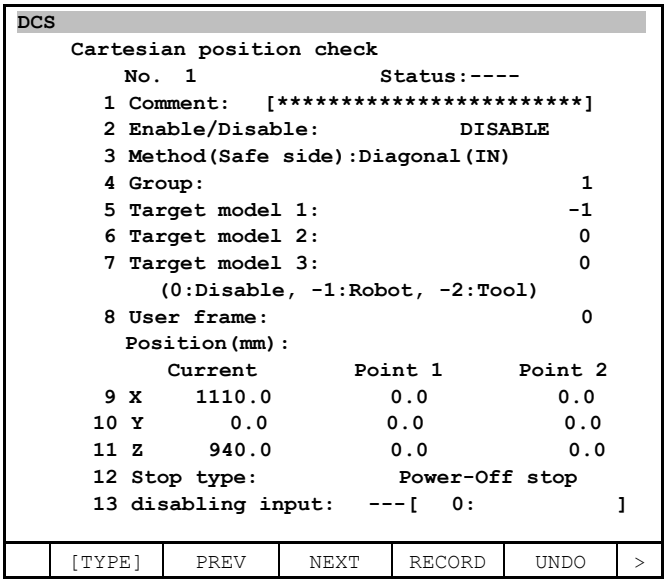
7 Set the TCP model as below. Please set the Tool frame position in (X, Y, Z) of Pos1. In this example, size is 50mm.



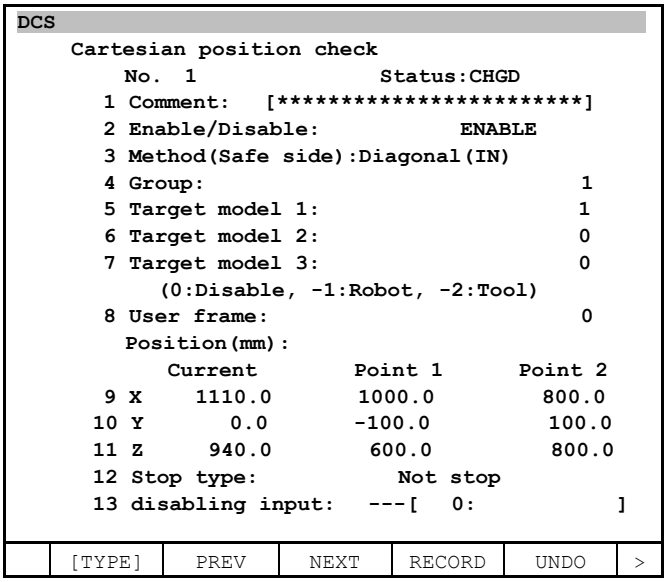
8 Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

DCS Cartesian Position Check setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Cart. position check, press [PREV] key, and select Cart. position check.
6 Select No.1 and press F3, [DETAIL]. You will see a screen similar to the following.



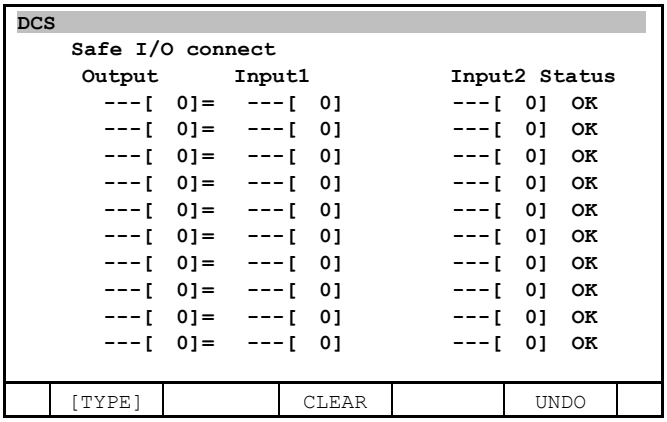
7 Set the zone for the payload change such as below.
- Set target model to TCP model.
- Set Stop type to Not stop. The robot can move both inside and outside this zone.
- Set the Position for the payload change. Please note that the contact stop function is disabled when TCP is in this zone.



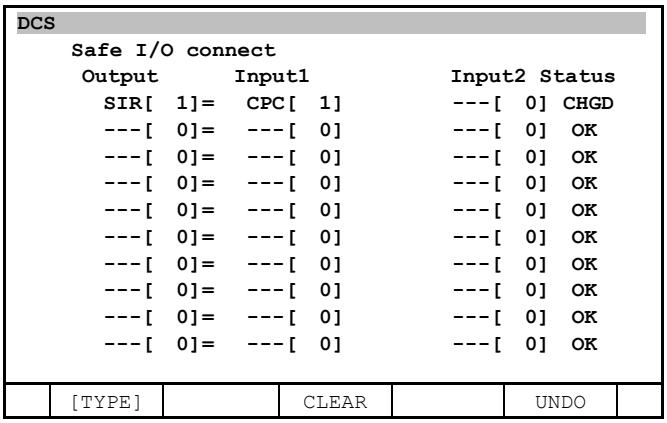
8. Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

Safe I/O connect setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Safe I/O connect, press [PREV] key several times, and select Safe I/O connect. You will see a screen similar to the following.

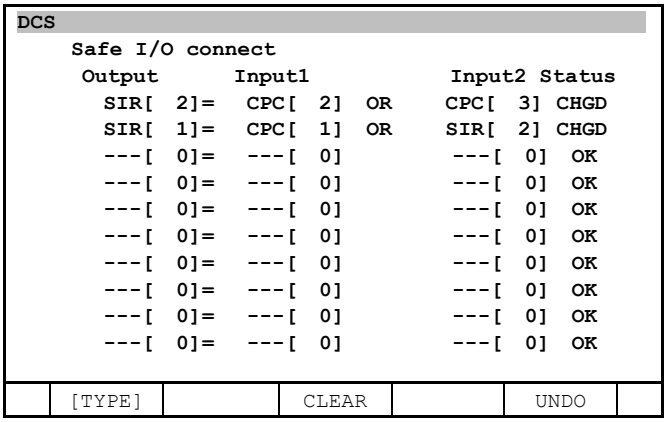


6 Set SIR[1] = CPC[1] (Cartesian Position Check of the zone for the payload change).



7 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

When you would like to set plural zones for the payload change, you can set such as followings.



Payload change distance Enabling input

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Collaborative robot screen, press [PREV] key, and select Collaborative robot.
6 Scroll down. You will see a screen similar to the following.

```
DCS
    Collaborative robot
      Limit 1:    105.00    ---[  0]        OK
      Limit 2:      0.00    ---[  0]        OK
      Limit 3:      0.00    ---[  0]        OK
      Limit 4:      0.00    ---[  0]        OK
      Escape:     300.00                    OK
    Payload change distance (mm)
            Current   +Limit   -Limit
      X:       0.00     1.00     1.00       OK
      Y:       0.00     1.00     1.00       OK
      Z:       0.00     3.00     1.00       OK
      Enabling input:      ON [  0]         OK

 | [TYPE] | CONFIRM |  |  | UNDO |  |
```

7 Set Payload change distance Enabling input to SIR[1].

```
DCS
    Collaborative robot
      Limit 1:    105.00    ---[  0]        OK
      Limit 2:      0.00    ---[  0]        OK
      Limit 3:      0.00    ---[  0]        OK
      Limit 4:      0.00    ---[  0]        OK
      Escape:     300.00                    OK
    Payload change distance (mm)
            Current   +Limit   -Limit
      X:       0.00     1.00     1.00       OK
      Y:       0.00     1.00     1.00       OK
      Z:       0.00     3.00     1.00       OK
      Enabling input:      SIR [  1]        CHGD

 | [TYPE] | CONFIRM |  |  | UNDO |  |
```

8 Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

In above setting, when the robot is out of the safety area, the contact stop is not disabled by the payload number change. To avoid the contact stop disabled in unexpected area, set the area as above.

5.2 DISABLING CONTACT STOP IN PROGRAM

This section provides how to disable the contact stop function by program. This is useful in a system such that the robot should stay in movement even though the robot is subjected to external force in specified area.

> ⚠ **WARNING**
> When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

SOFTWARE OPTION

The following options are necessary for below setting.
J567 DCS Position/Speed check function
J568 DCS Safe I/O connection function

Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN) for more detail information about these options. Below setting is one example.

SETTING

DCS Tool model setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor User model, press [PREV] key several times, and select User model.
6 Select No.1 and press F3, [DETAIL]. You will see a screen similar to the following.

```
DCS
     User element detail
     No.    1  [**************************]
     Element:   1     Status:  OK

        1 Enable/Disable:                DISABLE
        2 Link No. (99:FacePlate) :            99
        3 Link type:                     NORMAL
        4 Tool frame:                           0
        5 Shape:                         Point
        6 Size (mm):                         0.0
        Pos1
        7   X:     0.000 Y:     0.000 Z:     0.000
        Pos2
        8   X:     0.000 Y:     0.000 Z:     0.000

|  | [TYPE] |  | DETAIL | ROBOT | UNDO | > |
```

7 Set the TCP model as below. Please set the Tool frame position in (X, Y, Z) of Pos1. In this example, size is 50mm.

```
DCS
     User element detail
     No.    1  [**************************]
     Element:   1     Status:  CHGD

        1 Enable/Disable:                ENABLE
        2 Link No. (99:FacePlate) :            99
        3 Link type:                     NORMAL
        4 Tool frame:                           0
        5 Shape:                         Point
        6 Size (mm):                        50.0
        Pos1
        7   X:     0.000 Y:     0.000 Z:     0.000
        Pos2
        8   X:     0.000 Y:     0.000 Z:     0.000

|  | [TYPE] |  |  |  | UNDO | > |
```

8 Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

DCS Cartesian Position Check setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Cart. position check, press [PREV] key, and select Cart. position check.
6 Select No.1 and press F3, [DETAIL]. You will see a screen similar to the following.

```
DCS
    Cartesian position check
        No.  1              Status:----
      1 Comment:   [**********************]
      2 Enable/Disable:           DISABLE
      3 Method(Safe side):Diagonal(IN)
      4 Group:                          1
      5 Target model 1:                -1
      6 Target model 2:                 0
      7 Target model 3:                 0
          (0:Disable, -1:Robot, -2:Tool)
      8 User frame:                     0
        Position(mm):
           Current        Point 1      Point 2
      9 X    1110.0          0.0          0.0
     10 Y       0.0          0.0          0.0
     11 Z     940.0          0.0          0.0
     12 Stop type:            Power-Off stop
     13 disabling input:   ---[   0:           ]
```

	[TYPE]	PREV	NEXT	RECORD	UNDO	>

7 Set the zone for the contact stop disable
- Set target model to TCP model.
- Set Stop type to Not stop. The robot can move both inside and outside this zone.
- Set the Position for the contact stop disable.

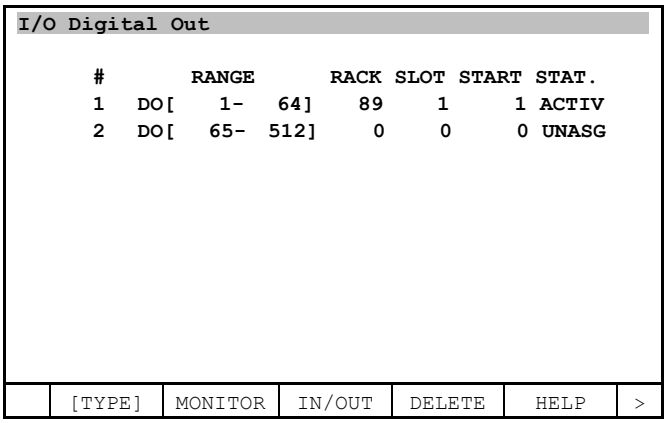
```
DCS
    Cartesian position check
        No.  1              Status:CHGD
      1 Comment:   [**********************]
      2 Enable/Disable:           ENABLE
      3 Method(Safe side):Diagonal(IN)
      4 Group:                          1
      5 Target model 1:                 1
      6 Target model 2:                 0
      7 Target model 3:                 0
          (0:Disable, -1:Robot, -2:Tool)
      8 User frame:                     0
        Position(mm):
           Current        Point 1      Point 2
      9 X    1110.0        1000.0         800.0
     10 Y       0.0        -100.0          100.0
     11 Z     940.0         600.0          800.0
     12 Stop type:             Not stop
     13 disabling input:   ---[   0:           ]
```

	[TYPE]	PREV	NEXT	RECORD	UNDO	>

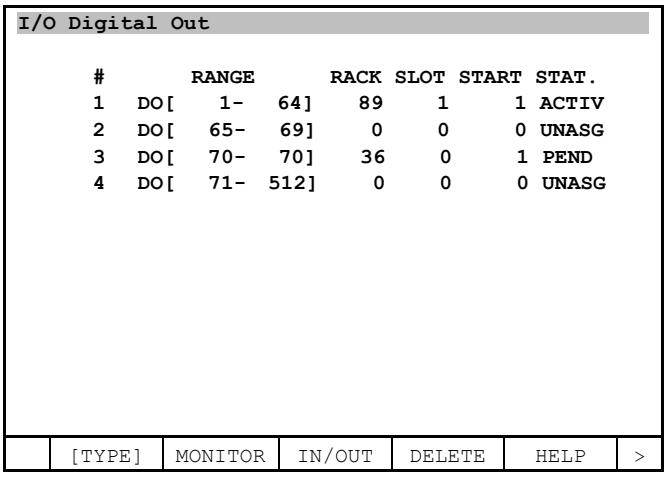
8 Apply to DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

DCS NSI setting

1 Press [MENU] key.
2 Select I/O.
3 Press F1, [TYPE].
4 Select Digital.
5 Press F2, [CONFIG], and press F3, [IN/OUT]. You will see a screen similar to the following.

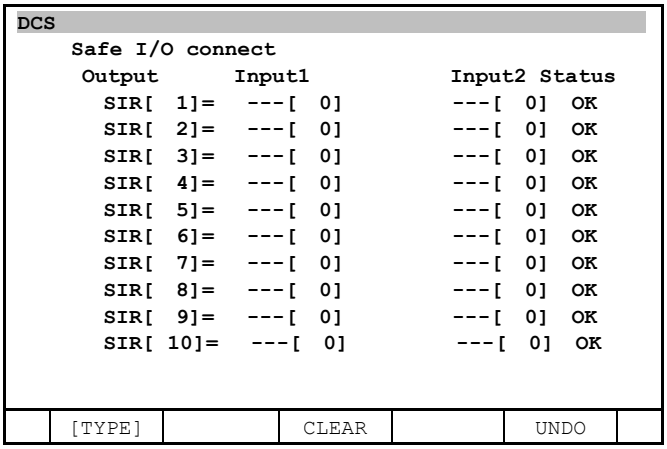


6 Set unassigned DO to NSI. In this example, DO[70] = NSI[1]. NSI is RACK 36, SLOT 0.

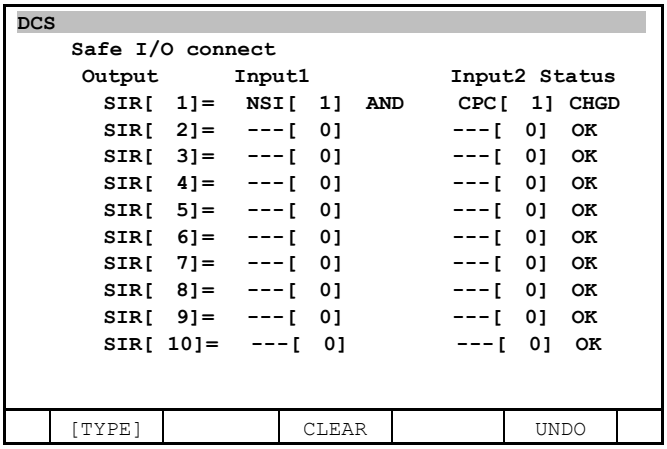


Safe I/O connect setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Safe I/O connect, press [PREV] key several times, and select Safe I/O connect. You will see a screen similar to the following.



6 Set SIR[1] = NSI[1] AND CPC[1] (Cartesian Position Check of the zone for the contact stop disable).



7 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

Force limit disabling input setting

1 Press [MENU] key.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select DCS.
5 If neither DCS top screen nor Collaborative robot screen, press [PREV] key, and select Collaborative robot. You will see a screen similar to the following.

```
DCS
     Collaborative robot
                                          Status
     Contact stop status:          SAFE
     Enable/Disable: ENABLE                 OK
     Force sensor
       Serial number:            XXXXXXXX    OK
     Group:                             1    OK
     Payload setup:               <DETAIL>   OK
     Active Payload: No. 1 [******************]
     External force (N)  /  Disabling input
       Limit 1:    105.00    ---[  0]         OK
       Limit 2:    100.00    ---[  0]         OK
       Limit 3:      0.00    ---[  0]         OK
       Limit 4:      0.00    ---[  0]         OK
       Escape:     300.00                     OK

 [TYPE]  CONFIRM                          UNDO
```

6 Set the all set limits of disabling input to SIR[1].

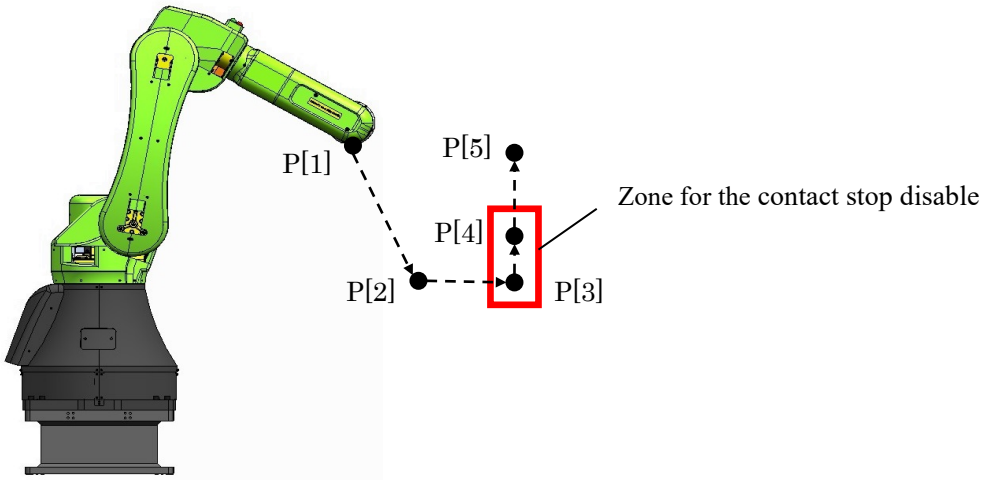
```
DCS
     Collaborative robot
                                          Status
     Contact stop status:          SAFE
     Enable/Disable: ENABLE                 OK
     Force sensor
       Serial number:            XXXXXXXX    OK
     Group:                             1    OK
     Payload setup:               <DETAIL>   OK
     Active Payload: No. 1 [******************]
     External force (N)  /  Disabling input
       LIMIT 1:    105.00    SIR[  1]       CHGD
       LIMIT 2:    100.00    SIR[  1]       CHGD
       LIMIT 3:      0.00    ---[  0]         OK
       LIMIT 4:      0.00    ---[  0]         OK
       Escape:     300.00                     OK

 [TYPE]  CONFIRM                          UNDO
```

7 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR'S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

SAMPLE PROGRAM

```
1: L P[1] 200mm/s CNT100
2: L P[2] 200mm/s CNT100
3: DO[70] = ON
4: L P[3] 50mm/s CNT100
5: L P[4] 50mm/s CNT100
6: DO[70] = OFF
7: L P[5] 200mm/s CNT100
```

In the above settings, the contact stop function is disabled when the robot is in the zone for the contact stop disable and DO[70] = ON. Therefore, in line 4 of the sample program, the contact stop function is disabled just after the robot enters into the zone. When the robot leaves the zone after that, the contact stop function is enabled.
If the external force is large and the contact stop function is enabled, the program will be paused. To avoid the situation, set the zone for the contact stop disable appropriately.



6 PERIODICAL CHECK

To check the force sensor accuracy, the periodical function check operation should be performed in proper interval. FANUC recommends once a month. Below check is unnecessary for CR-15*i*A and CRX series because check is performed automatically.

HOW TO CHECK

- Execute checking program according to the following.
- The robot program can be executed with the robot hand.

How to make the checking program

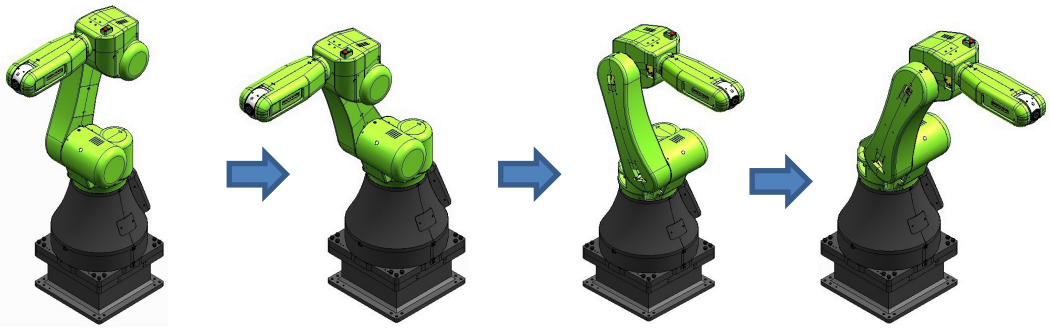
1 Make a program that the robot moves to some positions.
   - Term type of motion instruction is FINE.
   - Each postures of the robot in the checking program must have a distance from each other. This is for checking the output of all direction of the force sensor.
   - The maximum number of the position in the checking program is 30.
   - All operating time of the program must be less than 90 sec.

2 Insert CALL instruction to call FORCETST(parameter). FORCETST is KAREL program loaded by default.
   - In the first position, call FORCETST(1).
   - In the second position onward, call FORCETST(2).
   - In the last position, call FORCETST(3).

SAMPLE PROGRAM

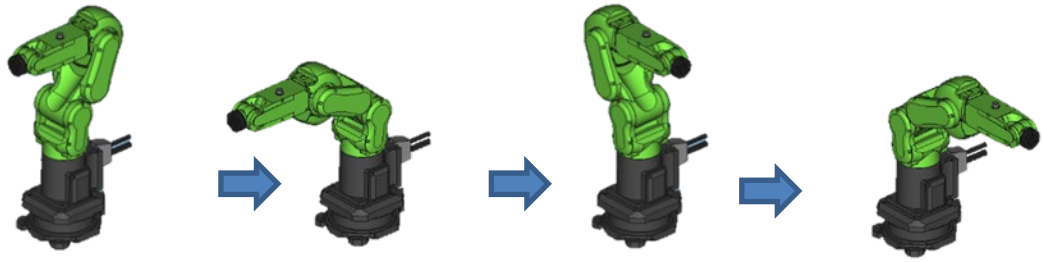
The following is the example of the proper position data for the periodical function check.

CR-35*i*A



Posture 1	Posture 2	Posture 3	Posture 4
J1 = 0 deg	J1=0 deg	J1 = 90 deg	J1 = 90 deg
J2 = -20 deg	J2=20 deg	J2 = -20 deg	J2 = 20 deg
J3 to J6 = 0 deg	J3 to J6 = 0 deg	J3 to J6 = 0 deg	J3 to J6 = 0 deg

CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L



Posture 1	Posture 2	Posture 3	Posture 4
J1 = 0 deg	J1=0 deg	J1 = 90 deg	J1 = 90 deg
J2 = -30 deg	J2=60 deg	J2 = -30 deg	J2 = 60 deg
J3 to J6 = 0 deg	J3 to J6 = 0 deg	J3 to J6 = 0 deg	J3 to J6 = 0 deg

The following is an example checking program.

```
1: J P[1] 30% FINE
2:   CALL FORCETST(1)
3: J P[2] 30% FINE
4:   CALL FORCETST(2)
5: J P[3] 30% FINE
6:   CALL FORCETST(2)
7: J P[4] 30% FINE
8:   CALL FORCETST(3)
```

RESULT OF CHECK

- If the execution of the checking program is completed without any alarms, the force sensor accuracy is good.
- If “SYST-325 Payload error is detected” occurs, check the payload setting at first. If the payload setting is correct, the force sensor may have problems.
- If “SYST-327 Inappropriate regular test program” occurs, the checking program has a problem. Please refer to above explanation.
  - Verify that each postures of the robot in the checking program must have a distance from each other.
  - Verify that the number of the positions of the checking program is less than 30.

7 UTILITY

This chapter explains special functions of the collaborative robot.

7.1 AUTO RESUME FUNCTION

Auto resume function automatically resumes the robot program paused by the contact stop function. When following conditions is satisfied, the program resumes 4 seconds after the contact stop.

Condition

- In AUTO mode
- Teach Pendant is OFF.
- The program is paused by the contact stop function.
- Any alarm is not posted.

In following cases, the auto resume is canceled.

- The contact stop occurs continuously.
- An operator pushes the robot for a certain time.
- It has a certain time after the contact stop.
- The program was aborted.
- Push To Escape is performed.
- Retreat after the contact stop is performed.
- The paused program's group mask is not same as collaborative robot group.
- HOLD key was pressed after contact stop.
- Contact stop function is disabled.

> ⚠ **CAUTION**
> 1 The auto resume function is disabled by default. If you enable this function, adequate risk assessment for the whole robot system is necessary to verify that the auto resume function does not cause any dangerous situation.
> 2 If the auto resume function is enable, the situation that the robot program is possible to be resumed automatically should be indicated clearly that the operator can notice from anywhere in the operation area.
> The program running output can be used to the indication; it is ON when the robot program is possible to be resumed automatically. Refer to Section 2.3.

Setting up

In the software version 7DC3/44, 7DF1/17 or later, set in the collaborative screen. In earlier software version, when the system variable $DCSS_CLLB[1].$AUTO_RESUME is 1, the auto resume function is enabled. When this value is 0, the auto resume function is disabled.

Limitation

- Multi task program is not supported, because the auto resume can resume only one task. When multiple programs is executed by multitasking function, all programs pause by the contact stop function. If you don’t want to stop a program by the contact stop, set Interruption Disable in the program detail screen. Refer to OPERATOR’S MANUAL (Basic Operation) (B-83284EN), Chapter of PROGRAM STRUCTURE.
- Auto resume function will not resume when the program group mask is not same as collaborative robot group setting. Therefore, CALL instruction may cause unintended resuming. For example, if using following two programs, the program will not be resumed when the cursor is in the PRG_A.TP but the program will be resumed when the cursor is in the PRG_B.TP. In this case, set

Group mask of collaborative robot group to 1 in PRG_A detail screen, then the auto resume function will resumes PRG_A.

PRG_A.TP(Group Mask *,*,...)

```
1:CALL PRG_B
2:DO[1] = ON
3:WAIT DI[1] = ON
4:CALL PRG_B
```

PRG_B.TP(Group Mask 1,*,...)

```
1:J P[1] 10% CNT 100
2:J P[2] 10% CNT 10
```

7.2 HIGH SPEED MODE

By default, the speed of the collaborative robot is limited by limited speed value (CR-35*i*A: 250mm/s, CR-15 *i*A: 350mm/s, CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L: 500mm/s, CRX series: 250mm/sec)

To use the collaborative robot as High Speed Mode, set [Max Speed] value in the collaborative robot screen (In the software version 7DC3/43, 7DF1/16 or earlier, the system variable $CF_LIM_GRP[group number of collaborative robot].$SPEEDLIM) to the value less than the maximum speed of the robot. About the maximum speed of the robot, refer to the manual of each robot.

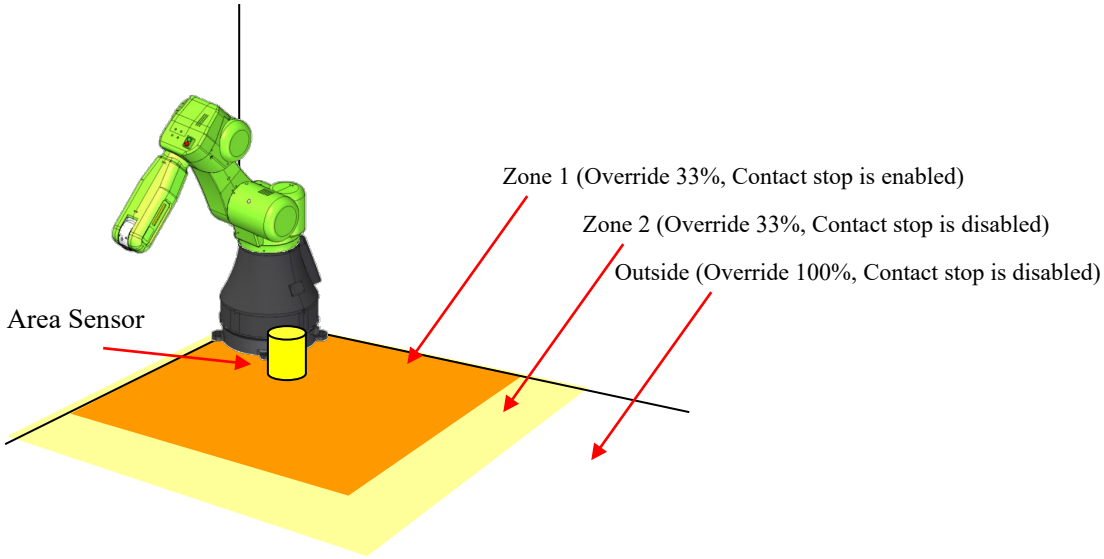
Setting method depends on the software version. Use in accordance with the following configuration.

SAMPLE CONFIGURATION (CR-35*i*A before 7DC3/22, CR-4*i*A, CR-7*i*A and CR-7*i*A/L before 7DC3/35 or 7DF1/05)

When the contact stop function is enable, TCP speed is checked regardless of the value of $CF_LIM_GRP[group number of collaborative robot].$SPEEDLIM. If the TCP speed exceeds the limit, the robot stops. For example, on CR-35*i*A, to avoid the stop, please set the override to a integer value less than “25000/$CF_LIM_GRP[group number of collaborative robot].$SPEEDLIM” when the contact stop function is enabled. For example, when $CF_LIM_GRP[group number of collaborative robot].$SPEEDLIM =750, set the override less than 33% (25000/750=33.333).

The following is the example of the robot system with high speed mode with the area sensor.

- When a human is in the Zone 1, the contact stop is enabled.
- When a human is in the Zone 2 (including Zone 1), the override is set to 33 % by Override Select function.
- When a human is not in Zone 2 (including Zone 1), the override is set to 100 % by Override Select function.



- Area sensor has 1 safety output and 1 non-safety output.
- The safety output of the area sensor is connected to SFDI1 of the robot controller. This signal is accessed as SPI[1] in DCS function. When a human is in Zone 1, the SPI[1] becomes OFF.
- The non-safety output of the area sensor is connected to digital input signal that is assigned to DI[20]. When a human is in the Zone 2, DI[20] becomes OFF.
- Set the disabling input of the force limit to SPI[1]. Refer to Section 2.2.

```
      @Limit 1:    105.00    SPI[  1]        OK
       Limit 2:      0.00    ---[  0]        OK
       Limit 3:      0.00    ---[  0]        OK
       Limit 4:      0.00    ---[  0]        OK
```

- Set the Override select as below. By this setting, the override is set to 100% when DI[20] is ON, and the override is set to 33% when DI[20] is OFF. (DI[21] is not used.)

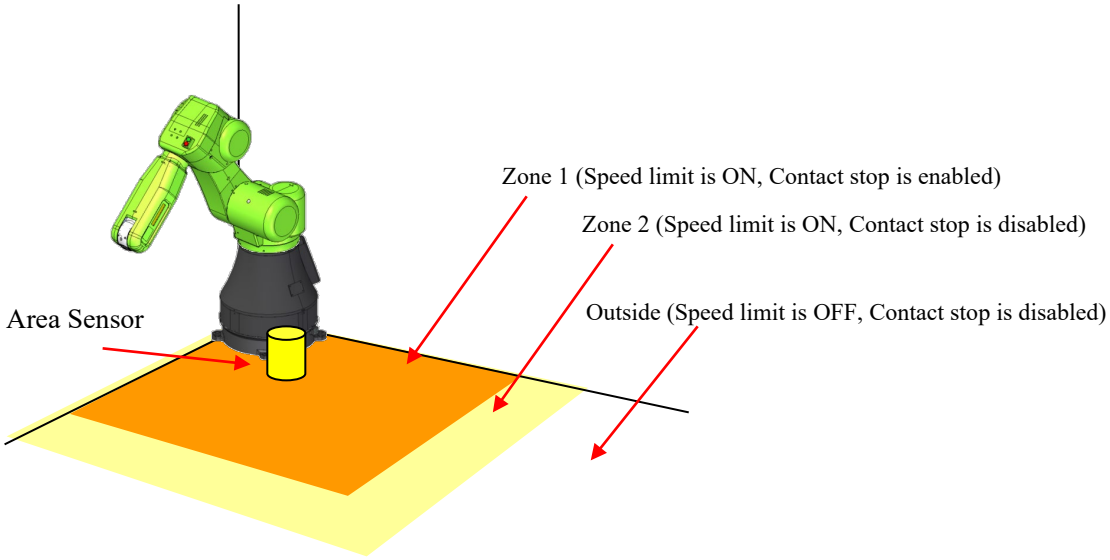
```
OVERRIDE SELECT

      1 Function Enable :ENABLE

      2 Signal 1        : DI[  20][OFF]
      3 Signal 2        : DI[  21][OFF]

        Signal 1    Signal 2     Override
      4    OFF         OFF          33 %
      5    OFF         ON           33 %
      6    ON          OFF         100 %
      7    ON          ON          100 %


 [TYPE]
```

⚠ WARNING
When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and a serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

SAMPLE CONFIGURATION (CRX series, CR-14*i*A/L, CR-15*i*A, CR-35*i*A after 7DC3/23, CR-4*i*A, CR-7*i*A and CR-7*i*A/L after 7DC3/36 or 7DF1/06)

The following is the example of the robot system with high speed mode with the area sensor.

- When a human is in the Zone 1, the contact stop is enabled.
- When a human is in the Zone 2 (including Zone 1), the speed limit is ON by turning OFF the disabling input of the speed limit.
- When a human is not in Zone 2 (including Zone 1), the speed limit is OFF by turning ON the disabling input of the speed limit.



- Area sensor has 1 safety output and 1 non-safety output.
- The safety output of the area sensor is connected to SFDI1 of the robot controller. This signal is accessed as SPI[1] in DCS function. When a human is in Zone 1, the SPI[1] becomes OFF.
- The non-safety output of the area sensor is connected to digital input signal that is assigned to DI[20]. When a human is in the Zone 2, DI[20] becomes OFF.
- Set the disabling input of the force limit to SPI[1]. Refer to Section 2.2.

```
@Limit 1:    105.00    SPI[  1]        OK
 Limit 2:      0.00    ---[  0]        OK
 Limit 3:      0.00    ---[  0]        OK
 Limit 4:      0.00    ---[  0]        OK
```

- Assign “Disabling input of Speed Clamping” to DI[20]. In the software version 7DC3/43, 7DF1/16 or earlier, set following system variables.
  $DCSS_CLLB[1].$DITYP_HISPD = 1 (Type of input DI:1, F:35)
  $DCSS_CLLB[1].$DIIDX_HISPD = 20 (Index of input)

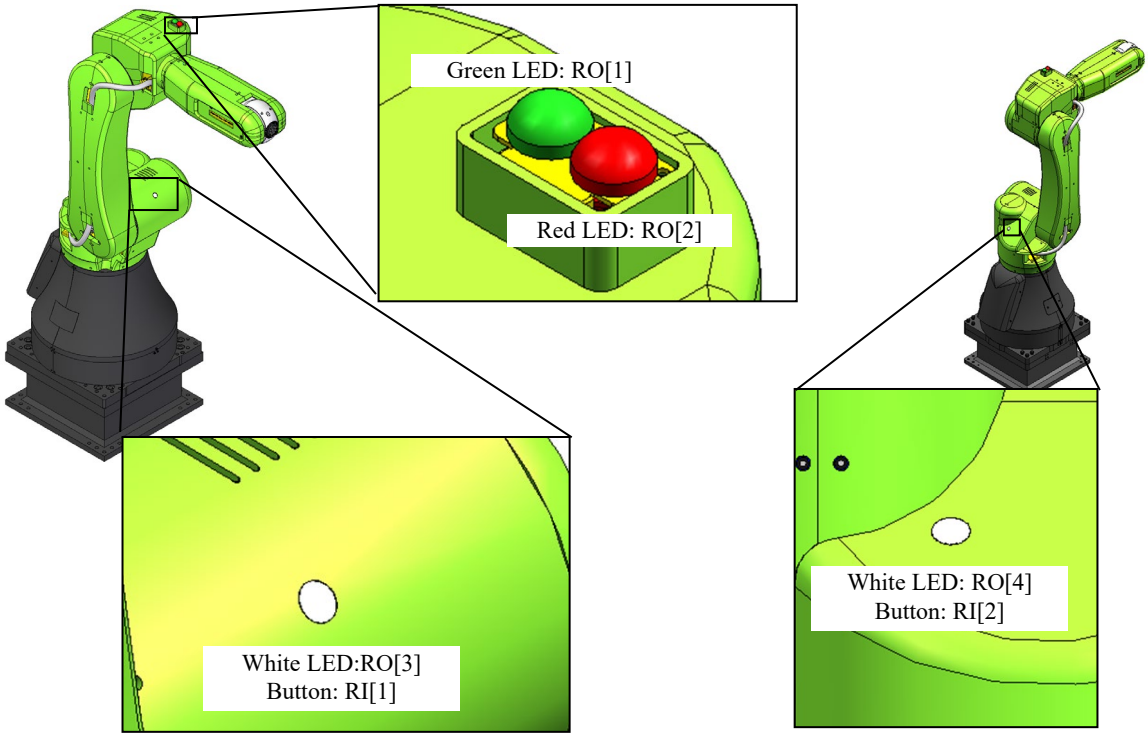
> ⚠ **WARNING**
> When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and a serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

7.3 LED AND BUTTON ON ROBOT ARM

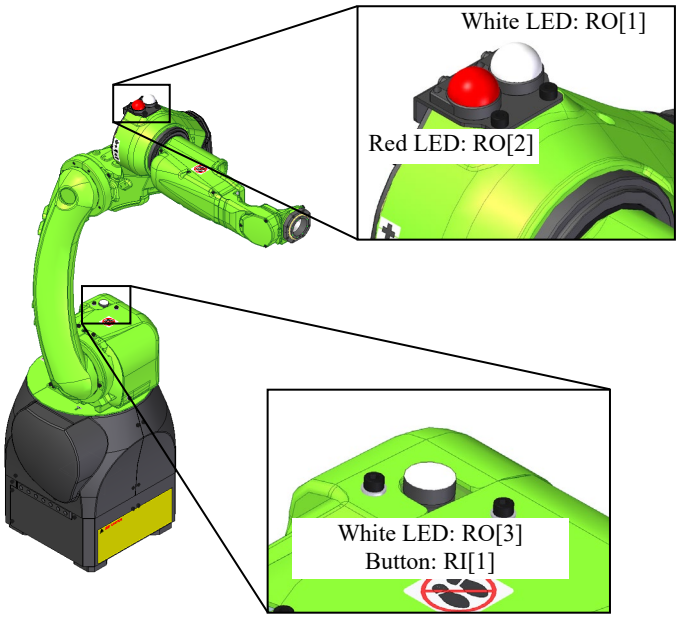
7.3.1 CR series

The collaborative robot has the following LED and button connected to RO and RI.

CR-35*i*A

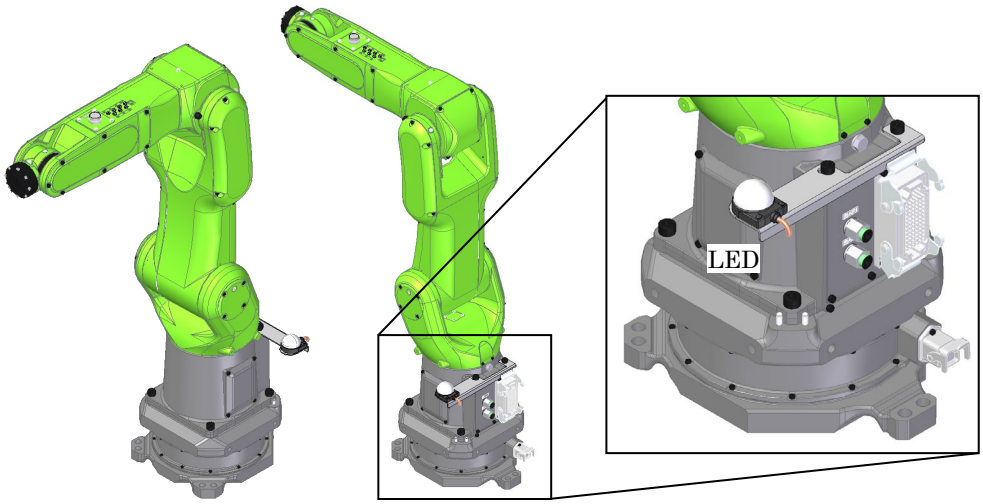


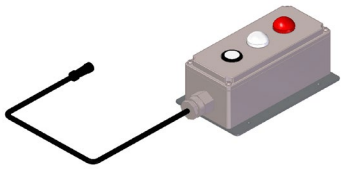
CR-15*i*A



CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L

In these robot models, LED and Switch Box are optional.





Switch Box

By default, these LED and button are not assigned to any function. The following is the example to set up the LED and Button.

SAMPLE CONFIGURATION

SPECIFICATION

- Green LED turns ON when program is running. (It keeps ON when a program is resumed by the auto resume function.)
- Red LED turns ON when an alarm occurs.
- White LED turns ON when the robot can move by pressing the button.
  (Remote, Program is not running, Alarm does not occur and the status of the contact stop is SAFE)

Setting

Flag and the back ground logic is used for this setting. For more detail procedure to set Flag and the back ground logic, refer to OPERATOR'S MANUAL (Basic Operation) (B-83284), Chapter of UTILITY, Section of BACKGROUND LOGIC.

- Set F[101-118] are assigned to UI[1-18]. So F[106] is assigned to UI[6:Start]
- Assign F[120] to SAFE state output. Refer to Section 2.3.
- Assign F[121] to DSBL state output. Refer to Section 2.3.
- Execute the following program as the background logic.

```
1: RO[1]= (!F[121])
2: RO[2]=(SO[3:Fault LED])
3: RO[3]=(SO[0:Remote LED] AND !RO[1] AND !RO[2] AND F[120])
4: RO[4]=(RO[3])
5: F[106]=(RO[3] AND (RI[1] OR RI[2]))
```

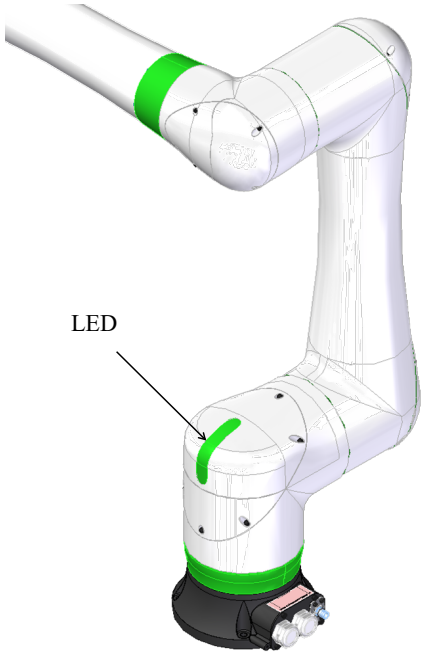
> **⚠ CAUTION**
> If the button on the robot arm is used to start robot program, emergency stop button must be prepared near the robot. The emergency stop button on the operator panel of the robot controller can be used for this purpose depending to the position of the robot controller.

7.3.2 CRX series

On CRX series, The LED color differs depending on the robot status according to the following table. You cannot change LED setting.

LED color	Robot status
Green	Collaborative mode
Flash green	Direct teaching
Yellow	High speed mode
Red	Alarm occurrence

RO[3]~RO[5] on CRX series are used for LEDs.



7.4 OPERATION LOG BOOK

Collaborative robot state, event of payload change and so on can be recorded in the Log Book by operation log book function.

To use function, Operation Log Book option (J695) is required.

Refer to Chapter 12 of Optional Function OPERATOR'S MANUAL (B-83284EN-2) for detail of this function.

The System variable of collaborative robot operation logbook number is $LOGBOOK.$LOG_CLLB. Default value is 4. Logbook is started to record after first payload confirmation.

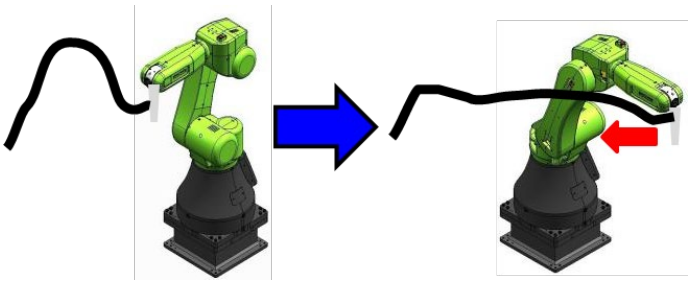
Following events are recorded to Log Book.

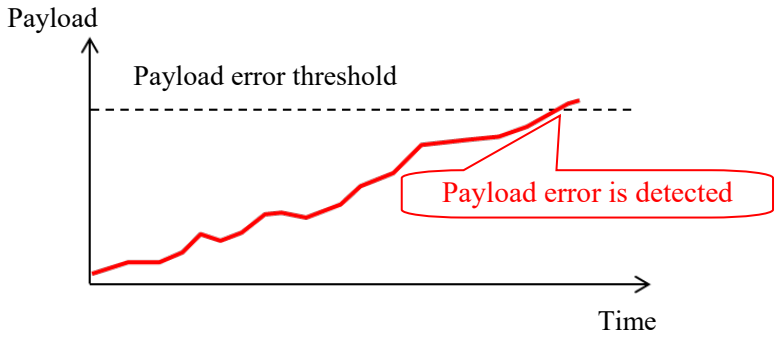
Message	Event	Reference
Collaborative state %d (Ch:%d)	This event is recorded when the collaborative robot state is changed.	Refer to Section 2.3 OUTPUT SIGNAL OF COLLABORATIVE ROBOT STATUS for detail.
Force limit is changed to %d	This event is recorded when the force limit is changed.	Refer to Section 2.2 SETTING COLLABORATIVE ROBOT FUNCTION for detail.
Contact stop is disabled	This event is recorded when all of force limit is disabled.	Refer to Section 2.2 SETTING COLLABORATIVE ROBOT FUNCTION for detail.
Payload number is changed to %d	This event is recorded when payload number is changed.	Refer to Section 2.2 SETTING COLLABORATIVE ROBOT FUNCTION for detail.
Contact stop(%s,%d)	This event is recorded when the robot is stopped by contact stop function.	Refer to Section 4.1 CONTACT STOP FUNCTION for detail.
Auto-resume done	This event is recorded when the program is resumed by auto resume function.	Refer to Section 7.1 AUTO RESUME FUNCTION for detail.
Auto resume canceled (%d)	This event is recorded when the program could not resumed by auto resume function. %d is the factor of this event. The factor is recorded in 2nd lines in message.	Refer to Section 7.1 AUTO RESUME FUNCTION for detail.
Reverse motion	This event is recorded when the reverse motion is executed after contact stop.	Refer to Section 4.3 RETREAT AFTER CONTACT STOP for detail.
Contact force is not released	This event is recorded when resumed or started in spite of exceeded the force limit and the collaborative state is stop.	

7.5 VARIABLE PAYLOAD COMPENSATION FUNCTION

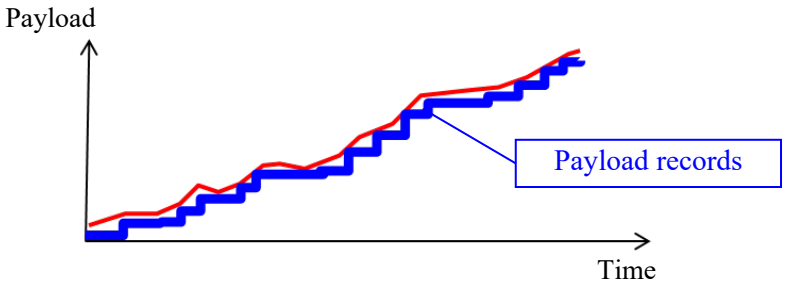
This function is available on the software version 7DC3/33 or after on CR series, or 7DF5/04 or after on CRX series.

When a payload acts on Collaborative Robot, “SYST-325 Payload error is detected” is posted, and the robot stops. For example, in case of that a cable is attached to the robot, when the robot moves and the attitude changes, tension by cable might be detected as payload, and the robot stops.

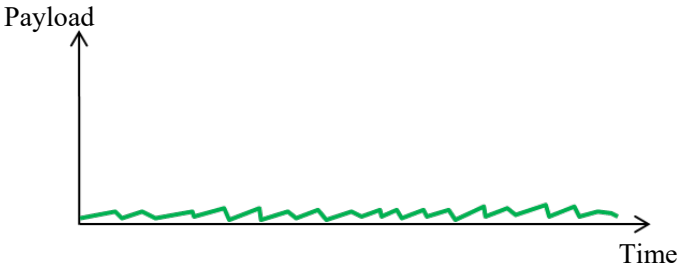




This function cancels an external payload as such system.
Firstly, move the robot in RECORD mode, and Payload is recorded at constant intervals.



During normal operation, recorded payload is canceled from payload detected by sensor.

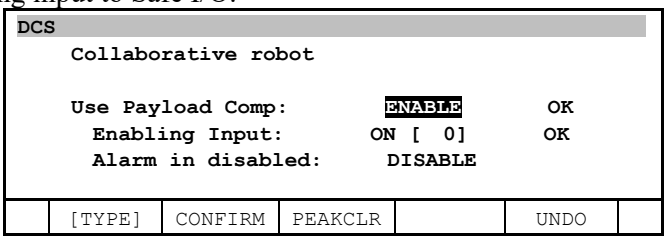


7.5.1 How to use Variable Payload Compensation Function

Enable the function

In the collaborative robot screen, you can enable this function by [Use Payload Comp].

- After change, you need to apply DCS parameters.
- When it is [ENABLE], you can record or playback the payload.
- When you change from [ENABLE] to [DISABLE], the recorded data is not deleted.
- When switching dynamically between enable and disable, set [Use Payload Comp] to [ENABLE] and assign Enabling input to Safe I/O.



Enabling input

Assign Enabling input, the signal turns to ON, then the payload compensation is enabled. And the signal turns to OFF, then the payload compensation is disabled.

Alarm in Disable

When it is enabled and you execute KAREL program for this function when payload compensation is disabled, the program stops by alarm.

Procedure for use

1 Call Karel program “FCMPSTRT” at the start position of compensation.

- 1st parameter : 1 = RECORD mode, 2 = RECORD mode (RECORD clear), 0 = PLAY mode
- 2nd parameter : Schedule number
- 3rd parameter : Interval for compensation (ms) Recordable time is “Interval x 1000”. Minimum of interval is 8(ms).

2 Call Karel program “FCMPEND” at the end position of compensation.

```
1: J P[1] 100% FINE
2:     CALL FCMPSTRT(0, 20, 100)
3: J P[2] 100% FINE
4: L P[3] 250mm/sec FINE
5: L P[4] 250mm/sec FINE
6:     CALL FCMPEND
7: J P[5] 30% FINE
```

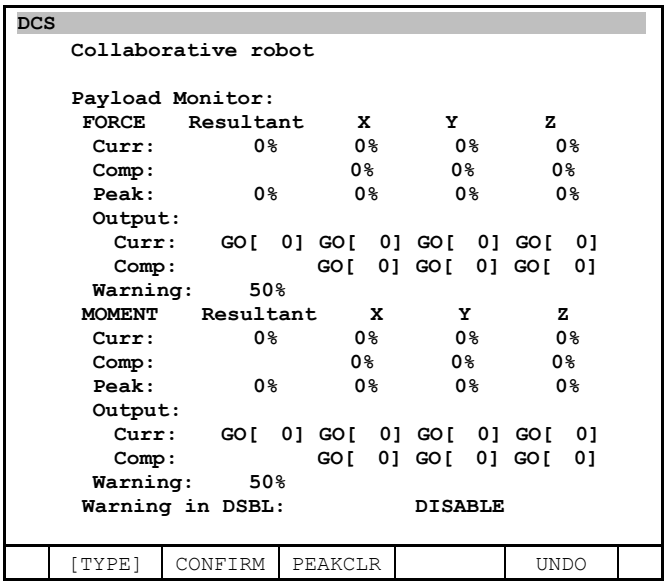
3 Execute with RECORD mode (1st parameter is 1)

- Payload is recorded at set intervals.
- When the recording starts, “SYST-352 Payload Record Start” warning is posted.
- When the recording ends, “SYST-353 Payload Record Finish” warning is posted. It may take time for save recorded data to the memory. If the controller power is off during saving data, recorded data is gone.
- When the recording fails, “SYST-354 Payload Record Failed” warning is posted. The program execution does not stop. For the cause of fail, refer to Subsection 7.5.2.
- When you execute again with the schedule already recorded, average of payload is recorded. When you record 10 times, average value of 10 times is recorded. If you want to delete records, execute with RECORD CLEAR (1st parameter is 2).

4 When you execute with PLAY mode (1st parameter is 0)
- Payload is compensated with the recorded payload.
- When you specify unrecorded schedule, the warning “SYST-355 Payload is NOT recorded” will be posted.
- When the compensation is failed, the warning “SYST-356 Payload Compensation is stopped” will be posted, and compensation will be zero. For the cause of fail, refer to Subsection 7.5.2.
- In PLAY mode, specification of 3rd parameter (interval) for compensation has no meaning. Compensation works at interval at the time of recording.

Compensation Data
- The compensation data is saved below FR:¥CLLB¥
- FR:¥CLLB is saved as CLLB.ZIP in backup of “all of above”.

Compensation value monitoring
Each elements of the compensation value is displayed in payload monitor screen. And you can set and output the values to GO or Register.



7.5.2 Restrictions of Variable Payload Compensation Function

General
- This function works well in the case of that the same payload acts at the same position every time.
- Payload is recorded in association with the point of motion path of the robot. There is no problem if the override is changed or the robot stops with WAIT statement in both RECORD mode and PLAY mode.
  - It is not supported that the payload is changed when the robot stops.
- In below situation, the difference between the recorded payload and actual payload, and the robot might stop by “SYST-325 Payload error is detected” alarm.
  - In the system that the payload changes every time
  - In the case of that the motion path or motion line is changed, the followings are examples
    - The program includes branches with IF and so on.
    - Execution with STEP mode
    - Addition of motion lines after recording
    - Re-teaching after recording
  - When the speed is changed, the payload is also changed.
- In the system that the external force is detected by floor vibration, vibration is changed between recording and playback, and this function will not compensates well.
- The shorter the interval for compensation, the higher the accuracy and the shorter the recording time. Recommended interval is the value obtained by dividing the operating time by 1000.

- Compensation don't work for Force Control.

> **⚠ CAUTION**
> 1. When the variable payload compensation is enabled and Push to Escape is enabled, the mismatch between recorded payload and actual payload causes Push to Escape movement with nobody pushing.
> 2. When the variable payload compensation is enabled and the retreat after contact stop is enabled, the mismatch between recorded payload and actual payload causes retreat movement without contact.

RECORD mode

- During recording, the compensation does not work. In the case of that the contact stop occurs on the way, recording fails. Set disabling input of force limit to ON, record with the contact stop disable.

> **⚠ WARNING**
> When the contact stop is disabled, the collaborative robot does not stop even though the external force exceeds the limit, and a serious personal injury could result. If the robot system is designed to be able to disable the contact stop, adequate risk assessment for the whole robot system is necessary to verify that the contact stop can be disabled.

- In following cases, the warning "SYST-354 Payload Record Failed (No.X, Y)" occurs. During first recording, it becomes an unrecorded state. During after second recording, it becomes the last recorded state. X of warning message means the schedule number, and Y means the error code. Refer below causes and remedies.

Error Code	Cause	Remedy
1	Hold occurs.	Don't hold during recording.
2	Hold occurs during after second recording.	Don't hold during recording.
3	The program is aborted.	Don't abort the program during recording.
4	The program is aborted during after second recording.	Don't abort the program during recording.
5	Backward execution occurs.	Don't execute backward during recording.
6	Backward execution occurs during after second recording.	Don't execute backward during recording.
7	FCMPSTRT is called.	Don't call other FCMPSTRT between FCMPSTRT and FCMPEND.
8	FCMPSTRT is called during after second recording.	Don't call other FCMPSTRT between FCMPSTRT and FCMPEND.
9	The recording data is abnormal.	Repower the controller. If the problem is not cleared, save the diagnostic log just after failure and send the files to FANUC sales person.
10	The recording data is abnormal during after second recording.	Repower the controller. If the problem is not cleared, save the diagnostic log just after failure and send the files to FANUC sales person.
11	Payload is Unrecorded during after second recording	Execute with 1st parameter 2 (RECORD(RECORD CLEAR))
12	The recording data is abnormal during after second recording.	Repower the controller. If the problem is not cleared, save the diagnostic log just after failure and send the files to FANUC sales person.
13	Cause Recording time exceeds.	Recording time limit is "Interval x 1000". Set the interval to longer value.

- When the controller power off occurs during recording, the recorded date does not remain.

PLAY mode

- When the program is paused, the compensation remains the value at stop.
- When the program is restarted with original path resume enable, the compensation remains the value at stop until the robot returns stop positon.
- In following cases, "SYST-355 Payload Compensation is stopped (No. X, Y)" warning occurs, and the compensation is finished. The compensation value is to zero. X of warning message means the schedule number, and Y means the error code. Refer below causes and remedies.

Error Code	Cause	Remedy
1	The program is aborted.	Don't abort the program during compensation.
2	Backward execution occurs.	Don't execute backward during compensation.
3	FCMPSTRT is called.	Don't call other FCMPSTRT between FCMPSTRT and FCMPEND.
4	The robot restarts on different motion path.	When the motion path is changed after resume, the compensation is stopped. If the original resume function is disabled, enable it. Don't change the program line
5	The recording data is abnormal.	Repower the controller. If the problem is not cleared, save the diagnostic log just after failure and send the files to FANUC sales person.

- When the controller power off occurs during playback, the compensation is finished.

7.5.3 Push to Escape with Variable Payload Compensation

In the software version 7DC3/47, 7DF1/17 or later, Push to Escape can be enabled when variable payload compensation is enabled.

> **⚠ CAUTION**
> When the variable payload compensation is enabled and Push to Escape is enabled, the mismatch between recorded payload and actual payload causes Push to Escape movement with nobody pushing.

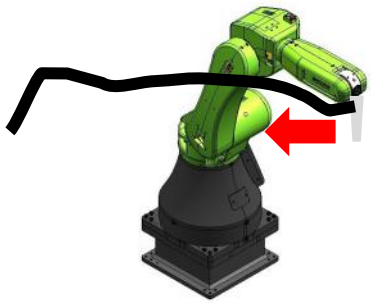
CONDITION

When [Check during moving] in [Auto status check] is enabled, [Push to Escape] cannot be enabled.

SETTING

1 In Collaborative Robot screen, when both [Use Payload Comp] and [Push to Escape] are enabled, the message "Mismatch between the payload recorded by payload comp and the actual payload might cause Push to Escape movement with nobody pushing. Do you enable Push to Escape?" is displayed.
   - When [No] is selected, [Push to Escape] becomes disabled.

2 When [Yes] is selected, [Push to Escape] becomes enabled, and the message "In case the payload remains during the escape, PyldComp during escp should be enabled. Do you enable PyldComp during escp?" is displayed.
   - In the case the payload still keeps even after robot position is changed by Push to Escape, select [Yes]. For example, when a cable is attached to the robot, payload by tension of cable keeps even if the robot position is changed. When [Yes] is selected, [PyldComp during Escp] becomes enabled and Compensation value keeps when Push to Escape is performed in PLAY mode.



⚠ CAUTION
When [PyldComp during Escp] is enabled and Robot position is changed by Push to Escape and the payload on the robot is changed, Push to Escape might be perfomed with nobody pushing because of mismatch between the recorded payload and the actual payload.

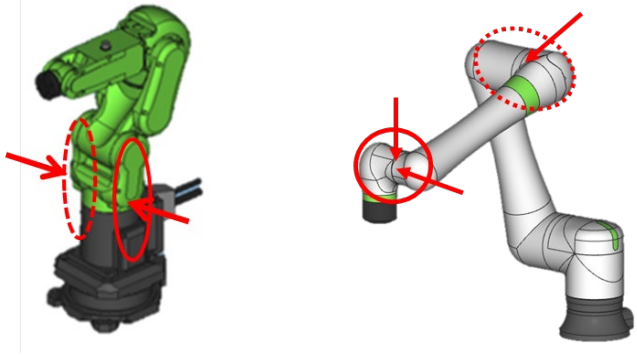
- In the case the payload will not work after Push to Escape, select [No]. For example, when the robot works while touching workpiece, the robot leaves workpiece by Push to escape, payload will not apply. When [No] is selected, [PyldComp during Escp] becomes disabled and the compensation value becomes 0 when Push to Escape is performed in PLAY mode. After restarting program, the compensation value will be back when the robot returns on original path.

⚠ CAUTION
When [PyldComp during Escp] is disabled, if the payload keeps after Push to Escape, the payload might cause Push to Escape.

- [PyldComp during Escp] is also configurable in Collaborative Robot screen.

7.6 DOUBLE TAP FUNCTION

When you push the parts shown in the figure below twice, the digital signal is output. For example, you set that the start signal is raised when the double tap signal is output, and then you can restart the robot with double tap after the contact stop.



> ⚠ **CAUTION**
> The double tap function is disabled by default. If you set this function, adequate risk assessment for the whole robot system is necessary to verify that the double tap function does not cause any dangerous situation.

Supported robots

Only support for CR-4*i*A, CR-7*i*A, CR-7*i*A/L, CR-14*i*A/L and CR-15*i*A.
CR-35*i*A is not supported.

TIPS for Pushing

- Push it lightly. It does not react when you swat it.
- Push the second within one second from the first.

7.6.1 Output Signal

Setting up

You can set “Output” signal for double tap in the collaborative robot screen.

In the software version 7DC3/46, 7DF1/16 or earlier, you can set up the double tap function with below system variables.
$DCSS_CLLB[1].$DOTYP_TAP: Set the type of output (DO:2, RO:9, F:35)
$DCSS_CLLB[1].$DOIDX_TAP: Set the index of output

7.6.2 Double Tap to Resume

This function is available on the software version 7DF5/05 or later.

When this setting is enabled, you can restart the TP program after contact stop by Double Tap.

Condition

- In AUTO mode
- Teach Pendant is OFF.
- The program is paused by the contact stop function.
- Any alarm is not posted.

In following cases, the auto resume is canceled.

- The program was aborted.
- The robot was moves after contact stop by operations such as JOG.
- Push to Escape is performed.
- Retreat after the contact stop is performed.
- The paused program's group mask is not same as collaborative robot group.
- HOLD key was pressed after contact stop.
- Contact stop function is disabled.

Limitation

- Multi task program is not supported, because the auto resume can resume only one task. When multiple programs is executed by multitasking function, all programs pause by the contact stop function. If you don’t want to stop a program by the contact stop, set Interruption Disable in the program detail screen. Refer to OPERATOR’S MANUAL (Basic Operation) (B-83284EN), Chapter of PROGRAM STRUCTURE.
- Auto resume function will not resume when the program group mask is not same as collaborative robot group setting. Therefore, CALL instruction may cause unintended resuming. For example, if using following two programs, the program will not be resumed when the cursor is in the

PRG_A.TP but the program will be resumed when the cursor is in the PRG_B.TP. In this case, set Group mask of collaborative robot group to 1 in PRG_A detail screen, then the auto resume function will resumes PRG_A.

PRG_A.TP(Group Mask *,*,...)

```
1:CALL PRG_B
2:DO[1] = ON
3:WAIT DI[1] = ON
4:CALL PRG_B
```

PRG_B.TP(Group Mask 1,*,...)

```
1:J P[1] 10% CNT 100
2:J P[2] 10% CNT 10
```

7.7 PAYLOAD IDENTIFICATION

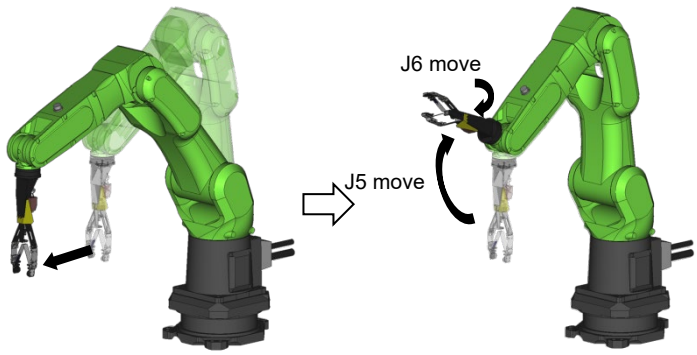
This function identifies the mass of the payload and the center of gravity automatically by movement of collaborative robot. Payload inertia is not identified with this function.

7.7.1 CRX series

Select “UTool Payload Setup” in “Setup” menu of the Tablet TP, and following the instructions shown, move the robot and make measurements to estimate the payload. After successful estimation, tapping “FINISH” in “Confirming and Applying Results” screen will apply the estimated results to the setting.
When using iPendant, in single display, press the [MENU] key, and select “SYSTEM”, “Motion”, then “IDENT” to show the instruction.

7.7.2 CR series

This function is available on the software version 7DC3/47, 7DF1/17 or after



Execute payload identification

1 Press [MENU] key.
2 Select [SYSTEM].
3 Press F1, [TYPE].
4 Select [Motion].

```
MOTION PERFORMANCE
      Group1                          1/10
   No.    PAYLOAD[kg]          Comment
    1          0.00   [                  ]
    2          0.00   [                  ]
    3          0.00   [                  ]
    4          0.00   [                  ]
    5          0.00   [                  ]
    6          0.00   [                  ]
    7          0.00   [                  ]
    8          0.00   [                  ]
    9          0.00   [                  ]
   10          0.00   [                  ]
  Active PAYLOAD number = 0

 [ TYPE ]  GROUP  DETAIL  ARMLOAD  SETIND  >
```

NOTE
If equipment is mounted on the robot arms, please set up ARMLOAD beforehand.

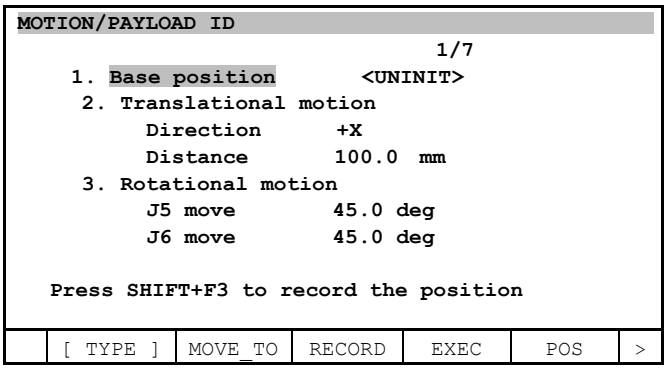
5 Press [NEXT], then press F2[IDENT]. The payload identification screen will be displayed.

```
MOTION/PAYLOAD ID
                                  1/2
      Group 1
      Schedule No[   1]:[****************]
    1 PAYLOAD ESTIMATION            *****
       Previous Estimated value (Maximum)
       Payload [Kg] :      0.00 ( 7.00)
       Axis Moment [Nm]
        J4:          0.00E+00 ( 1.66E+01)
        J5:          0.00E+00 ( 1.66E+01)
        J6:          0.00E+00 ( 9.40E+00)
       Center of Gravity [cm]
         X:          0.00
         Y:          0.00
         Z:          0.00

    2 MASS IS KNOW    [NO ]    0.000[Kg]

 [ TYPE ]        NUMBER  EXEC  APPLY  >
```

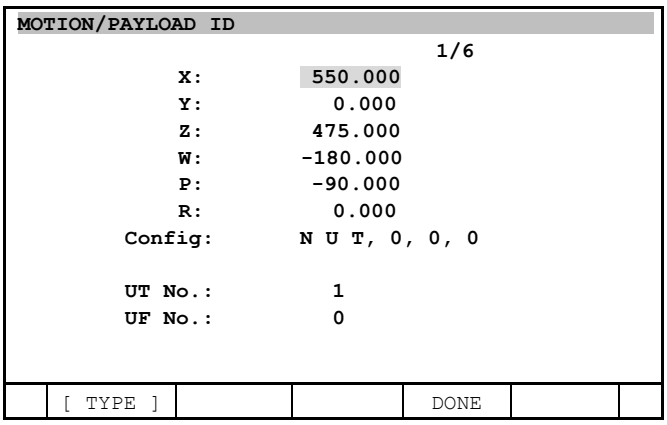
6 Press F3[NUMBER], and select the payload No. for which payload identification is to be set up.
7 If the mass of the payload for which payload identification is to be performed is known, move the cursor to line 2, select [YES], and enter the mass.

NOTE
1 A payload with very small mass cannot be identified.
2 The center of gravity can be identified more accurately by specifying the mass.

8 Press [NEXT] key, then press F4[DETAIL]. The detail payload identification screen will be displayed.



9 Set base position. Move the robot to the desired position by jogging, then hold down the [SHIFT] key and press F3[RECORD] to record the position. Hold down the [SHIFT] key and press F2[MOVE_TO] moves the robot to the base position. By pressing F5[POS] shows the position information of base position recorded. The position information (XYZWPR) can be modified by entering their values directly.



10 Set the translational motion. Select the direction of translational motion from +X, -X, +Y, -Y in the robot world frame. The distance of translational motion can be modified by entering the value directly. Please set it larger than 100mm. Move the cursor aligned with the translational motion, hold down the [SHIFT] key and press F2[MOVE_TO], the robot will perform the translational motion. Please verify that no interference occurs during the translational motion.

11 Set the rotational motion. The rotation angle of J5 and J6 motion can be modified by entering the values directly. Please set it larger than 45deg. Move the cursor aligned with the rotational motion, hold down the [SHIFT] key and press F2[MOVE_TO], robot will perform the rotational motion. Please verify that no interference occurs during the rotational motion.

NOTE
Identification will be failed under specific conditions. For example:
- After J5 move, the direction of Z-axis of mechanical interface coordinate system is parallel for the ground.
- The direction of the Z-axis of mechanical interface coordinate system is symmetric for a horizontal plane between before and after J5 move. (For example, when J3 = 0 deg and J4 = 0 deg, J5 moves from -45 deg to +45 deg)

12 Hold down the [SHIFT] key and press F4[EXEC]. The message “Did you verify that no interference occurs during all motions?” will be displayed. It can also be executed in modes other than AUTO mode. In that case, press Enabling device (Deadman switch) and hold down the [SHIFT] key while executing the motion.

NOTE
1 Payload identification motion cannot be started if robot is in the STEP operation mode. Please make sure robot is not in the STEP operation mode.
2 Payload identification motion will be aborted when the robot passes near the singularity or the position is not reachable. Please check the base position and the setting of the payload identification motion.

13 Specify whether to perform payload identification
- To perform payload identification by running the robot, select [YES].
- To quit execution, select [NO].

NOTE
1 Robot will move. Please adjust the robot motion speed by changing the override.
2 If payload setting data while in identify motion is far different from the actual payload, robot may stop by “SYST-320 Program paused by contact stop” or “SYST-325 Payload error is detected”. In that case, please set the payload roughly.

14 After the identify motion are finished, the payload identification result will be displayed.
15 Press F5[APPLY] to set the estimate at a payload setting schedule No. The message “Payload identification result will be applied. Please apply to DCS parameter after this setup.” will be displayed.
16 Specify whether to set the payload identification result.
- To set the payload identification result, select [YES].
- Not to set the payload identification result, select [NO].

17 If the value to be set is greater than the maximum allowable load (indicated in parentheses), the message “Load is OVER spec! Accept?” will be displayed. Specify whether to set this value, just as in the step above.

NOTE
1 When the payload identification is complete, “*****” of “1 PAYLOAD ESTIMATION *****”changes to [DONE]. However if it is aborted for some reason, such as Emergency Stop, it changes to [ABORT]. The payload are not estimated, so do not [APPLY] and execute the estimation again.
2 If the payload identification fails, any or all of the applied results (payload, center of gravity) would be 0. For example, identification fails.
- A payload with very small mass cannot be identified.
- After J5 move, the direction of Z-axis of mechanical interface coordinate system is parallel for the ground.
- The direction of the Z-axis of mechanical interface coordinate system is symmetric for a horizontal plane between before and after J5 move. (For example, when J3 = 0 deg and J4 = 0 deg, J5 moves from -45 deg to +45 deg)

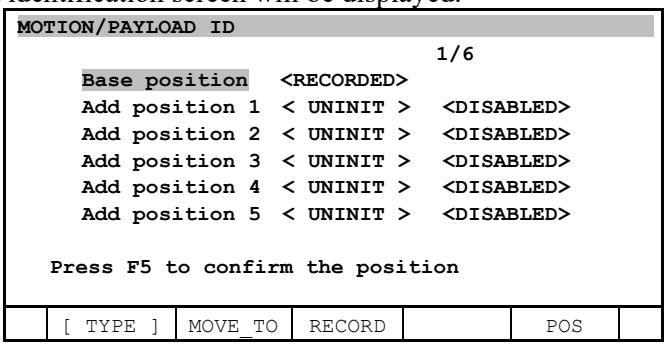
18 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

Add positions of payload identification

Add positions can further improve the accuracy of payload identification. After executing payload identification, please execute in the following procedure.

Add positions of payload identification

1 On the payload identification detail screen, press [NEXT] key, then press F3[ADVANCED]. The advanced payload identification screen will be displayed.



2 Set the add position. Add position should be set the same wrist posture, the same UT No. and the same UF No. with base position. Move the robot to the desired position by jogging, then hold down the [SHIFT] key and press F3[RECORD] to record the position. The status will change from [DISABLED] to [ENABLED] when add position recorded. Please change it to [DISABLED] if you do not use it. By pressing F5[POS] shows the position information of add position recorded. The position information (XYZ) can be modified by entering their values directly. Hold down the [SHIFT] key and press F2[MOVE_TO], robot will first move to the base position, and then move to the added positions with joint motion, in displayed order. Please verify that no interference occurs during all motions.

NOTE
For example, when add position 1 and 3 are set to [ENABLED], the robot will move in the following way.
Base position -> translational motion -> base position -> rotational motion -> base position -> add position 1 -> add position 3 -> base position.

3 Press [PREV] key to return to the payload identification detail screen.
4 Hold down the [SHIFT] key and press F4[EXEC]. The message “Did you verify that no interference occurs during all motions?” will be displayed. It can also be executed in modes other than AUTO mode. In that case, press the deadman switch and hold down the [SHIFT] key while executing the motion.

NOTE
1 Payload identification motion cannot be started if robot is in the STEP operation mode. Please make sure robot is not in the STEP operation mode.
2 Payload identification motion will be aborted when the robot passes near the singularity or the position is not reachable. Please check the base position and the setting of the payload identification motion.

5 Specify whether to perform payload identification
- To perform payload identification by running the robot, select [YES].
- To quit execution, select [NO].

NOTE
1 Robot will move. Please adjust the robot motion speed by changing the override.
2 If payload setting data while in identify motion is far different from the actual payload, robot may stop by “SYST-320 Program paused by contact stop” or “SYST-325 Payload error is detected”. In that case, please set the payload roughly.

6 After the identify motion are finished, payload identification result will be displayed.
7 Press F5[APPLY] to set the estimate at a payload setting schedule No. The message “Payload identification result will be applied. Please apply to DCS parameter after this setup.” will be displayed.
8 Specify whether to set the payload identification result.
- To set the payload identification result, select [YES].
- Not to set the payload identification result, select [NO].

9 If the value to be set is greater than the maximum allowable load (indicated in parentheses), the message “Load is OVER spec! Accept?” will be displayed. Specify whether to set this value, just as in the step above.

NOTE
1 When the payload identification is complete, “*****” of “1 PAYLOAD ESTIMATION *****”changes to [DONE]. However if it is aborted for some reason, such as Emergency Stop, it changes to [ABORT]. The payload are not estimated, so do not [APPLY] and execute the estimation again.
2 If the payload identification fails, any or all of the applied results (payload, center of gravity) would be 0. Please change movement setting and execute the estimation again.

10 Apply DCS parameter. Refer to Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN), Chapter of OVERVIEW, Section of APPLY TO DCS PARAMETER.

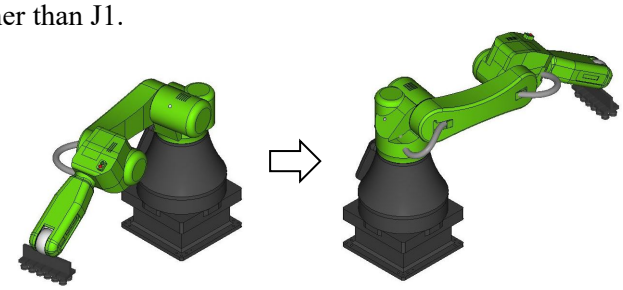
7.8 INSTALLATION DIAGNOSTIC TOOL (CR series)

This tool is available on the software version 7DC3/47, 7DF1/17 or later.

You can verify the correctness of the robot installation by letting the robot do simple movement with this tool. Verification with this tool is recommended first after installation of the robot.

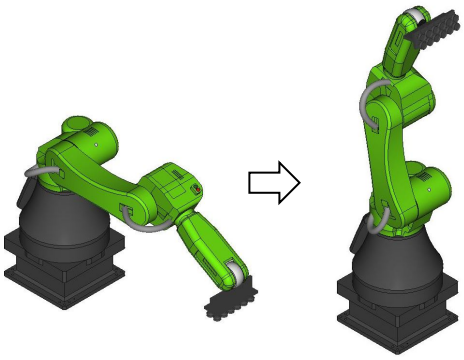
Execution of Installation Diagnostic Tool

1 Create TP program for Diagnosis.
2 Teach movement only for J1.
- For the accurate diagnosis, teach J1 movement over 90 degrees.
- Don’t move other than J1.



3 Teach movement only for J2.

- For the accurate diagnosis, teach J2 movement over 90 degrees.
- J3 may move.
- Don't move other than J2 and J3.



4 Insert CALL commands to call "CRDIAG(parameter)" before and after each movements. CRDIAG is KAREL program installed by default.
- Call CRDIAG(1) before J1 movement. Call CRDIAG(2) after J1 movement.
- Call CRDIAG(3) before J2 movement. Call CRDIAG(4) after J2 movement.
- Following is sample program.

```
1: J P[1] 30% FINE      : Start position of J1 movement
2:    CALL CRDIAG(1)
3: J P[2] 30% FINE      : J1 movement
4:    CALL CRDIAG(2)
5: J P[3] 30% FINE      : Start position of J2 movement
6:    CALL CRDIAG(3)
7: J P[4] 30% FINE      : J2 movement
8:    CALL CRDIAG(4)
```

5 Run program.

6 When the movement is done, installation state is judged, and judgment result is displayed.
- When the judgment is A or B, there is no problem for installation. Installation is done.
- When the judgment is C or D, deal according to the following tables depending on mode displayed by the teach pendant.

Mode	Remedy
Mode 1	Verify active payload settings match actual payload on the robot. Re-run Diagnostics test. If result is the same, verify robot installation.
Mode 2	Verify active payload settings match actual payload on the robot.
Mode 3	Verify robot installation based on robot mechanical installation procedure.

For installation state, refer to manuals for each mechanical unit, Chapter of TRANSPORTATION AND INSTALLATION.
For payload settings, refer to Section 7.7 PALOAD IDENTIFICATION, and manuals for each mechanical unit, Section of LOAD SETTING.

- After remedy, re-run the program, and verify the judgment is A or B.
- If judgment is still not A or B after certain measures, sensor may be damaged. Contact your local FANUC representative.

7.9 STOP TYPE SETTING FOR CONTACT STOP (CRX series)

This setting is available on the software version 7DF5/13 (V9.40P/13) or later.

You can select the stop type at contact stop: “Smooth Stop” or “Sudden Stop”.

“Sudden Stop” reduces the generation force when pinching between the robot and the other object by stopping the robot more quickly than “Smooth Stop”. With “Sudden Stop”, the robot cannot pause on the taught trajectory unlike “Smooth Stop”. Thus, when the original path resume is enabled and you restart the TP program after “Sudden Stop”, the robot executes restart move and resume the TP program.

The standard stop type is “Smooth Stop”.

> ⚠ **CAUTION**
> Even if “Sudden Stop” is enabled, when person is pinched between the robot and the other object (wall, floor, etc.), and the robot arm, it may result in personal injury. Design the workspace where person work near robot following “NOTE TO DESIGN THE COLLABORATIVE WORKSPACE” on MECHANICAL UNIT OPERATOR’S MANUAL and conduct adequate risk assessment for the whole robot system

7.9.1 Setup

You can choose the contact stop type at Controlled start mode.

1. Enter Controlled start mode and open the MAINTENANCE screen. Refer to OPERATOR’S MANUAL (Basic Function) (B-83284EN), Chapter of SPECIAL OPERATION, Section of START MODE.
2. Put the cursor on the robot name, and press F4 [MANUAL]
3. Select the stop type at the question below.

```
******** Group 1 Initialization ********
********** CRX-10iA ********************

------ CONTACT STOP TYPE SELECT -----

0.  Smooth Stop (recommended)
1.  Sudden Stop
 Select stop type (0 or 1)->

Default value = 0
```

4. Do Cold start.

7.10 SYSTEM VARIABLES TO INDICATE COLLABORATIVE ROBOT'S STATUS

These variables are available on the software version 7DC3/47, 7DF1/17 or later on CR series, and 7DF5/18 or later on CRX series.

These system variables indicate collaborative robot's status.

variables	description
$CR_VAR[1].$STATE	Contact stop status 0: contact stop is disabled in screen, 1: SAFE, 2: STOP, 3: DSBL, 4: ESCP
$CR_VAR[1].$FS_MON[1-7]	Force Monitor values [%] CR series 1: X 2: Y 3: Z 4: Resultant CRX series 1~6: J1~J6 7: Resultant
$CR_VAR[1].$PLF_MON[1-7]	Payload Monitor values [%] CR series (Force) 1: X 2: Y 3: Z 4: Resultant CRX series 1~6: J1~J6 7: Resultant
$CR_VAR[1].$PLM_MON[1-4]	Payload Monitor values [%] CR series (Moment) 1: X 2: Y 3: Z 4: Resultant
$CR_VAR[1].$TCP_SPD	TCP speed [% to collaborative speed]
$CR_VAR[1].$ELB_SPD	Elbow speed [% to collaborative speed]
$CR_VAR[1].$TIME_CHK	Time from the last auto status check [second]
$CR_VAR[1].$TIM_LIM	The current auto status check time limit [second]

8 *i*HMI FOR COLLABORATIVE ROBOT

*i*HMI is a user interface with a design that even who have never used FANUC product can start up easily.
Refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Chapter of *i*HMI.
This chapter introduces functions and operation of *i*HMI for Collaborative robot.

Contents of this chapter

*i*HMI can only be used with R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Mini Plus controller.

8.1 OVERVIEW OF THE HOME SCREEN

This section explains the overview of the home screen.
For *i*HMI for collaborative robot, added functions for collaborative robots to groups of "SETUP", "TEACH", and "RUN".

Fig. 8.1 (a) Home screen

Table 8.1 (a) Icons on the home screen

Type	Icon	Description
Setup	 BASIC	Display the Basic Setup Selection screen. On the selection screen, you select the Initial Setup screen and End of Arm Tool Setup Screen, Collaborative Setup screen. The collaborative setting guide will guide settings that make simple pick & place programs executable and settings that enable to switch between fast modes.
Teach	 CREATE PROGRAM	Display the Create a Program screen. On the Create a Program screen, you create programs using template programs (sample programs) for achieving certain objectives. You can also select a "Blank Template" for creating a program from scratch.
Run	 COLLABORATIVE	Display the Collaborative Monitor screen. Graphically displays the external force applied to the robot.

8.2 OPERATIONS RELATED TO SETUP

Tap the [BASIC] icons on the home screen and display the Basic Setup Selection screen.
On the Basic Setup Selection screen, select either the Initial Setup screen or the End of Arm Tool Setup screen, Collaborative Setup screen.
The screen display flow for setup is shown below.

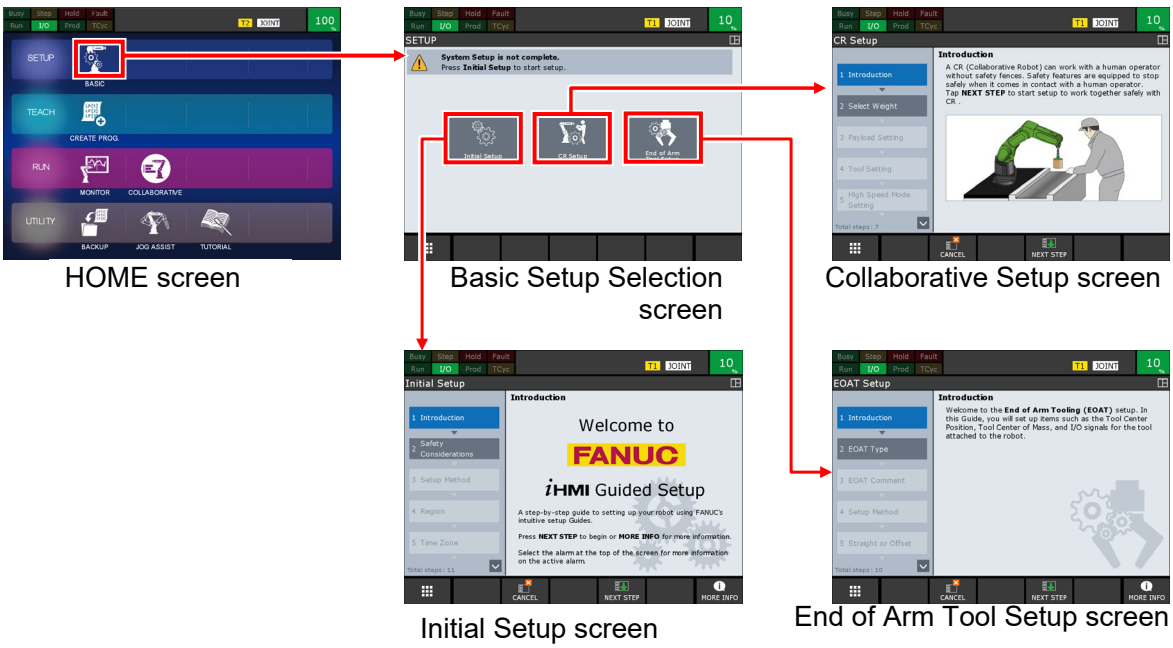


Fig. 8.2(a) Screen display flow (Setup)

For Initial Setup Guide and End of Arm Tool Setup Guide, refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Section of Operations related to Setup.

8.2.1 Collaborative Setup Guide

The collaborative setup guide will guide settings that make simple pick & place programs executable and settings that enable to switch between fast modes. The collaborative setup guide screen is shown below.

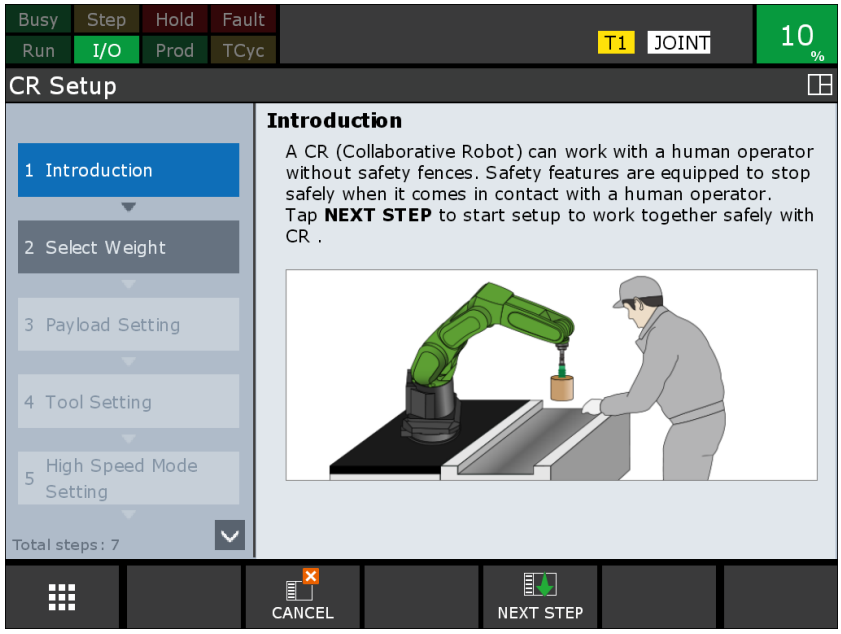


Fig.8.2.1(a) Collaborative Setup Guide screen

The main setup items on the Collaborative Setup Guide are as follows:

- Payload Setup
- Contact-Stop Invalid Area (Payload change distance)
- Tool Setup
- High Speed Mode

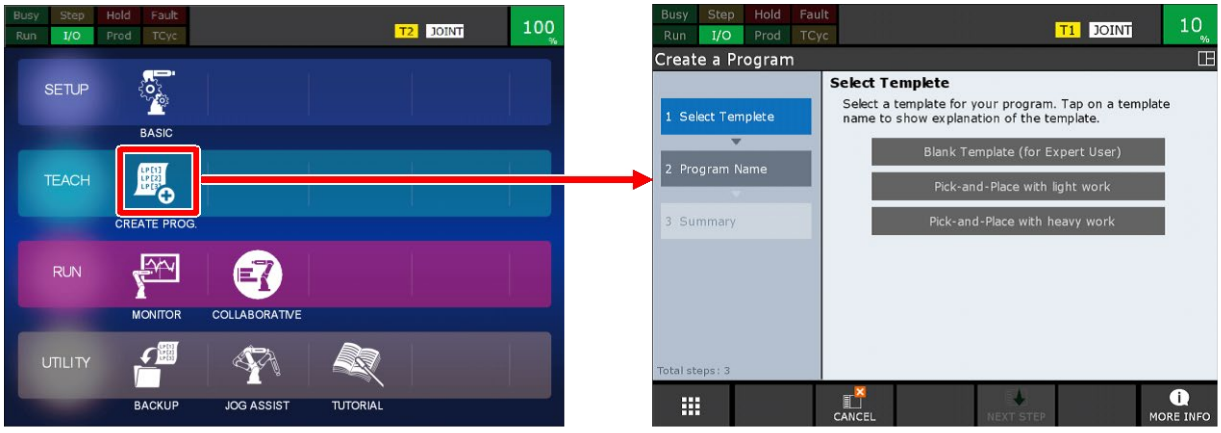
NOTE

1 When the Collaborative Setup guide is completed, the tool setting guide is also automatically set to the completion state.
2 When the Collaborative Setup guide is completed, go to DCS screen.

8.3 OPERATIONS RELATED TO TEACH

Tap the [Create Program] icon on the home screen and display the Create a Program screen.

The screen display flow when there are no programs is shown below.



HOME screen Create a Program screen

Fig.8.3(a) Screen display flow (when there are no programs)

Refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN), Section of Operations related to teach.

8.3.1 Create Program

On the Create a Program screen, you create programs using template programs (sample programs) for achieving certain objectives. You can also select a "Blank Template" for creating a program from scratch. The Create Program guide screen is shown below.

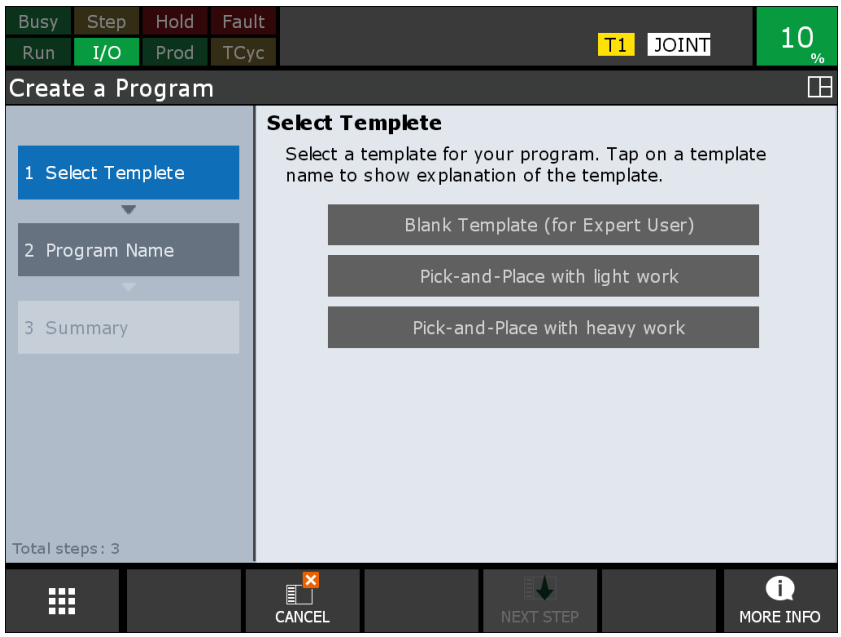


Fig.8.3.1(a) Create a Program Screen

The templates that can be selected on the Create Program Guide screen are as follows:

- Blank Template
- Pick & Place with light work
- Pick & Place with heavy work

8.3.2 Pick & Place with Light Work

This is a template for creating pick & place program with workpiece weight less than 1 kg. You can create a pick & place program with only three teachings.
Teaching points that require teaching by Operator are 1st, 2nd, and 5th point. Other teaching points are taught automatically from 1st and 5th point.

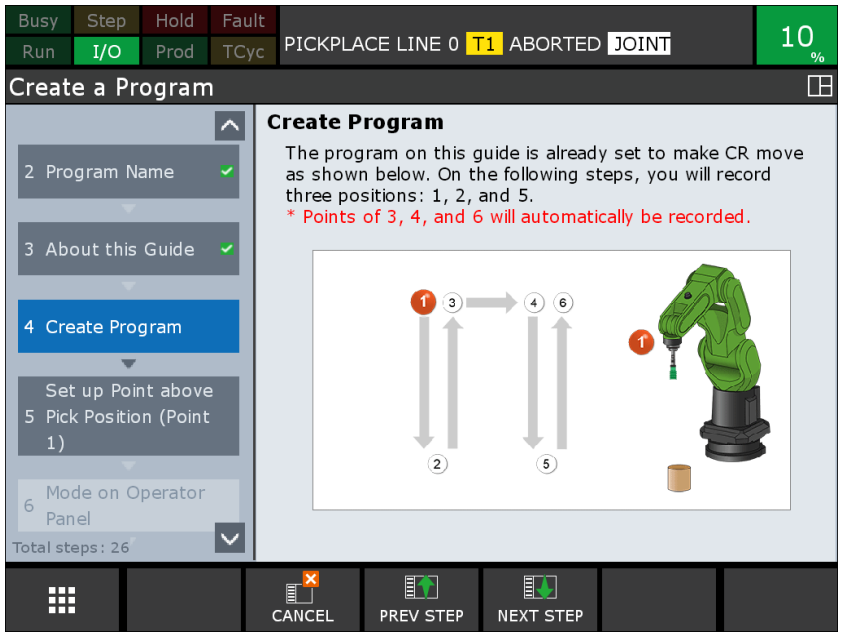


Fig. 8.3.2(a) Create a Pick & Place with light work screen

If the workpiece is less than 1 kg, you can usually operate without stopping the robot without switching payload.

NOTE
If the workpiece is less than 1 kg, the robot may stop. In that case, please use Pick & Place with heavy work template.

8.3.3 Pick & Place with Heavy Work

This is a template for creating a pick & place program with a workpiece weight of 1 kg or more. You can create a pick & place program with only 5 teachings.
Teaching points that require teaching by Operator are 1st, 2nd, 3rd, 4th and 7th point. Other teaching points are taught automatically from 1st and 7th point.

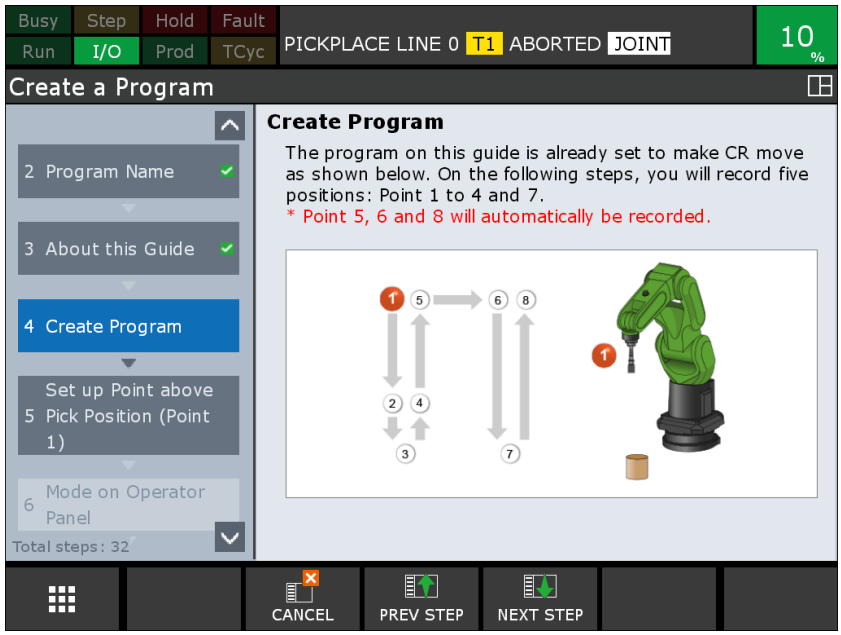


Fig. 8.3.3(a) Create a Pick & Place with heavy work screen

If the workpiece weight is 1 kg or more, the robot stops unless the payload switching is properly performed. Please make appropriate settings before operating.

> ⚠ **WARNING**
> If switch payload, Contact Stop function is disabled In Contact-Stop Invalid Area. The robot does not stop, if an operator contacts. If switch payload, adequate risk assessment for the whole robot system is necessary to verify that the contact stop function becomes invalid within the Contact-Stop Invalid Area.

8.4 COLLABORATIVE MONITOR (CR series only)

Collaborative Robot Monitor provides the screen that can be graphically monitored external forces on cooperating robots.
Tap the "COLLABORATIVE" icon on the home screen to display the Collaborative Robot Monitor screen.

HOME screen — Collaborative Robot Monitor Screen

Fig. 8.4(a) Screen display flow (Collaborative Robot Monitor)

8.4.1 Collaborative Robot Monitor Screen

Collaborative Robot Monitor Screen shows the following information.

(1) Collaborative Robot
(2) Contact Stop status
(3) The value of External Force, Payload and Moment
(4) Active Payload Number
(5) Direction and magnitude of the Force

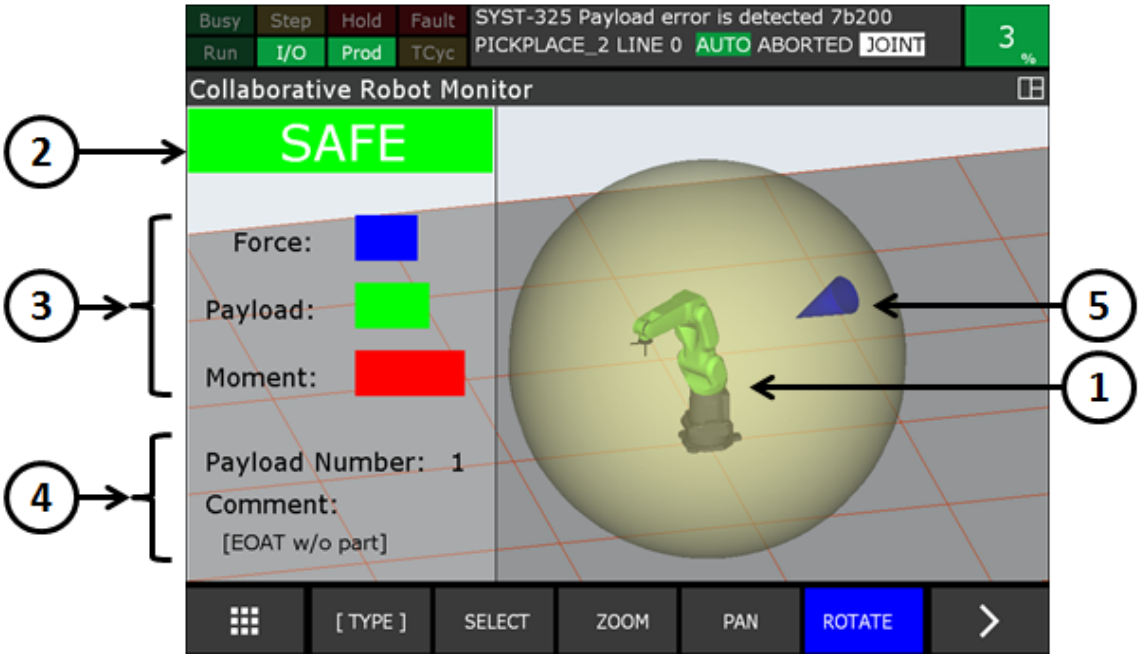


Fig. 8.4.1(a) Information on Collaborative Robot Monitor screen

Followings are explanation of the information on the screen.

Collaborative Robot (1)

Collaborative robot graphic is shown. The robot model is the same posture as the actual robot.

Contact Stop status (2)

This parameter is the status of contact stop status of the collaborative robot. The contact stop status has the following four statuses. Depending on each state, the background color of the status also changes. Please refer to “2.3 OUTPUT SIGNAL OF COLLABORATIVE ROBOT STATUS” for details of the parameter.

SAFE (green) : The contact stop function is enabled and the safety is confirmed.
STOP (red) : The contact stop function is enabled and the safety is not confirmed.
DSBL (yellow) : The contact stop function is disabled.
ESCP (yellow) : In Push To Escape.

The value of Force, Payload and Moment (3)

The magnitude of the force applied to the robot is displayed. Please refer to “4.2.3 Collaborative Robot Monitor Screen” for details of the parameter.

Force[%]

External force applied to the robot is displayed by a blue bar. The maximum value is assumed to be 100%, and when it exceeds 80% the color of the bar changes to red.

Payload[%]

Steady load applied to the robot is displayed by a green bar. The maximum value is assumed to be 100%, and when it exceeds 80% the color of the bar changes to red.

Moment[%]

Moment applied to the robot is displayed by a green bar. The maximum value is assumed to be 100%, and when it exceeds 80% the color of the bar changes to red.

Active Payload Number (4)

The selected payload number is displayed. If a comment is set for the selected payload, that comment is also displayed.

Direction and magnitude of the Force (5)

The direction and magnitude of the external force applied to the robot is displayed. From the inner surface of the sphere drawn to enclose the robot, a blue cone is displayed towards the direction of force applied to the robot. The length of the cone changes depending on the magnitude of the external force. When the magnitude of force applied to the robot exceeds 80 %, the color of the cone changes to red. If the magnitude of force applied to the robot is less than 20%, the cone is not displayed. Please refer to “4.2.3 Collaborative Robot Monitor Screen” for details of external force.

APPENDIX

A TROUBLESHOOTING

A.1 INDELIBLE ALARM

“SRVO-358 DCS INVPRM alarm” occurs.

Verify followings.

- The group number setting of the collaborative robot is correct.
- The force limit settings are between 0 and 150, inclusive.

“SRVO-473 DCS CLLB CC_EXTF alarm” occurs.

Verify followings.

- Refer to A.2 “SYST-320 Program paused by contact stop” or “SYST-325 Payload error is detected” occurs, even though nobody contacts the robot.”
- Perform Payload confirmation operation after warm-up operation.
- Don’t cycle power when the payload CONFIRM input is ON.
- Don’t switch the payload CONFIRM input several times in a short time
- Replace the force sensor.

“SRVO-477 Calibration data error” occurs.

Verify if backup files were loaded after initial start. If not, execute one of the following items. After executing, check that “Force Sensor Serial number on the manufacturing plate” corresponds to that of “Force Sensor Serial number on TP”. Refer to PREFACE of each MECHANICAL UNIT OPERATOR’S MANUAL.

- Restore appropriate backup files. If necessary, perform “APPLY TO DCS PARAMETER”. Refer to section 1.3 of Dual Check Safety Function OPERATOR’S MANUAL (B-83184EN).
- Copy the "CLLB.CM" file from the CD-R that comes with the robot to the root directory of a memory card or USB device. Using the Teach Pendant, select the CLLB.CM file and execute it using the ENTER key to load the calibration for the sensor. After this file is executed, perform "APPLY TO DCS PARAMETER". Refer to section 1.3 of Dual Check Safety Function OPERATOR'S MANUAL(B-83184EN).

“SRVO-481 Invalid payload number” occurs.

Set correct payload number except for 0.

“SRVO-508 Collabo Sensor Large Value error” occurs.

If you can’t move the robot by this alarm when large force is applied to the robot, please do following procedures and move the robot.

- If you can disable the contact stop, disable contact stop and do JOG.
- Enable the teach pendant, and do manual guided teaching (free mode) with the heaviest setting. Note: Please use the heaviest setting (0%) to avoid too quick move by lighter setting.

“SYST-326 Need to confirm payload” occurs.

Payload confirmation operation is necessary after power on. Refer to Chapter 3.

A.2 STOP DURING MOVE

"SYST-320 Program paused by contact stop" or "SYST-325 Payload error is detected" occurs, even though nobody contacts the robot.

Verify followings.

- The robot does not touch any object.
- Current payload setting is consistent with the actual payload. Estimated value by CAD may not match to actual payload.
- Perform Payload confirmation operation after warm-up operation.
- Robot installation plate is fixed.
- The thickness of installation plate is more than the recommended installation plate. Refer to each MECHANICAL UNIT OPERATOR'S MANUAL, Chapter of TRANSPORTATION AND INSTALLATION for the recommended installation plate.
- Robot installation plate is not warped. When Robot installation plate is warped, correct warped installation surface using spacer etc.
- Tighten the robot base diagonally evenly with the specified torq. Refer to each MECHANICAL UNIT OPERATOR'S MANUAL, Chapter of TRANSPORTATION AND INSTALLATION for the specified torq.
- No gaps are present at the installation surfaces.
- Vibration of the floor or the hand is not applied to the robot. If a vibration is applied to the robot, deal so that the vibration is not applied to the robot. Reducing the speed or extending the acceleration time with Acceleration override instruction may reduce the vibration of the hand.
- "Force Sensor Serial number on the manufacturing plate" corresponds to that of "Force Sensor Serial number on TP". Refer to PREFACE of each MECHANICAL UNIT OPERATOR'S MANUAL .
- The time limit of the auto status check is too long.

"SYST-322 Auto status check time out" occurs.

External force reset must be performed periodically. Refer to the subsection 4.2.1.

"SYST-323 Collaborative speed limit (TCP)" or "SYST-359 Collaborative speed limit (Elbow)" occurs.

TCP or Elbow position moves at over collaborative speed, and the robot stops.

- Confirm Speed clamping is enabled in the collaborative robot screen. Refer to Section 2.2.
- In jogging, lower override.
- In circular motion or arc circular motion, lower teaching speed.

"SYST-324 Over Payload change distance(Payload number is changed)" occurs.

The robot moves over Payload change distance before the payload monitor confirms the external force is small, and the robot stops. Verify followings. Refer to the subsection 5.1.1 for details.

- Payload change distance is sufficient long to move a position that the external force is not applied.
- The robot doesn't moves over payload change distance soon after payload change. Addition of "WAIT 1.0sec" command at the position that the external force is not applied is recommended.
- Rotation limit of Payload change distance is sufficient large.

A.3 STOP DURING PERIODICAL CHECK

Refer to Chapter 6.

INDEX

REVISION RECORD

Edition	Date	Contents
05	Oct., 2021	• Support for new functions for CRX series • Addition of “Use DCS parameters” settings, Double Tap to resume, and Disabling input for Auto Status Check.
04	Jul., 2020	• Addition for CRX series and R-30*i*B Mini Plus
03	Nov., 2019	• Change of settings, High Speed Mode Specification for Small Collaborative Robot • Addition of setting items, Payload Identification
02	Oct., 2017	• Support of small collaborative robot • Addition of monitor function, Variable Payload Compensation function, Double Tap function, iHMI
01	Sep., 2015	

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