FANUC Robot series

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

Learning Robot

OPERATOR'S MANUAL

B-83534EN/07

- **Original Instructions**

Thank you very much for purchasing FANUC Robot.
Before using the Robot, be sure to read the "FANUC Robot series SAFETY HANDBOOK (B-80687EN)" and understand the content.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.
Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

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

This chapter describes the precautions which must be followed to enable the safe use of the robot. Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
For safe use of FANUC robots, you must read and follow the instructions in “FANUC Robot series SAFETY HANDBOOK (**B-80687EN)**”.

1 PERSONNEL

Personnel can be classified as follows.

Operator:
- Turns the robot controller power ON/OFF
- Starts the robot program from operator panel

Programmer or Teaching operator:
- Operates the robot
- Teaches the robot inside the safeguarded space

Maintenance technician:
- Operates the robot
- Teaches the robot inside the safeguarded space
- Performs maintenance (repair, adjustment, replacement)

- The operator is not allowed to work in the safeguarded space.
- The programmer or teaching operator and maintenance technician are allowed to work in the safeguarded space. Works carried out in the safeguarded space include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safeguarded space, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safeguarded space. In this table, the symbol "O" means the work allowed to be carried out by the specified personnel.

Table 1 (a) List of work outside the Safeguarded Space

	Operator	Programmer or Teaching operator	Maintenance technician
Turn power ON/OFF to Robot controller	O	O	O
Select operating mode (AUTO/T1/T2)		O	O
Select remote/local mode		O	O
Select robot program with teach pendant		O	O
Select robot program with external device		O	O
Start robot program with operator's panel	O	O	O
Start robot program with teach pendant		O	O
Reset alarm with operator's panel		O	O
Reset alarm with teach pendant		O	O
Set data on teach pendant		O	O
Teaching with teach pendant		O	O
Emergency stop with operator's panel	O	O	O
Emergency stop with teach pendant	O	O	O
Operator's panel maintenance			O
Teach pendant maintenance			O

During robot operation, programming and maintenance, the operator, programmer, teaching operator and maintenance technician take care of their safety using at least the following safety protectors.

- Use clothes, uniform, overall adequate for the work
- Safety shoes
- Helmet

2 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.

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1 GENERAL

1.1 OVERVIEW

- LVC (Learning Vibration Control) is a function that realizes smoothed and high-speed motion while maintaining the path, by utilizing an accelerometer. A robot learns and suppresses the measured vibration by an accelerometer during the learning process.
- High-speed motion is typically desired. However, vibration is a difficult issue to be solved. LVC can overcome the vibration issue and reduce cycle time.
- LVC is an optional function.
- Using the LVC function requires the LVC option (J573). Using the function also requires that your model support the LVC function. If your model does not support the function, you cannot use it.

⚠ CAUTION
The robot base needs to be fastened with anchors so that LVC measures the vibration when the robot is in motion. Check the robot is fastened.

NOTE
Please contact FANUC for the specific robot model support list.

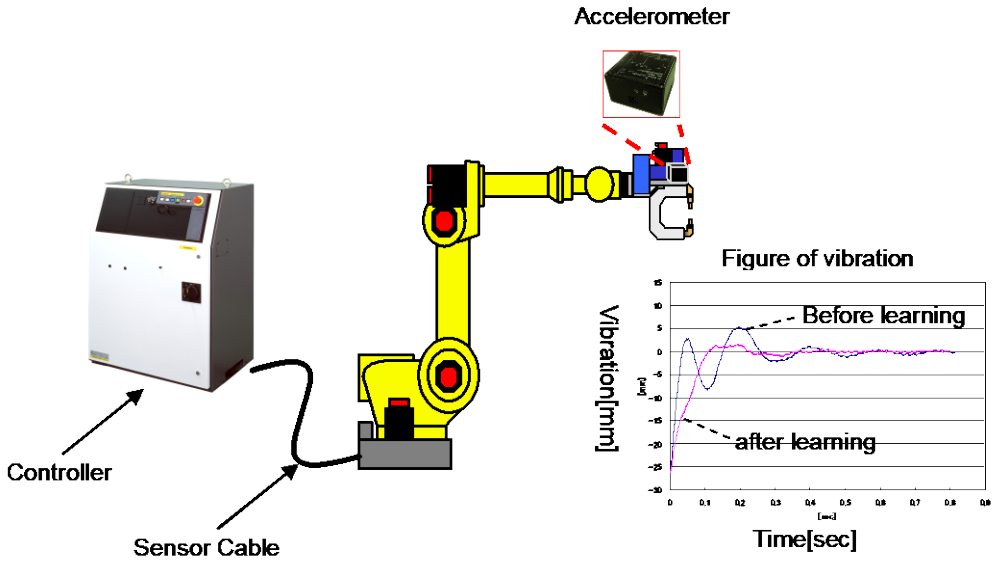


Fig. 1.1 LVC configuration

1.2 TERMINOLOGY

This chapter contains the terminology for this function. These terminology is used in the following chapter.

- LVC command
  The following four commands are LVC commands. Section 4.3 explains them more in detail.
  - LVC_START: This is the command that starts learning mode or playback mode.
  - LVC_END: This is the command that stops learning mode or playback mode.
  - NORMAL_MOTION_START: This is the command that starts a normal motion block.
  - NORMAL_MOTION_END: This is the command that stops a normal motion block.

- Learning percentage
  This is the parameter for learning percentage, whose range is 0 to 100%. 100% means learning process is completed.

- LVC data
  This is the compensation data to reduce the vibration from robots' motion. It is applied to the motion lines between LVC_START and LVC_END.

- Learning mode, Learning motion
  - LVC is in learning mode when the learning percentage is between 0 to 99%. The motion in the learning mode is defined as learning motion.
  - When LVC_START is executed with learning percentage of 0%, the data measured by the accelerometer and other motion data is recorded in memory up to LVC_END. LVC data is calculated at LVC_END.
  - When LVC_START is executed with learning percentage of 1 to 99%, the data measured by the accelerometer and other motion data is recorded in memory up to LVC_END. The TP program is executed again with LVC data, which was updated at LVC_END of previous iteration.

- Playback mode, Playback motion
  - Playback mode is defined as program execution when the learning percentage is 100%. The motion in the playback mode is defined as playback motion.
  - When LVC_START is executed with learning percentage of 100%, the motion data is not recorded in the memory. TP programs are executed with stored LVC data. Accelerometer is not required in the Playback mode.

1.3 PROCEDURE

In order to set up this function, please follow this sequence:

1. Understand necessary hardware, necessary software, and function limitations. (Detailed information in Chapter 2)
2. Set up hardware and software. (Detailed information in Chapter 3)
3. Create TP programs with LVC instructions, and perform learning procedure. (Detailed information in Chapter 4)
4. Backup LVC data. (Detailed information in Chapter 5)

2 HARDWARE AND SOFTWARE

This chapter explains necessary hardware, necessary software, and software limitations.

2.1 HARDWARE

LVC requires the following hardware.

- 64MB (or more) D-RAM is necessary. LVC requires 18MB available memory in D-RAM.
- 64MB (or more) F-ROM is recommended. LVC requires 8MB available memory in F-ROM.
- Wired accelerometer or wireless accelerometer manufactured by MicroStone co. ltd.

NOTE
Wireless accelerometer can be used with version 7DC3/26 or later. Also the firmware version of teach pendant must be 7DC3/26 or later, do not exchange teach pendant which is used in another controller.

2.1.1 Wired Accelerometer

Specification

The specification and dimension of the wired accelerometer are shown in Table 2.1.1(a), (b) and Fig. 2.1.1(a).

Table 2.1.1 (a) LVC part number quick reference

Part number	Description
A860-2090-T341	ACC SENSOR
A05B-1410-K102	R-30*i*B and R-30*i*B Plus ACC SENSOR CABLE KIT (25m)
A05B-1410-K001	ACC MAGNETIC SENSOR ADAPTOR
A05B-1410-K002	ACC C-CLAMP SENSOR ADAPTOR

Table 2.1.1 (b) Wired accelerometer sensor specification

Item	Specification
Supply Voltage	5V-5% to 5V+5%
Current Consumption	80mA or less
Shock durability (Sensor)	5000G (≈50000m/s^2)
Operation temperature	0℃ to 60℃
Measurement directions	X, Y, Z 3-orthogonal axes
Measurement range	-5G (≈-49m/s^2) to +5G (≈+49m/s^2)
Resolution	0.15 to 0.25mG(≒1.5 to 2.5mm/s^2)
Offset	+/- 50mV
Frequency response	To 1kHz
Interface	FANUC Serial Interface
Structure	Waterproof, Dustproof (IP67 at mating)
Weight	Approximately 130g

⚠ **CAUTION**
The ACC SENSOR CABLE KIT for R-30*i*A (A05B-1410-K101) can be used neither for R-30*i*B nor R-30*i*B Plus, because of the difference of the controller interface. Please use ACC SENSOR CABLE KIT for R-30*i*B(R-30*i*B Plus) (A05B-1410-K102).

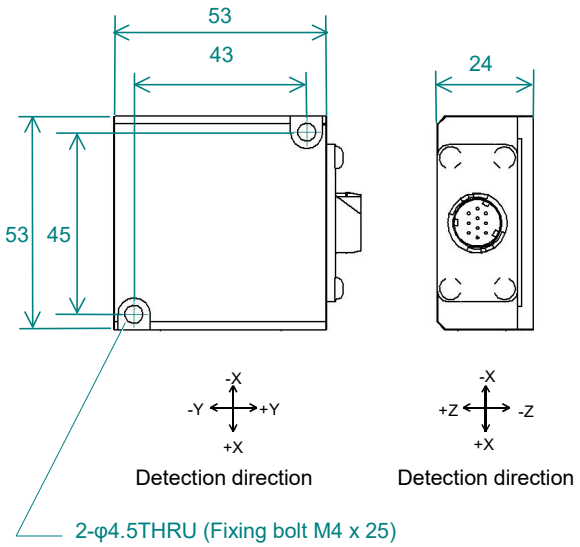


Fig. 2.1.1 (a) Dimensions of the wired accelerometer

Sensor connection

Please connect a wired accelerometer cable to an accelerometer and the JD17 connector of the main CPU board (if you use R-30*i*B or R-30*i*B Plus controller). Please refer to Fig. 2.1.1 (b).
Please connect to the controller's JD17 slot and connect the cable shield to ground.

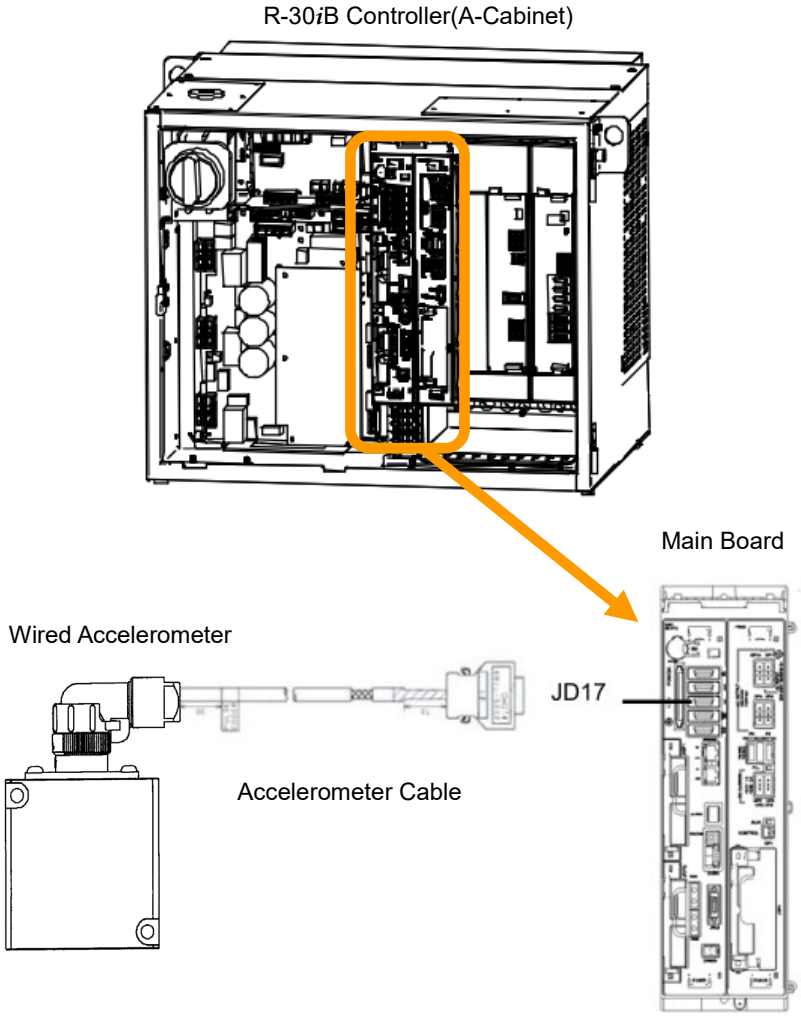


Fig. 2.1.1 (b) Connection between wired accelerometer and controller cabinet

> ⚠ **CAUTION**
> Please turn off the power when you connect or disconnect an accelerometer cable.

Sensor Installation

Two methods of installing the wired accelerometer to robots or servo guns are offered.

1. Magnetic Adapter kit
   Mount the wired accelerometer on the adapter kit and tighten the bolts to secure the two together as shown in Fig. 2.1.1 (c). Fit the accelerometer to an end-of-arm tool or servo gun, and turn on the adapter switch to attach it to a ferromagnetic portion of the tool.

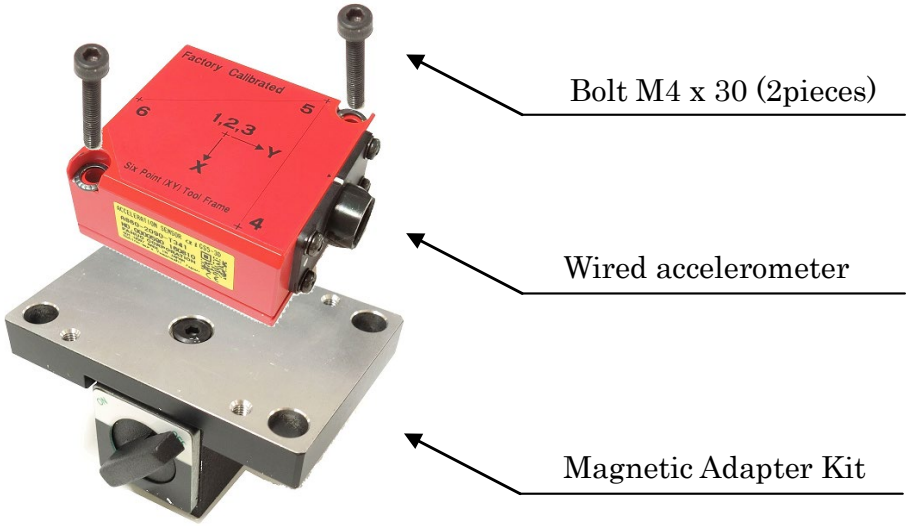


Fig. 2.1.1 (c) Magnetic adapter kit for wired accelerometer

2. C-clamp Adapter kit
   Mount the wired accelerometer on the adapter kit and tighten the bolts to secure the two together as shown in Fig. 2.1.1 (d). After that, attach the accelerometer to an end-of-arm tool or servo gun by clamping the plate of the kit with a C-clamp, as shown in Fig. 2.1.1 (e).

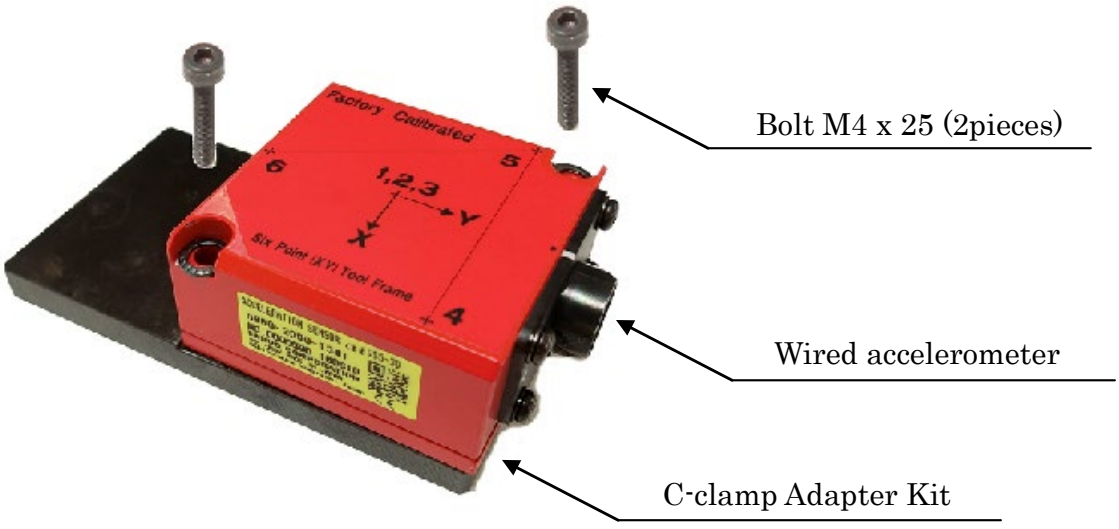


Fig. 2.1.1 (d) C-clamp adapter kit for wired accelerometer

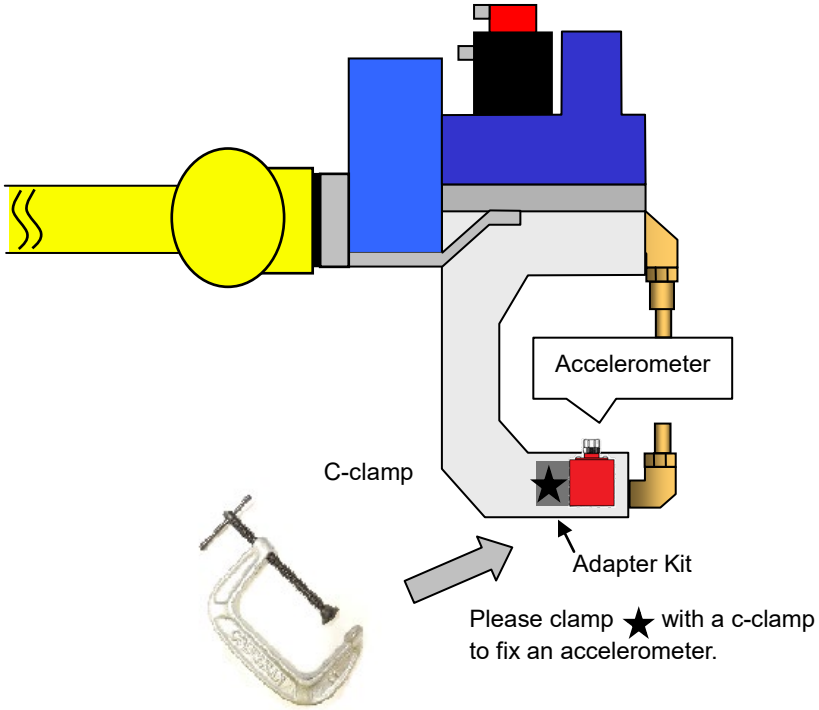


Fig. 2.1.1 (e) Clamping an accelerometer with a C-clamp kit

⚠ CAUTION

- Clamping an accelerometer directly with a C-clamp may deform the accelerometer and cause sensor failure.
- If welding is enabled with clamping an accelerometer, malfunction or damage to accelerometer would occur. Please execute LVC instruction in tryout mode.

2.1.2 Wireless Accelerometer

Specification

The specification and dimensions of the wireless accelerometer are shown in Table 2.1.2 (a), (b), (c) and Fig. 2.1.2 (a).

Table 2.1.2 (a) LVC Part Number Quick Reference

Part number	Description
A05B-1410-K201	Wireless ACC SENSOR KIT (for USA)
A05B-1410-K202	Wireless ACC SENSOR KIT (for Japan)
A05B-1410-K211	ACC C-CLAMP SENSOR ADAPTOR for wireless ACC

NOTE

1. Wireless ACC SENSOR KIT contains a wireless accelerometer, a USB receiver, and a charging cable.
2. One Wireless accelerometer can be used with only one USB receiver which is pairing registered before shipment. You can check which accelerometer (receiver) matches for the receiver (accelerometer) by S/N(Serial Number) printed on label.

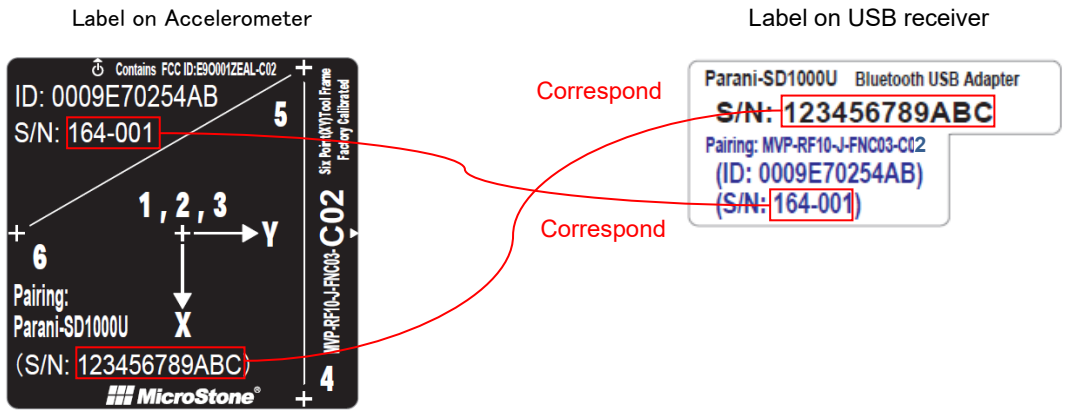


Table 2.1.2 (b) Wireless accelerometer sensor specification

Item	Specification	
	For USA	For Japan
Part number	MVP-RF10-J-FNC03-C02 manufactured by MicroStone co. ltd	MVP-RF10-J-FNC03-C01 manufactured by MicroStone co. ltd
Operation temperature	0℃ to 40℃	
Measurement directions	X, Y, Z 3-orthogonal axes	
Measurement range	-6G (≈-58.8m/s^2) to +6G (≈+58.8m/s^2)	
Resolution	0.22mG (≈2.2mm/s^2)	
Frequency response	To 1kHz	
Structure	IP64	
Wireless standard	Bluetooth 2.1+EDR Class-2	Bluetooth 2.0+EDR Class-1
Communication distance(published value by MicroStone co. ltd)	Within 5m	Within 20 m
Certification countries	USA, Japan	Japan
Communication protocol	Serial transmission	
Communication speed	460.8Kbps	
Battery	700mAh (Lithium polymer rechargeable battery)	
Battery duration	For 8 hours on end (At normal temperature)	
Charging time	For 2 hours (Charging from empty to full)	

NOTE

1. Communication distance in Table 2.1.2(b) is with good visibility. It would be changed by environment. Please put the accelerometer and the USB receiver as close as possible to each other while ensuring the safety.
2. If a wireless accelerometer is used only in Japan, please use it for Japan (A05B-1410-K202) because communication distance of a wireless accelerometer for Japan is longer than that for USA.
3. Do not store the wireless accelerometer in the conditions that its internal battery level is empty because the battery performance or service life will become low. As a guide, if you leave it unused for a long time, it is recommended to charge it fully every year.
4. When the battery life is over, need to exchange it by manufacturer for profit. Please contact your local FANUC representative.
5. The sensor contains a lithium polymer rechargeable battery. Please dispose of it properly without dismantling as an industrial waste in accordance with local regulations to prevent hazards for health and environment.

⚠ CAUTION

The sensor contains lithium polymer rechargeable battery. Although the sensor is not subject to the dangerous goods regulation or the prohibited exports regulations, the following items are required in case of packing 3 or more wireless accelerometers in a single package. It is recommended sending 2 or less wireless accelerometers at the maximum in the same packing.

Lithium battery mark

Describing the necessary wording on the air waybill

Lithium ion batteries in compliance with Section II of PI967

Source: IATA Air Dangerous Goods Regulations 58th edition (2017)

- The mark is a rectangle hatched with diagonal lines.
- The minimum dimension of the mark is 120 mm (width) × 110 mm (height), the minimum width of hatching is 5 mm
- Hatching is red.
- Display UN3481 (United nation number)

Table 2.1.2 (c) USB Receiver Specification

Item	Description
Part number	Parani-SD1000U (manufactured by Sena Technologies, Inc)
Operation temperature	-20℃ to 70℃
Wireless standard	Bluetooth 2.0+EDR Class-1
Communication distance(published value by Sena Technologies, Inc)	300m
Certification countries	USA, Japan, Europe, South Korea, Canada

Item	Description
Communication protocol	Serial transmission
Communication speed	460.8Kbps

NOTE
1. Communication distance in Table 2.1.2(c) is with good visibility, It would be changed by environment. Please put the wireless accelerometer and the USB receiver as close as possible to each other while ensuring the safety.
2. The part number of the USB receiver is the same when A05B-1410-K201 and A05B-1410-K202 is selected.

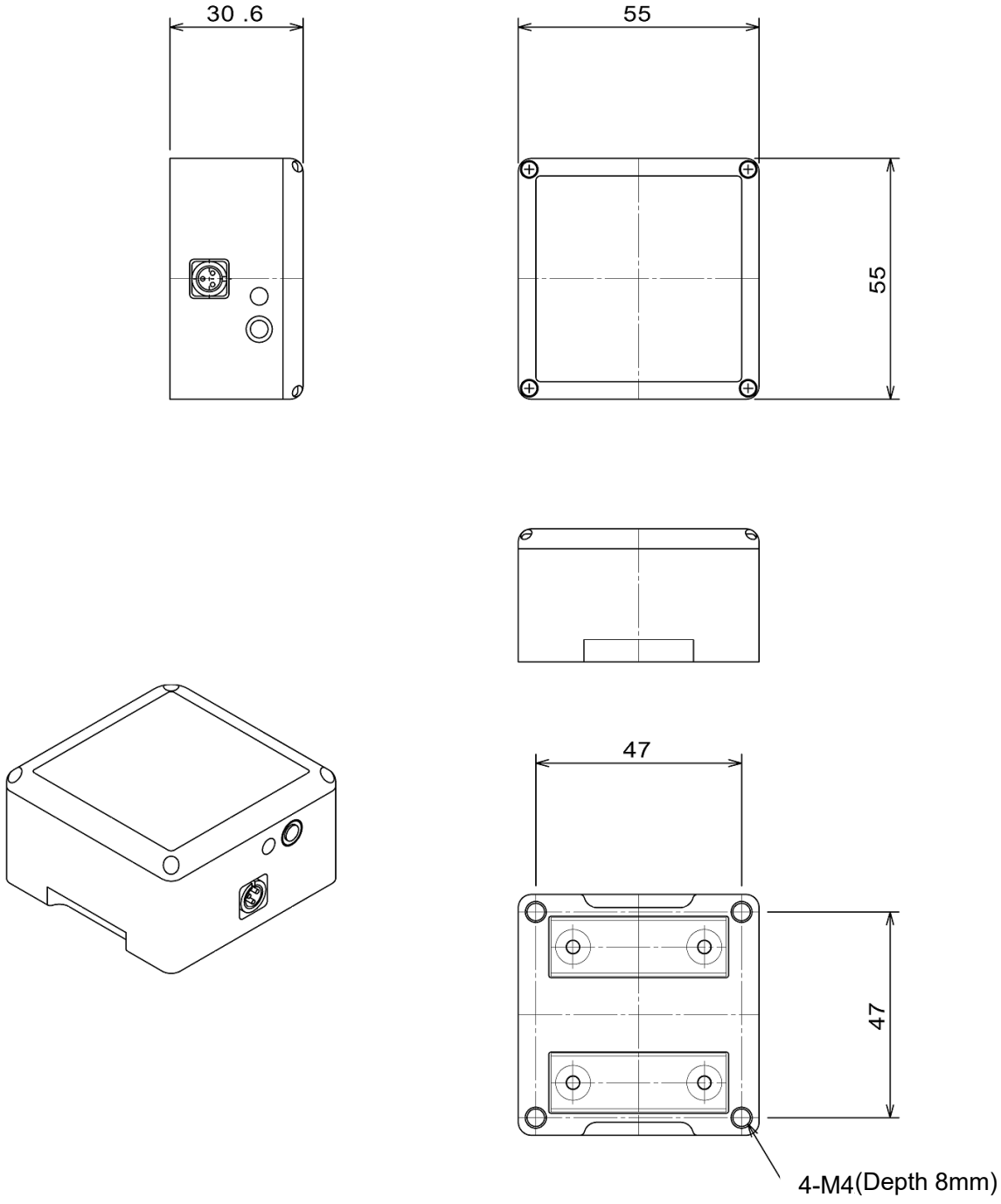


Fig. 2.1.2 (a) Dimensions of the wireless accelerometer

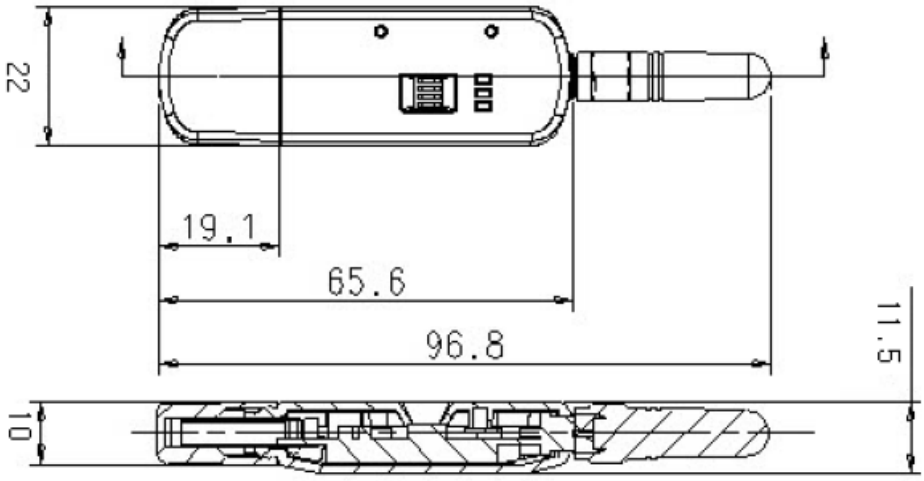


Fig. 2.1.2 (b) Dimensions of the USB receiver

The wireless accelerometer has 2 buttons as shown in Fig 2.1.2 (c). LED1 is a power button. LED2 is a reset button.

Fig. 2.1.2 (c) LEDs on Accelerometer

The status of the accelerometer indicated by LED1 and LED2 is shown in Table 2.1.2 (d) and (e).

Table 2.1.2(d) LED1 on Accelerometer

Status	Red light	Blue light
Power off	Off	
Power on (pairing incomplete)	On at 1-second interval	Off
Power on (pairing completed)	Off	On
Connecting	Off	Blink
Power on (the battery is low)	On at 0.5-second interval	Depend on connection status (On/Off/Blink)
Power on (the battery is zero)	On for 1 minute then turn off	Off

NOTE
1. Pairing means the wireless connection between the accelerometer and the USB receiver.
2. However the wireless accelerometer can be used up to several tens of minutes when its battery is low, it is recommended using after charging the battery.
3. Don’t use the wireless accelerometer with charging the battery.

Table 2.1.2(e) LED2 on Accelerometer

Status	Green light
Non-charging	Off
During charging	On

USB receiver has three LEDs that indicate the status of receiver as shown in Fig. 2.1.2 (d).

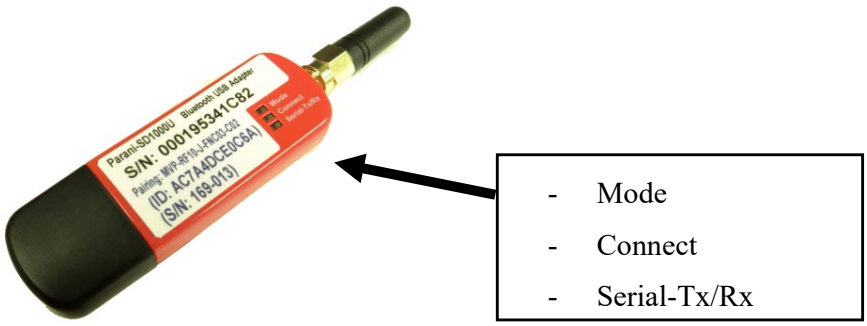


Fig. 2.1.2 (d) LED on USB receiver

The status of the USB receiver is shown in Table 2.1.2(f).

Table 2.1.2(f) LEDs on USB receiver

Status	Mode	Connect	Serial-Tx/Rx
Pairing incomplete	Blink	Off	Off
Pairing completed	Off	Blink	Off
Communicating	Off	Blink	Blink fast

⚠ CAUTION

- Don’t turn off an accelerometer or disconnect a USB receiver during the communication of the data.
- The wireless accelerometer communicates with the USB receiver wirelessly. The communication may be unstable if there are Wi-Fi spots (2.4GHz band) or strong radio transmission source nearby. The communication between the wireless accelerometer and the USB receiver may affect the other wireless communications.
- Don’t disassemble, repair nor remodel the wireless accelerometer and the USB receiver.
- The USB receiver is not available with tablet TP. Please connect *i*Pendant in using wireless accelerometer.

Sensor connection

Please connect the USB receiver to the teach pendant (*i*Pendant) as shown in Fig. 2.1.2 (e).

Fig. 2.1.2 (e) Connection of the USB receiver

The wireless accelerometer can turn off/on when press and hold the power button for 2 seconds (The power button is LED1. Please refer to Fig. 2.1.2 (c)).
When pairing the accelerometer and the USB receiver is completed, LED1 turns on blue as shown in Table 2.1.2 (d) and blink Connect LED on the USB receiver as shown in Table 2.1.2 (f). As for the confirmation of wireless communication, please refer to Section 3.5.

Sensor Installation

Two methods of installing an accelerometer to robots or servo guns are offered.
Please mount the accelerometer at the location where vibration control is needed.

1. Magnet adapter
   The accelerometer can be attached by the magnet built in it.

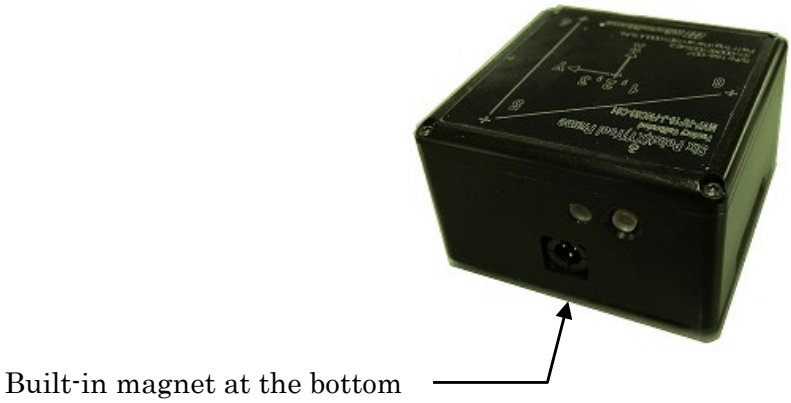


Fig. 2.1.2 (f) Magnet adapter in wireless accelerometer

2. C-clamp Adapter kit
Mount the wireless accelerometer on the adapter kit and tighten the bolts with tightening torque 2.25Nm as shown in Fig. 2.1.2 (g). After that, attach the accelerometer to an end-of-arm tool or servo gun by clamping the plate of the kit with a C-clamp, as shown in Fig. 2.1.2 (h).

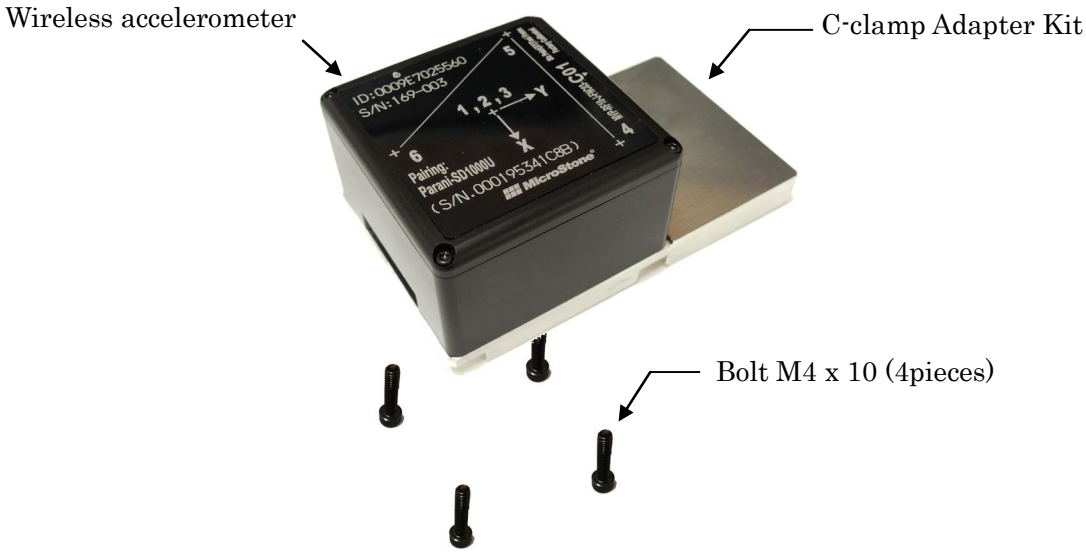


Fig. 2.1.2 (g) C-clamp adapter kit for wireless accelerometer

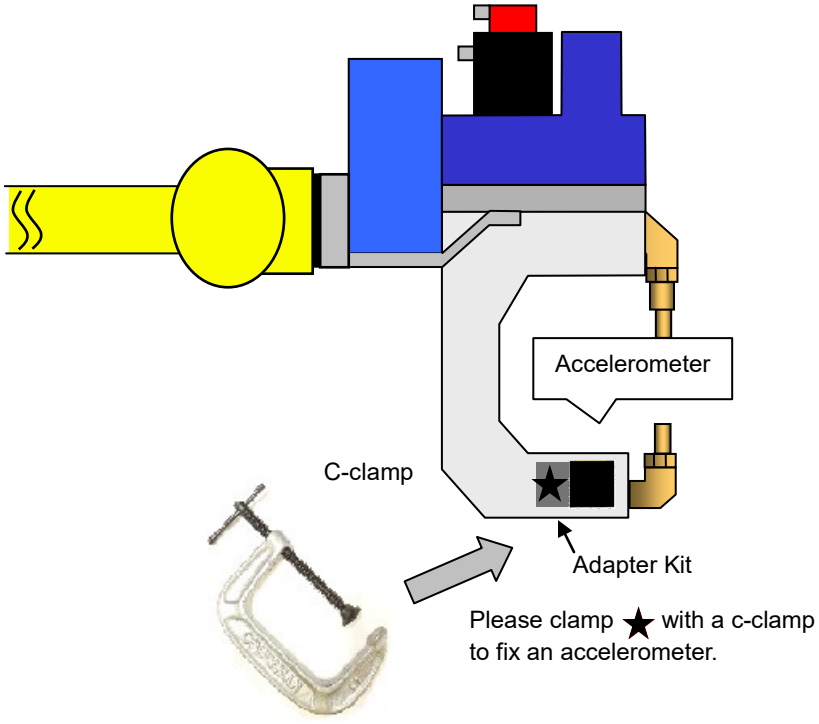


Fig. 2.1.2 (h) Clamping an accelerometer with a C-clamp kit

⚠ CAUTION
- Clamping an accelerometer directly with a C-clamp may deform the accelerometer and cause sensor failure.
- If welding is enabled with clamping an accelerometer, malfunction or damage to accelerometer would occur. Please execute LVC instruction in tryout mode.

2.2 SOFTWARE

2.2.1 Necessary Software Option

- LVC (J573) can be used with Software version as shown in Table 2.2.1.

Table 2.2.1 Software version LVC(J573) can be used

Type of Controller	Type of accelerometer	Version
R-30*i*B	Wired	7DC1/10 or later
R-30*i*B	Wireless	7DC3/26 or later
R-30*i*B Plus	Wired/Wireless	7DF0/03 or later

- The Constant Path option (R663) is necessary for this option, unless standard setting option (R651) or SpotTool+ (H590) is ordered.

2.2.2 LVC Applicable System Configuration

- LVC can be used only with SpotTool+(H590) application and Handling Tool(H552) application.

NOTE
Please contact your local FANUC representative for the specific robot model support list.

2.2.3 Limitations

- LVC can speed up robot motion automatically during the learning process. However, this automatic speed-up function cannot be applied to a stand-alone SPOT instruction. (More detailed information in Section 4.2)
- LVC can't speed up robot motion when the robot has reached the upper limit of performance.
- LVC can be installed with the following options. However, LVC instructions cannot be executed with those options' instructions at the same time. When they are executed at the same time, the alarm "MOTN-529 LVC: This isn't allowed" is issued. (More detailed information about MOTN-529 can be found in Appendix A)
  - External Path Optimization (J829)
  - KAREL function (R632)
  - Weaving (J504)
  - Line tracking (J512)
  - Touch Sensing (J536)
  - Coordinated Motion Package (J686)
  - AI Path Control (J574)

- LVC can be installed with Continuous Turn (J613) but LVC is set to be disabled. Because Continuous Turn disables Constant Path option though LVC needs the condition that Constant Path option is enabled.

- LVC can be installed with *i*RVision Core (J900). However, if motion changes by vision instructions in learning mode, the alarm MOTN-537 is issued. (More detailed information about MOTN-537 can be found in Appendix A).

- LVC can be installed with Independent Axis (H895) or Extended Axis Control (J518). The extended axis and independent axis is not applicable for learning. If they are moved, no automatic speed-up

function but only vibration control function is applied for the robot. Please don't move the rail axis between LVC_START and LVC_END.

- LVC can be used with Space Check function. However, during learning, if the robot cannot enter the interference area and stops because of another robot or peripheral device located in the area, the subsequent motion becomes normal motion. In this cycle, the learning mode becomes disabled and the learning percentage does not increase.

- LVC can be installed with ADV-Max Speed Ctrl (R805). However, process speed in ADV-Max Speed Ctrl can't be used.

- LVC can be installed with Spline Motion (R904). However, LVC instructions cannot be executed with spline instructions at the same time. When they are executed at the same time, the alarm "MOTN-165 LVC Not support SPLINE" is issued. (More detailed information about MOTN-165 can be found in Appendix A)

NOTE

LVC requires the motion path to be the same during Learning. If a program has logic to either perform some additional moves (or conditionally skip some moves) sometimes, these differences cannot be executed until the schedule is 100% completed. If LVC detects motion difference during learning, the MOTN-537 or MOTN-538 alarm may be posted. (More detailed information about MOTN-537 and MOTN-538 can be found in Appendix A)

- The learning mode and playback mode become disabled under the following conditions, and normal speed robot motion is used:
  - Less than 100% override
  - LVC status is disabled in the setup menu. (Please refer to Section 3.1)
  - LVC data is disabled in the LVC data menu. (Please refer to Subsection 4.6.1)
  - T1 mode
  - Single step mode
  - Backward mode
  - Resumption of the robot motion after HOLD and ESTOP
  - Execution of TP programs from the line between LVC_START and LVC_END
  - Power failure handling

- LVC can support multi-arm system with version 7DC1/12 or later. However, a program that has multiple robot groups cannot run LVC instructions. When multiple robots are run by multi-motion function with LVC instructions, "MOTN-547 LVC: Sync motion not supported" is issued. (More detailed information about MOTN-547 in Appendix A)

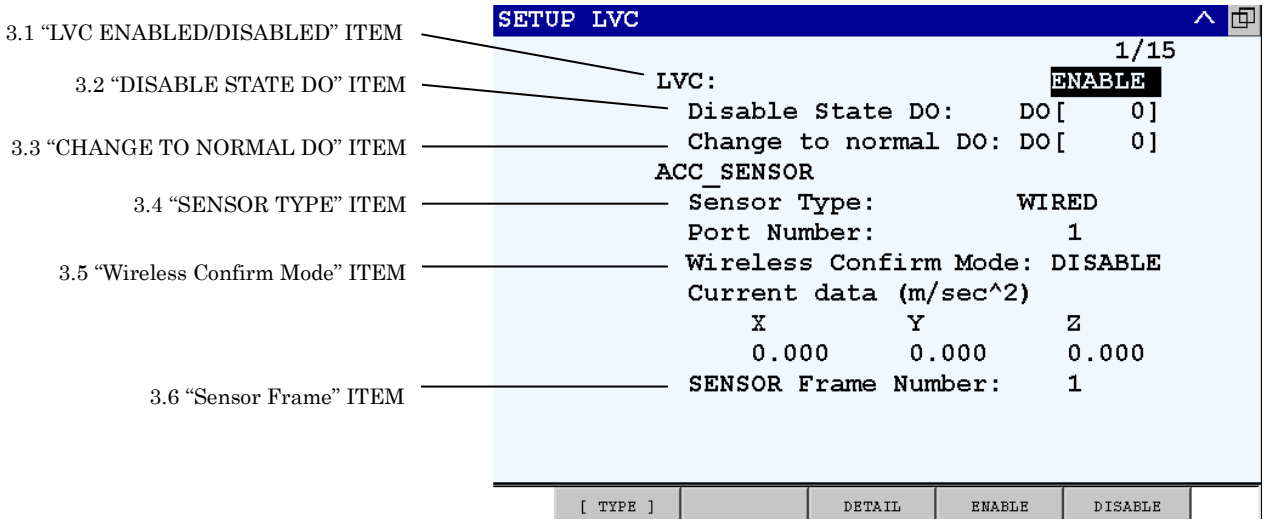
3 SETTING LVC

This chapter explains how to use TP programs containing LVC instructions. As the first step, LVC must be configured in the setup menu. The following procedure is used to set up LVC.

Procedure 3-1 Displaying LVC setup menu

1 Press the [MENU] key.
2 Select “6 Setup”.
3 Press F1, “[TYPE]” to display the screen, change menu, and select “LVC”.
4 The following screen will be displayed.

The following items are explained in this chapter.



NOTE
The accelerometer interface is built into the main board from R-30*i*B and the port number is fixed to 1.

3.1 "LVC ENABLED/DISABLED" ITEM

- In the setup menu, LVC status can be set to enabled/disabled. Initial setting for this item is "ENABLED".
- When this item is set to "ENABLED" and a TP program with LVC instructions is executed, learning motion or playback motion is performed according to the learning percentage.
- When this item is set to "DISABLED" and a TP program with LVC instructions is executed, normal motion is performed with learning instructions disabled.

NOTE
In the following cases, LVC cannot be enabled.
- Available memory size in D-RAM is less than that of the required memory for LVC. Please confirm if MOTN-527 or MOTN-528 is issued, when power is turned on. Please refer to Appendix A for MOTN-527 and MOTN-528 descriptions.
- The system configuration is not correct for an LVC system. Please refer to Section 2.1 for supported system configurations. Please change the system configuration to support LVC.

- To enable/disable LVC, please move the cursor to "ENABLE/DISABLE" and press the function key to select "ENABLE" or "DISABLE".

NOTE
When LVC is disabled, the entire LVC data in the data menu (Please refer to Ch. 4) is disabled.
In order to enable/disable LVC data individually, enable LVC status in the LVC setup menu and select ENABLE/DISABLE for each data ID. (Please refer to Procedure 4-6)

3.2 "DISABLE STATE DO" ITEM

When LVC data is disabled (Please refer to Section 4.6) in the data menu, learning motion or playback motion associated with the LVC data also becomes disabled and normal motion is performed. In that case, if "Disable state DO" item is set to the DO number, the DO signal is set ON. "Disable state DO" output is ON when any of the LVC data is disabled. When all LVC data are enabled, "disable state DO" becomes OFF.
To use Disable state DO items, please follow these instructions:
- Move the cursor to the Disable State DO and enter the desired ID number.
- The type of the output signal is "DO".

3.3 "CHANGE TO NORMAL DO" ITEM

In playback mode, when a TP program with LVC instructions is executed after touch-up is done, robot motion becomes normal motion in the modified motion lines (Please refer to Subsection 4.6.2). In that case, if "Change to normal DO" item is set to the DO number, the DO signal is set ON. When LVC_START is executed, the DO signal turns OFF.
To use Change to normal DO items, please follow these instructions:
- Move the cursor to the Disable State DO and enter the desired ID number.
- The type of the output signal is "DO".

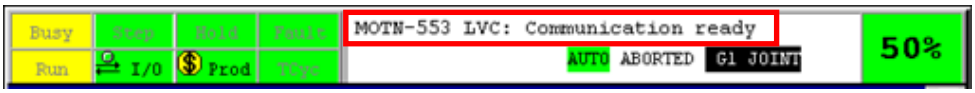
3.4 “SENSOR TYPE” ITEM

The setting of the sensor type can be changed by the following item.

- When this item is set to “WIRED”, you can use a wired sensor.
- When this item is set to “WIRELESS”, you can use a wireless sensor.

NOTE

- If “LVC ENABLED/DISABLED” item is “ENABLED” and “SENSOR TYPE” item is “WIRED”, the current value from accelerometer is displayed in the “Current data” item.
- If “LVC ENABLED/DISABLED” item is “ENABLED” and “SENSOR TYPE” item is “WIRELESS”, the following message is displayed after readying communication between the wireless accelerometer and the USB receiver.



- The current value from the accelerometer is displayed in the “Current data” item only when “WIRELESS CONFIRM MODE” item is “ENABLED”.

3.5 “WIRELESS CONFIRM MODE” ITEM

It is the item to confirm whether communication between the sensor and the controller is ready.
When this item is set to “ENABLED” and wireless sensor can communicate, sensor data is displayed in “Current data”.
This item cannot be selected when “wired” is selected in “sensor type” item.

NOTE

- As for the connection of the wireless sensor, please refer to Section 2.1.2.
- If the alarm “MOTN-553 Communication ready” doesn’t appear over 30 seconds have passed since the wireless accelerometer is on and connect the USB receiver to the teach pendant, or if the alarm “MOTN-556 Wireless sensor timeout” or “MOTN-557 USB receiver removed” is displayed when communication start, apply the following procedure:
  1 Reboot the accelerometer.
  2 Disconnect/Connect the USB receiver.
  3 Push LED2 reset button (please refer to Fig. 2.1.2 (c)) to turn off the wireless sensor, then restart sensor again.
  4 Reboot the controller.

LVC can’t be used with wireless confirm mode enabled. Please change this item to “DISABLED” when LVC instruction is executed.

3.6 "SENSOR FRAME AND SENSOR FRAME NUMBER" ITEM

Set up the sensor frame (sensor position and orientation) after the accelerometer is connected.

NOTE
Please mount the accelerometer at the location where vibration control is needed. (For example, locations close to servo gun tips). Attach the accelerometer to a relatively stiff part of the end-of-arm tool or servo gun in order to measure the vibration correctly.

The sensor frame is a fixed frame in mechanical interface coordinate system as shown Fig. 3.6 (a).

Fig. 3.6(a) Sensor Frame (Left: Wired Accelerometer, Right: Wireless Accelerometer)

Please refer to Fig. 3.6 (b) for an example of setting the sensor frame.

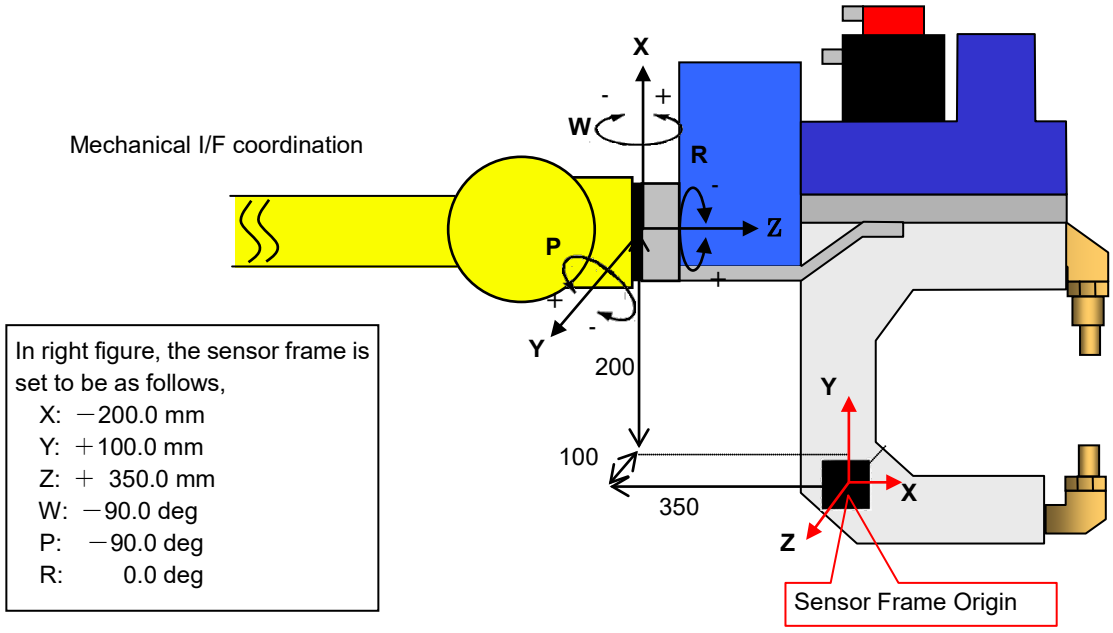


Fig. 3.6(b) Mechanical interface frame and sensor frame

To set the sensor frame, following methods can be used.

1. Sensor frame automatic setting function
   Set the sensor frame automatically by the predetermined robot movements.

2. Six point method
   Set the sensor frame by touching a sharp instrument with six postures.
3. Direct list method
   Set the sensor frame by entering the values of X, Y, Z, W, P and R directly.
   If you know the sensor frame of a different robot on which the accelerometer is attached at the same place, you can enter these values directly.

To determine which method to be used, please refer to the following flowchart.

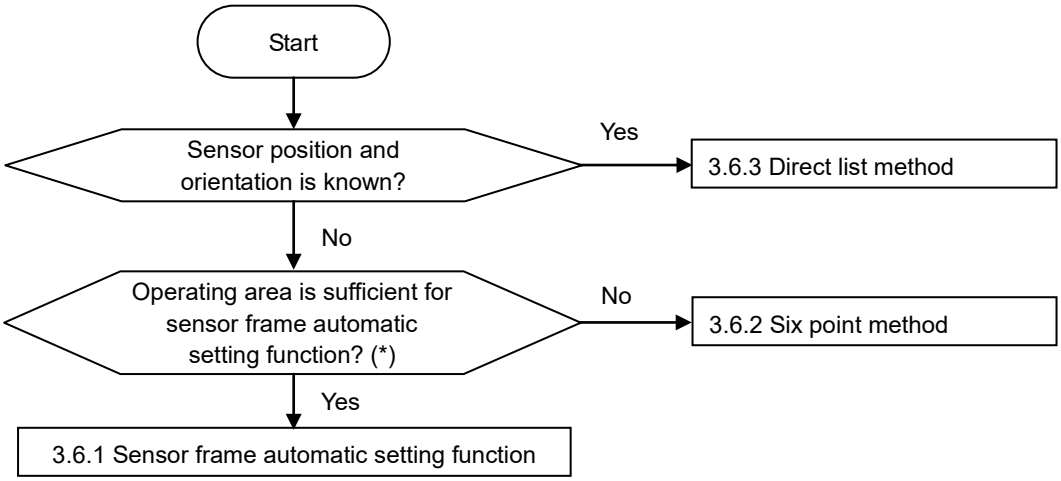
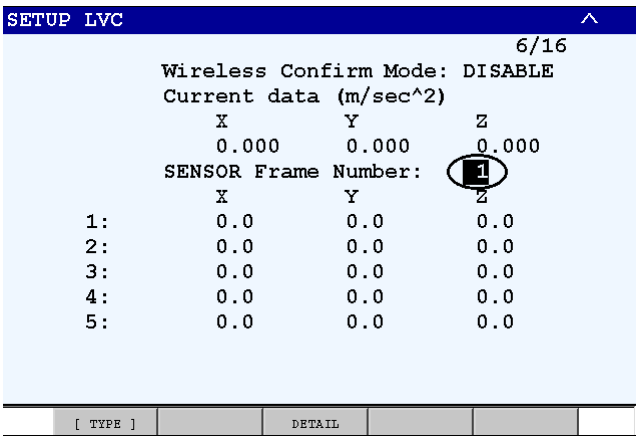


Fig. 3.6(c) How to determine sensor frame setting method

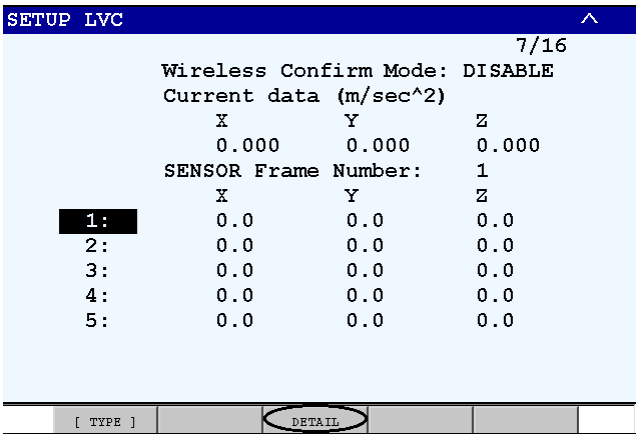
About (*) in Fig. 3.6(c):
Predetermined robot movements for sensor frame automatic setting function are reciprocating movements of +/- 100mm in each direction of X, Y, Z and +/- 15deg in each direction of W, P, R in mechanical interface frame. If you are not sure whether the operating area is sufficient for sensor frame automatic setting function or not, you can verify it by using sensor frame automatic setting function which will provide slow motion verification process.

> ⚠ **WARNING**
> When the sensor frame number is not set correctly, LVC may generate incorrect data, which can result in poor LVC performance. Also the incorrect frame may cause the robot to move in an unexpected way. Be careful to set the sensor frame and the sensor frame number correctly.

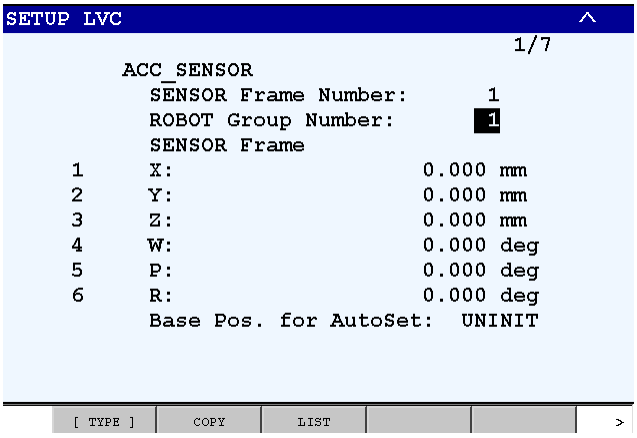
LVC records 10 sets of sensor frame. When the program is executed, set the sensor frame number to use in the sensor frame number item.



After setting the sensor frame number, move the cursor to the desired sensor frame and press F3 “DETAIL”.



The setup menu is displayed. To set the sensor frame, please refer to Subsection 3.6.1 or Subsection 3.6.2 or Subsection 3.6.3 depending on the setting method.



3.6.1 Sensor Frame Automatic Setting Function

Overview

Sensor frame automatic setting function is a function that sets the sensor frame automatically by predefined robot movements.

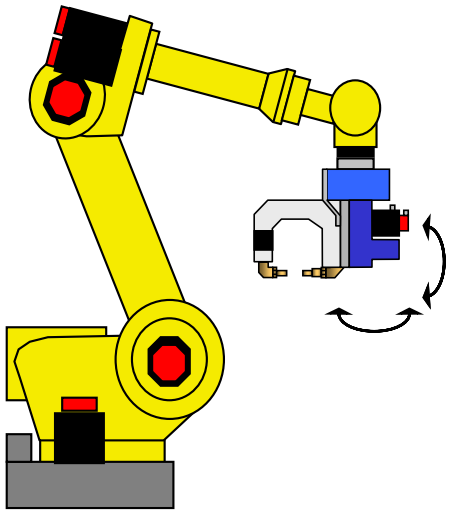


Fig. 3.6.1(a) Sensor frame automatic setting

Limitations

- With a wired accelerometer, sensor frame automatic setting function can be used with certain types of robot if the robot software version is 7DC3/02 or later. For 7DC3/17 or later software, Sensor frame automatic setting function can be used as long as the robot has LVC supported.
- With a wireless accelerometer, the sensor frame automatic setting function can be used as long as the robot has LVC supported if the robot software version is 7DC3/26 or later.
- Sensor frame automatic setting function can be used in T2 mode or Auto mode and can't be used in T1 mode.
- To use automatic setting function in T2 mode, you should keep holding dead man switch and holding down [SHIFT] key during the movements.

Setting menu

Automatic setting function can be executed from following screen.

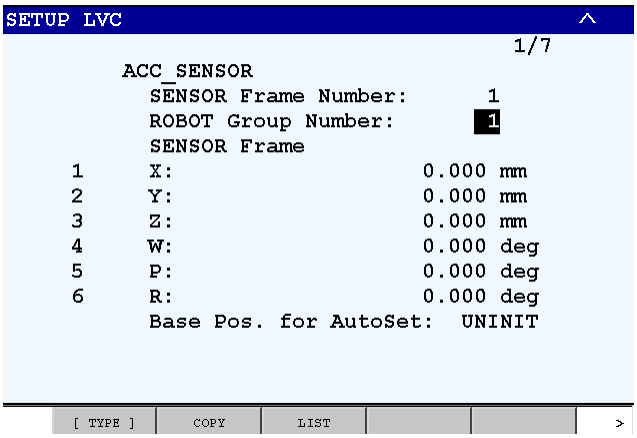


Fig. 3.6.1(b) Setting menu for sensor frame

Press the [F->] key, then following function keys are displayed. Function keys to be used are as follows.

Key	Label	Description
F2	AutoSet	When hold down the [SHIFT] key and press this key, start the movements for automatic setting.
F4	MOVE_TO	When hold down the [SHIFT] key and press this key, move to the base position for automatic setting with joint motion.
F5	RECORD	When hold down the [SHIFT] key and press this key, teach the base position. Then Base Pos. for AutoSet item is turned from UNINIT into RECORDED.

⚠ WARNING
For safety, the above function keys must be pressed together with the [SHIFT] key.

Movements

Automatic setting performs the slow movements to check movements. Then it performs the fast movements to calculate the sensor frame. The slow movements and the fast movements are the same movements but the slow movements are performed at 1% override while the fast movements are performed at higher than 30% override. (For 7DC3/17 or later software, 3 types of overrides are used) You can change the override during the slow movements but cannot change the override during the fast movements.

⚠ CAUTION
- The slow movements are used to verify whether there is interference or not by the movements for automatic setting. Therefore set the override to the extent that if interference is about to occur, HOLD stop or emergency stop can be applied before interference occurs.
- If the override is changed during the fast movements, MOTN-584 occurs and the robot stops.

Contents of the slow movements and the fast movements are the following movements in mechanical interface frame with reference to the base position for automatic setting.

1. Reciprocating movements of +/- 100mm in direction of X.
2. Reciprocating movements of +/- 100mm in direction of Y.
3. Reciprocating movements of +/- 100mm in direction of Z.
4. Reciprocating movements of +/- 15deg in direction of W.
5. Reciprocating movements of +/- 15deg in direction of P.
6. Reciprocating movements of +/- 15deg in direction of R.

NOTE
Regardless of the selected tool frame, the movements for automatic setting are with respect to mechanical interface frame.

Base position for automatic setting

Base position for automatic setting should be determined based on the following criteria.

1. Do not allow interference to the surroundings during movements for automatic setting.
2. For the accuracy of automatic setting, set the posture which has the moments acting on the robot wrist as small as possible.
3. For the accuracy of automatic setting set the posture so that the flange position is as close to the robot base as possible by setting the angle of J2 and J3 as small as possible.

NOTE
The criterion 1 is indispensable. The criteria 2 and 3 are not indispensable if the alarm does not occur after automatic setting.

Detailed descriptions for three items above are as follows.

About 1:

The angle of J1 axis does not affect the accuracy of automatic setting. Therefore set the angle of J1 axis to the angle which leads to as wide operating area as possible. Please set the angle of J2-J6 to satisfying 2 and 3 above as much as possible while not to occur interference to the surroundings during the movements for automatic setting.

About 2:

To reduce the moments acting on the robot wrist, please set base position like the posture of Fig. 3.6.1(c) or Fig. 3.6.1(d).

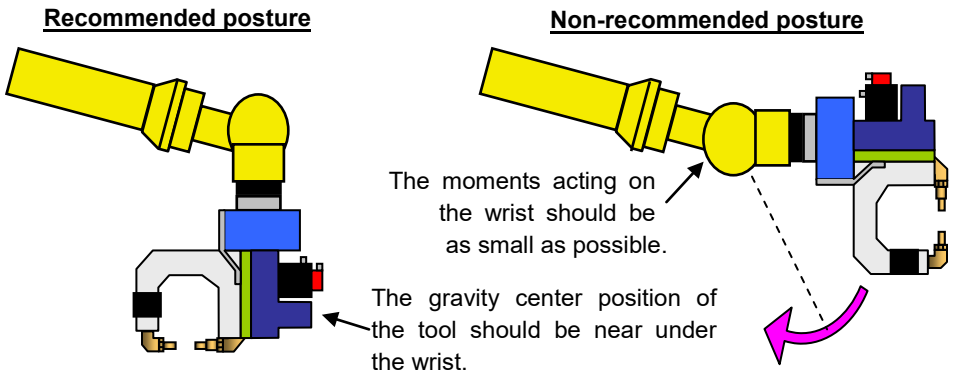


Fig. 3.6.1(c) Example 1 of recommended posture

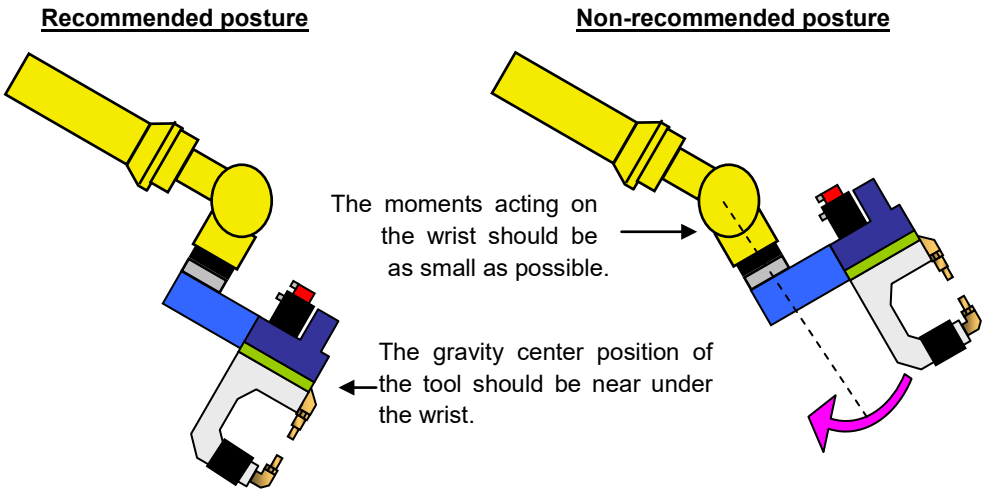


Fig. 3.6.1(d) Example 2 of recommended posture

About 3:

As shown in Figure 3.6.1(e), set the posture so that the flange position is as close to the robot base as possible by setting the angle of J2 and J3 value as small as possible.

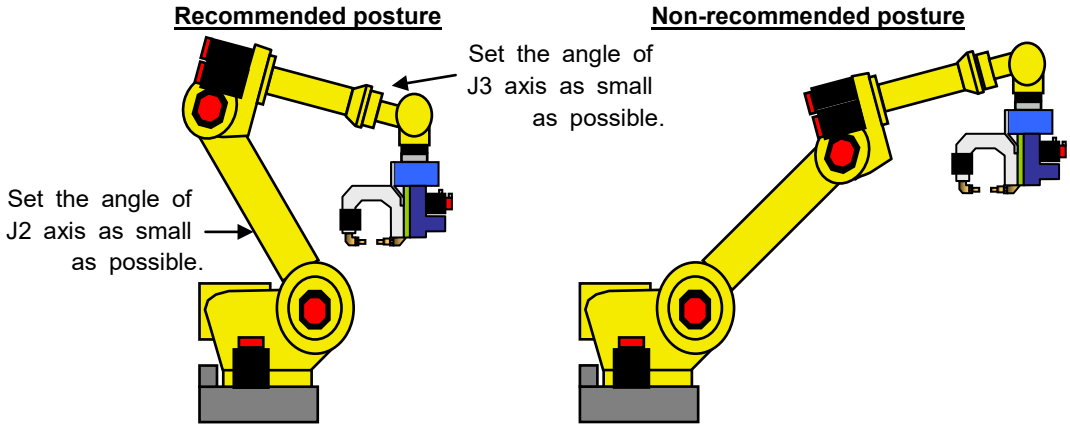


Fig. 3.6.1(e) Example 3 of recommended posture

> ⚠ **CAUTION**
> By setting the above recommended posture, the tool attached to the robot wrist may interfere with the robot arm. Please set close to the recommendation posture within the limits which do not have interference.

Procedure

Fig. 3.6.1(f) is the overview of the procedure for automatic setting.

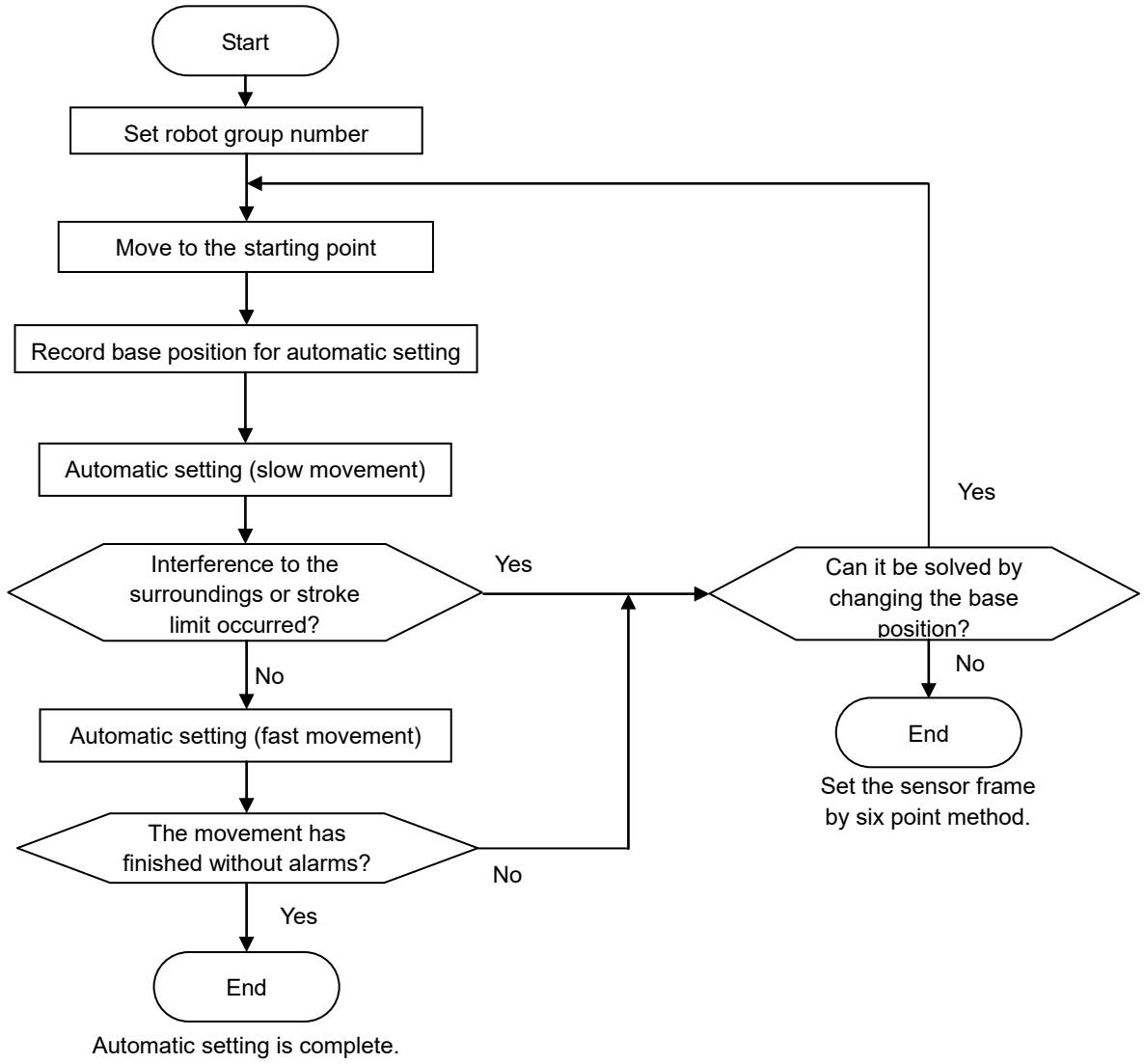
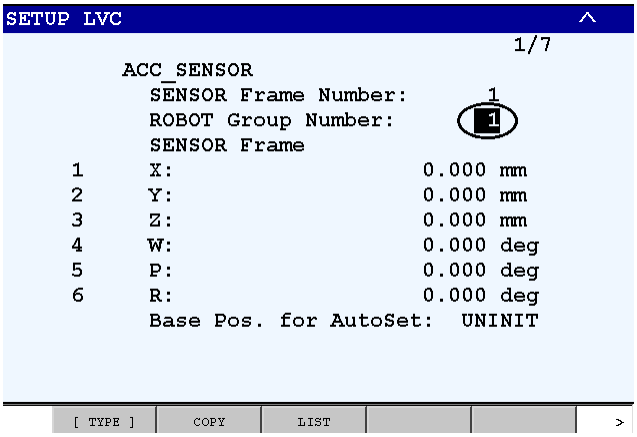


Fig. 3.6.1(f) Procedure of automatic setting

Detailed descriptions are as follows.

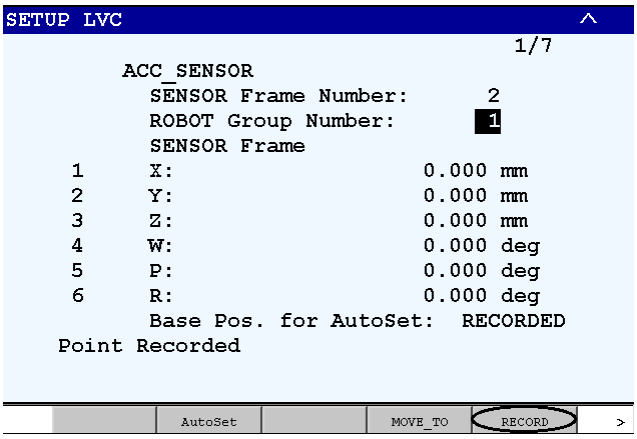
Procedure 3-2 Executing sensor frame automatic setting function

1 Set robot group number in [ROBOT Group Number] item which accelerometer is attached to.



2 Move the robot to the starting point for automatic setting by using jog operation or executing the TP program.

3 After moving to the starting position, hold down the [SHIFT] key and press F5,"RECORD".

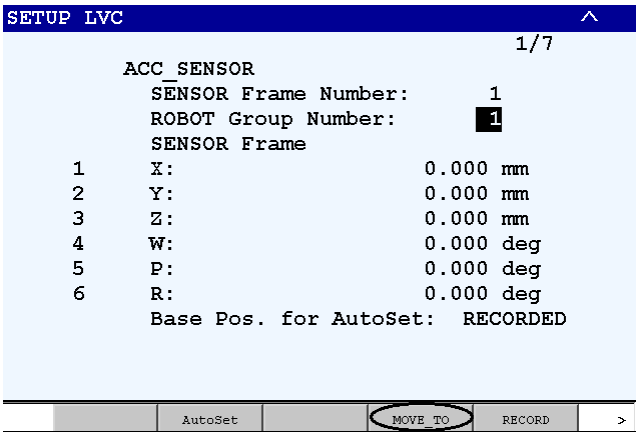


NOTE

If the message "Point Recorded" is not displayed, apply following procedure.

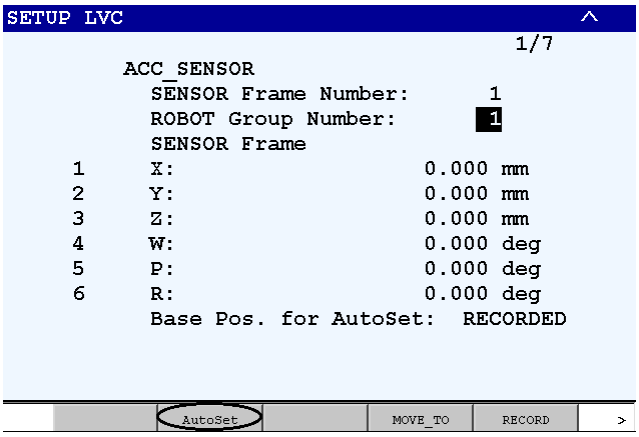
- If the message "This robot is not supported" is displayed, set the sensor frame by six point method.
- If the message "Perform mastering" is displayed, perform mastering and retry automatic setting.

4 (In the case that you want to move to base position) Check the override and safety of the surroundings. Then reset the alarm and hold down the [SHIFT] key and press F4, “MOVE_TO”.



⚠ CAUTION
In T2 mode, the robot stops the movements to base position if you release the [SHIFT] key. In Auto mode, you should press the [HOLD] key or the emergency stop button to stop the movements.

5 Check safety of the surroundings. Then reset the alarm and hold down the [SHIFT] key and press F2, “AutoSet”.



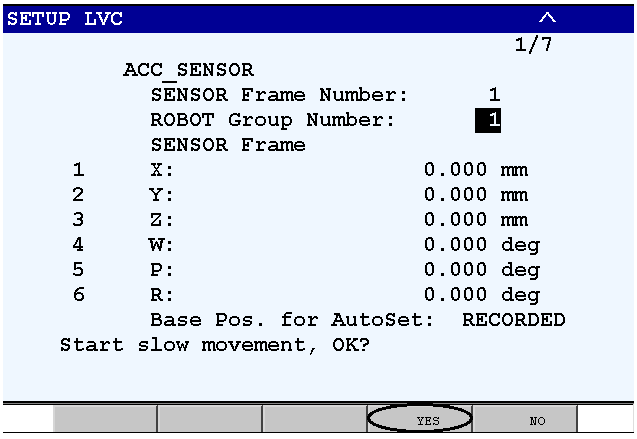
⚠ CAUTION
In T2 mode, the robot stops the movements for automatic setting if you release the [SHIFT] key. In Auto mode, you should press the [HOLD] key or the emergency stop button to stop the movements for automatic setting.

NOTE

If the movements for automatic setting do not start, apply following procedure.

- If the message “This robot is not supported” is displayed, set the sensor frame by six point method.
- If the message “Switch to T2 or AUTO mode” is displayed, switch to T2 or AUTO mode and retry automatic setting.
- If the message “Perform mastering” is displayed, perform mastering and retry automatic setting.
- If MOTN-582 is occurred, correct active PAYLOAD number or the value of PAYLOAD CENTER and PAYLOAD INERTIA of the active payload number. Then retry automatic setting.
- If the message “Base pos. is uninit. Cannot start” is displayed, teach the base position according to steps 2 and 3 and retry automatic setting.
- If the message “Enable LVC” is displayed, enable LVC according to Section 3.1 and retry automatic setting.
- If the message “This sensor is not supported” is displayed, verify sensor type according to Section 3.4. If sensor type is incorrect, correct it and retry automatic setting. If sensor type is correct, change sensor type to use and retry automatic setting or set the sensor frame by six point method.

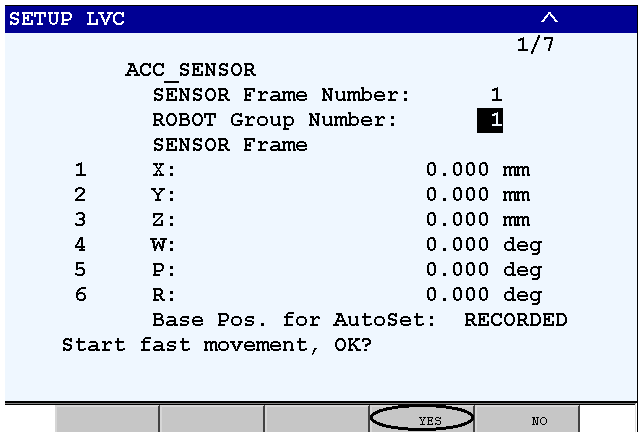
6 Hold down the [SHIFT] key and press F2, “AutoSet”. Then confirmation message to start the slow movements are displayed. Press F4, “YES” to start the movements at 1% override. Press F5, “NO” to abort the movements. If there are no problems such as interference to the surroundings, you can change the override during the movements. Sensor frame is not set by the slow movements.



NOTE

If the alarm "INTP-105 (~ LV_AUTOSET, 1) Run request failed" is displayed, abort the program by selecting ABORT(ALL) from the function menu. Then retry automatic setting.

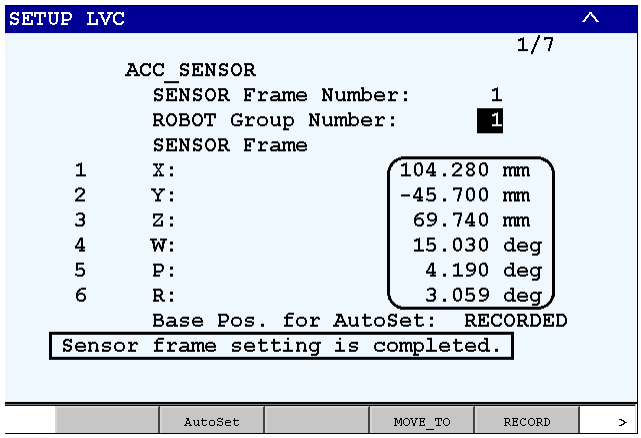
7 After the slow movements has finished, confirmation message to start the fast movements is displayed. If pressing F4, “YES”, the program starts the same movements at higher than 30% override. (For 7DC3/17 or later software, 3 types of overrides are used) If pressing F5, “NO”, the program finishes.



NOTE

1. If the alarm "INTP-105 (~ LV_AUTOSET, 1) Run request failed" is displayed, reset the alarm and retry automatic setting.
2. If you change the override during the fast movements, MOTN-584 occurs and the robot stops. Please do not change the override during the fast movements. Reset the alarm and then retry automatic setting.
3. If the alarm “MOTN-556 Wireless sensor timeout” or “MOTN-557 USB receiver removed” is displayed when the fast movements start with the wireless accelerometer, apply the following procedure.
   - Reboot the accelerometer.
   - Disconnect/Connect the USB receiver.
   - Push LED2 reset button (please refer to Fig. 2.1.2 (c)) to turn off the wireless sensor, then restart sensor again.
   - Reboot the controller.

8 After the fast movements have finished, if the accuracy of calculated sensor frame is satisfactory, the result and the message “Sensor frame setting is completed” are displayed. In that case, sensor frame automatic setting function is completed.



NOTE

1. If MOTN-583 occurs after the fast movements, apply following procedure and retry automatic setting.
   - Verify whether the accelerometer is fixed firmly to an end-of-arm tool or servo gun.
   - Verify the active payload number.
   - Verify the value of gravity center position, and inertia of active payload number.
   - Set the base position for automatic setting as close to the recommended posture as possible.

   If the problem could not be resolved with these procedures, set the sensor frame by six point method or three point method.
   If the message for MOTN-583 includes “Er:1”, perform six point method. (For six point method, please refer to Subsection 3.6.2.)
   If the message for MOTN-583 includes “Er:2”, set the sensor frame by six point method then input XYZ results into sensor frame. (For the procedure of three point method, please refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN) Subsection 3.9.1.)
2. If MOTN-581 occurs after the fast movements, apply following procedure and retry automatic setting. If the problem could not be resolved, set the sensor frame by six point method.
   - Verify sensor type (wired or wireless) is selected correctly.
   - Verify whether the accelerometer is fixed firmly to an end-of-arm tool or servo gun.

3.6.2 Six Point Method

Six point method calculates the sensor frame by moving the robot such that the accelerometer touches a sharp instrument with six postures.

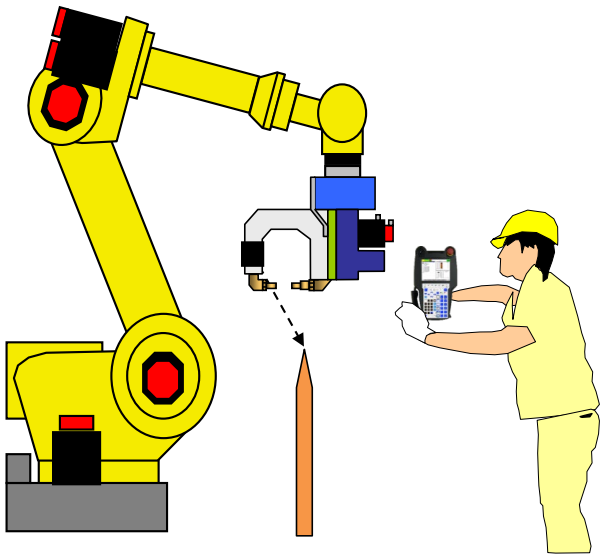


Fig. 3.6.2(a) Six point method

Procedure 3-3 Setting by six point method

1 Use Tool Frame Six Point (XY) method to set LVC Sensor Frames. This allows users to “touch” the top of the sensor in various locations to define a TCP corresponding to the Sensor Origin and Orientation. The numbers on the sensor label corresponds to each points of Six Point method as Fig 3.6.2(b). More information about Tool Frame Six Point (XY) method, please refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN) Subsection 3.9.1.
Use the “+” mark printed on the accelerometer near “1, 2, 3” for Approach point 1, 2, 3.
Use the “+” mark printed on the accelerometer near “4” for Orient Origin Point.
Use the “+” mark printed on the accelerometer near “5” for X Direction Point
Use the “+” mark printed on the accelerometer near “6” for Y Direction Point

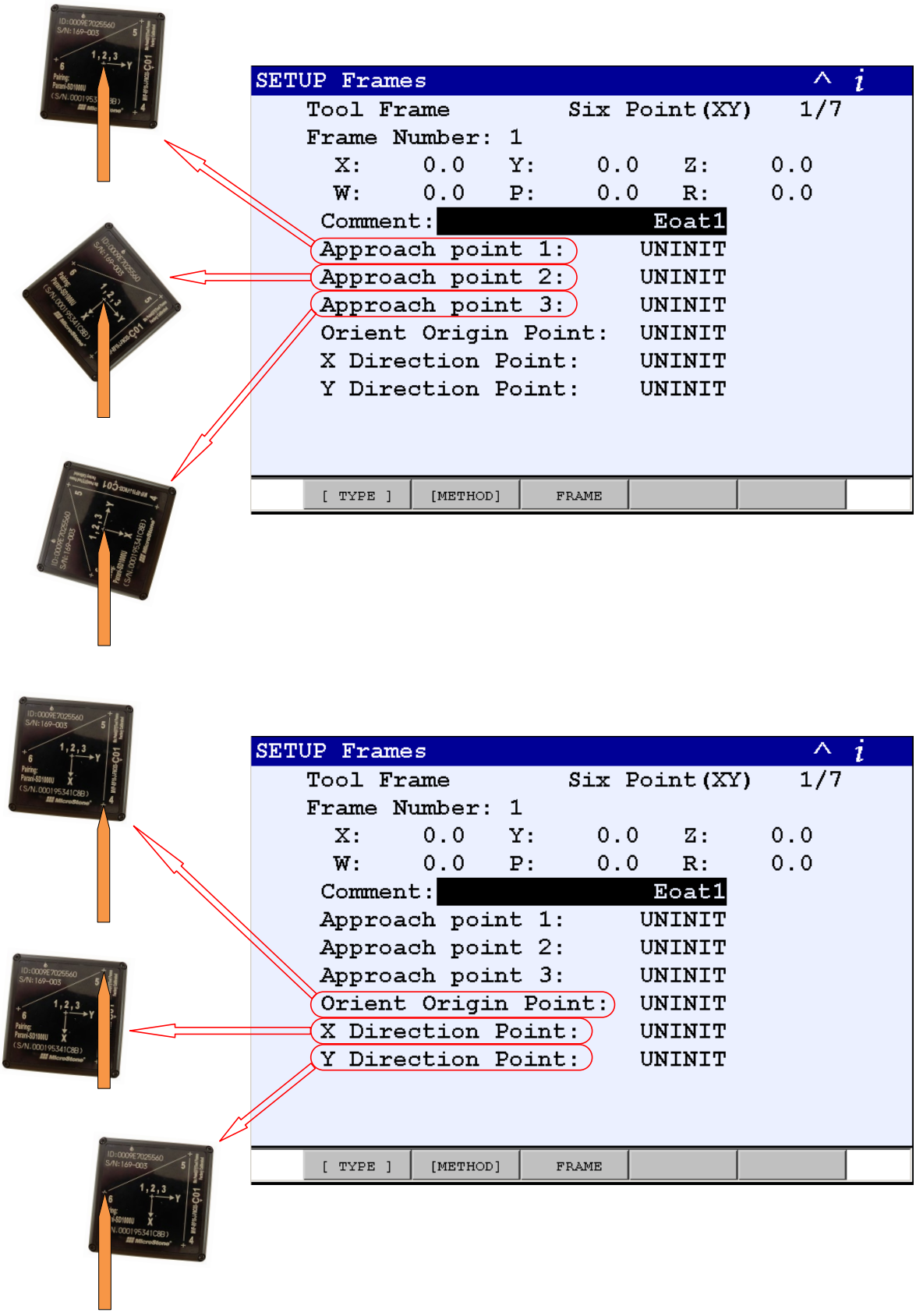
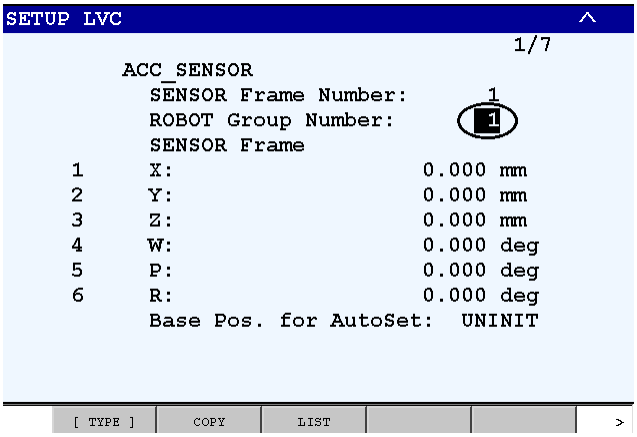


Fig. 3.6.2(b) Corresponding points between the top of the sensor and six point (XY) frame

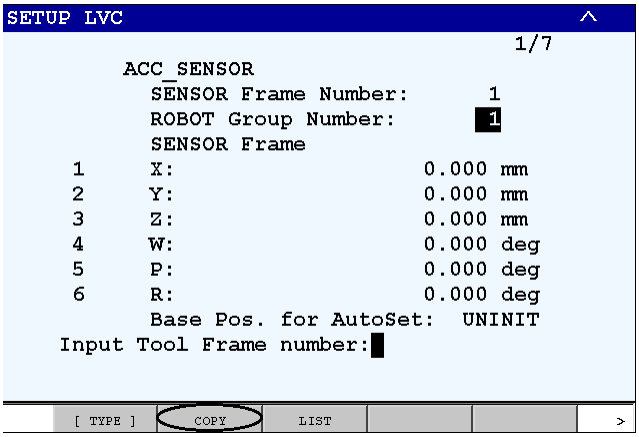
2 Make sure that the tool frame is correct. Jog the robot in directions X, Y, and Z of the tool frame, the robot move in direction of the frame that is printed on the accelerometer (for example, when you jog the robot in direction X of the tool frame, the robot move in direction of the X arrow on the accelerometer. Also check direction of rotation W, P, and R rotate around the origin point on the accelerometer.

> ⚠ **WARNING**
> Make absolutely sure that the sensor frame is correct. The incorrect sensor frame may cause the robot to move in an unexpected way. This is very dangerous.

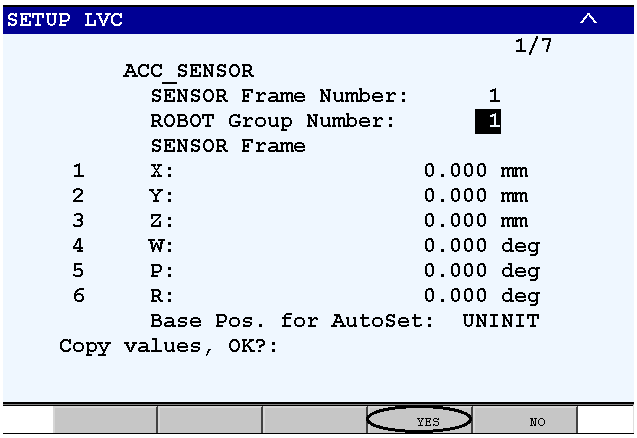
3 Display sensor frame setting menu and set robot group number in [ROBOT Group Number] item which accelerometer is attached to.



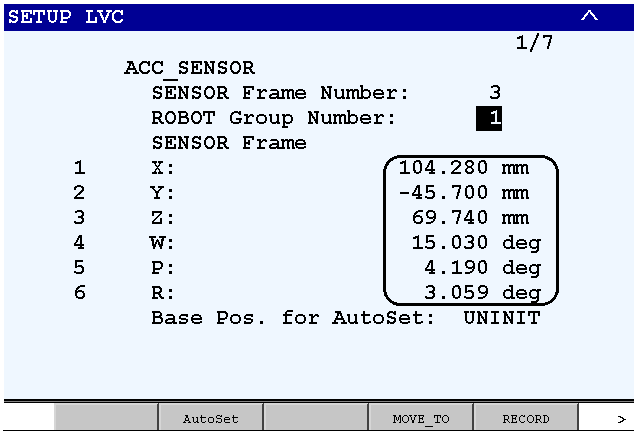
4 Press F2, “COPY” then message “Input Tool Frame number” is displayed. Input tool frame number from which you would like to copy. (In multi-arm system, please also input robot group number after input tool frame number.)



5 After input tool frame number, message “Copy values, OK?” is displayed. If you would like to copy values, press F4, “YES”. Then sensor frame is copied from tool frame.



6 Make sure that the sensor frame is correctly copied from tool frame. After this, setting of sensor frame is complete and the tool frame can be used for other purposes.

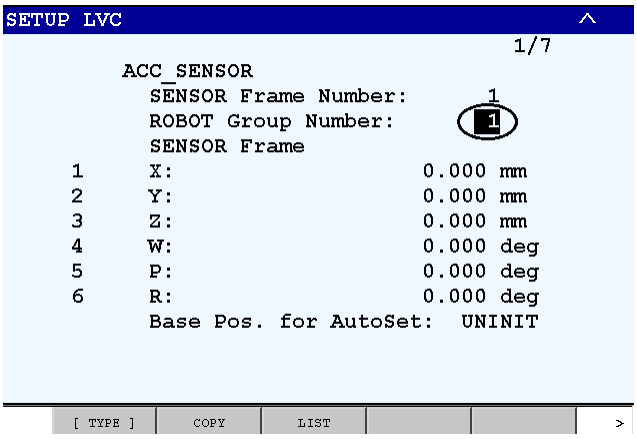


3.6.3 Direct List Method

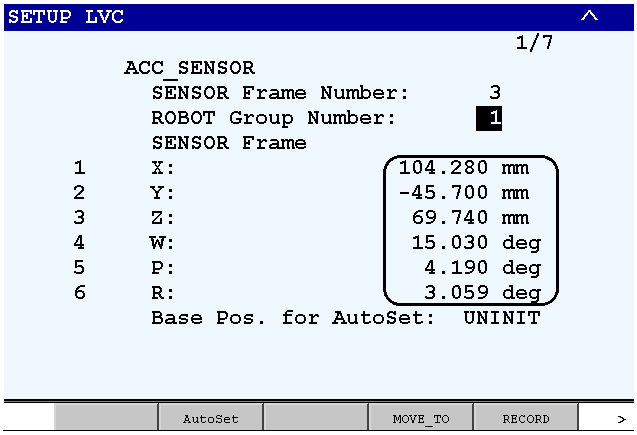
Direct list method is the way to directly enter the values of X, Y, Z, W, P, and R in the sensor frame. If you know the sensor frame of a different robot on which the accelerometer is attached on the same place, you can enter these values directly.

Procedure 3-4 Setting sensor frame by direct list method

1 Set robot group number in [ROBOT Group Number] item which accelerometer is attached to.



2 Enter the values of X, Y, Z, W, P, and R which are relative to the robot faceplate frame.



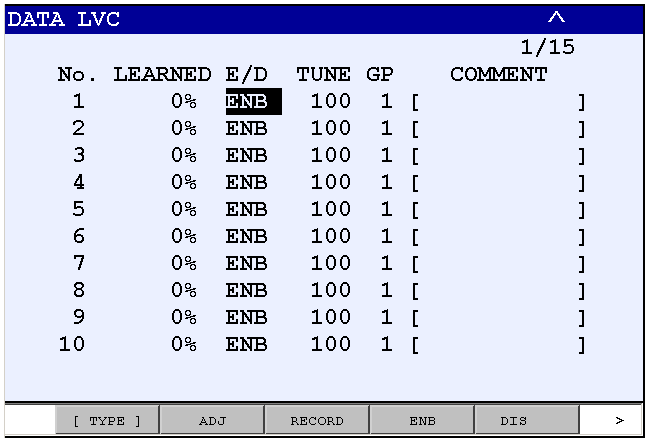
3 Setting of sensor frame is complete.

4 PROGRAM EXECUTION

This chapter explains how to teach, execute, and touch-up TP programs with LVC instructions.

Procedure 4-1 Displaying LVC data menu

1 Press [DATA] key.
2 Press F1, "[TYPE]" to display screen change menu, and select "LVC".
3 The LVC data menu appears.



4.1 LVC DATA MENU

- Learning motion and playback motion are performed between LVC_START and LVC_END in TP programs.
- Do not delete LVC instructions after the learning process is completed. Also LVC status needs to be enabled.
- The ID in LVC_START corresponds to the LVC data ID in the LVC data menu. For example, "LVC_START[1] Learned 0%" status is shown in that of LVC data No.1 in the LVC data menu.

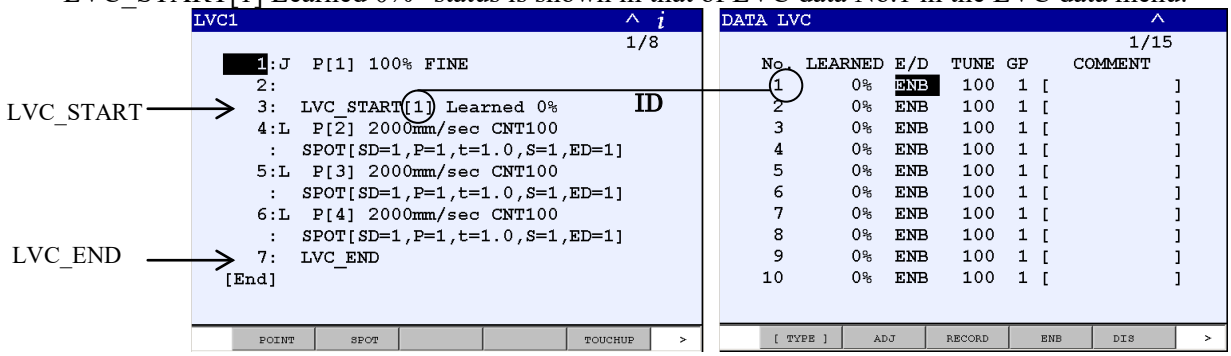


Fig. 4.1(a) ID in LVC data

NOTE
1 CNT0/FINE is recommended the termination types of the motion line before LVC_START. When the termination types of the motion line before LVC_START is CNT1-100, automatic speed-up and vibration control are also available. However, when touch-up modifies the motion before LVC_START, alarm "MOTN-537 LVC: Changed motion" would occur.
2 LVC command can't be taught in ARC motion or spline motion.

- The flow chart (shown in Fig. 4.1(b)) explains the process flow for teaching, executing (learning motion and playback motion), and touch-up of TP programs.

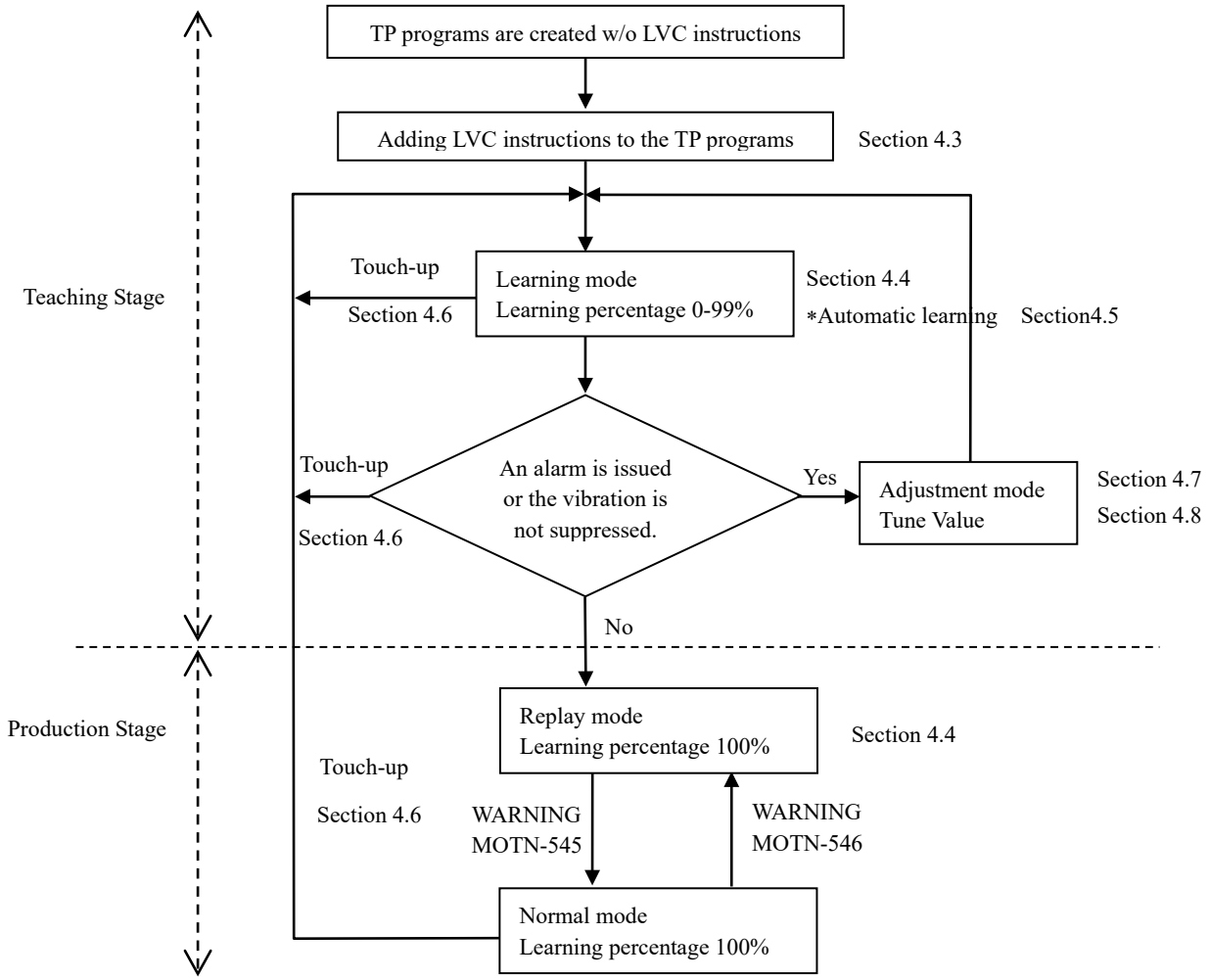


Fig. 4.1(b) Teaching, Execution, and Touch-up of TP programs with LVC instructions

4.2 LIMITATIONS

The LVC instruction has limitations to the size of LVC data stored in the memory as follows.

- The number of motion lines between LVC instructions must be less than six hundred. The motion line with SPOT instruction is counted as four motion lines.
- The execution time of motion lines between LVC instructions must be less than 45 seconds.
- Each LVC "Block" (CNT0/FINE to CNT0/FINE) cannot exceed 15 sec of motion.

When the execution time is over the limitation, the alarm MOTN-524 "LVC: Full memory" or MOTN-542 "LVC: Full memory" or MOTN-532 "LVC: Internal error 2(M%d, Id%d)" is issued. Please correct this issue in the following ways:

- Reduce the number of motion lines or logic commands between LVC instructions.
- Break up the motion lines in one LVC start/end block into the motion lines in two or more LVC start/end blocks.
- Reduce the number of motion lines or logic instructions within the LVC "Block".

LVC has two functions: automatic speed-up, and vibration control for the motion lines between LVC instructions. The automatic speed-up function can be applied only to the following motion lines.

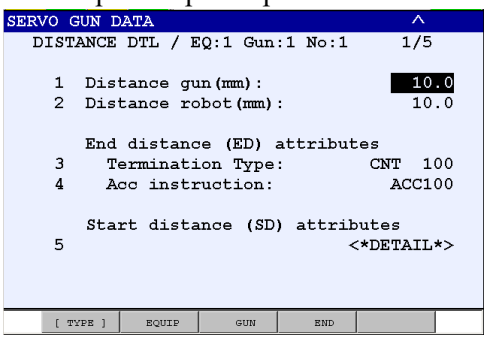
- Aircut motion
- Motion lines are SPOT motion lines termination types of motion lines are CNT1-100 and ED (end distance) termination types for spot instruction are CNT1-100

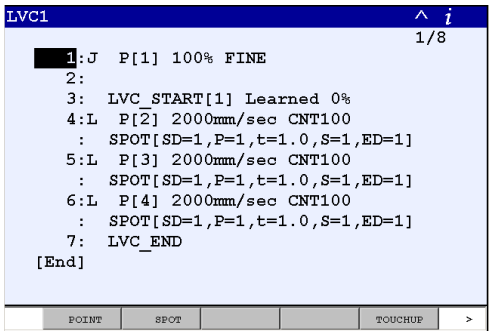
The automatic speed-up function can be applied partially for the following condition.

- For application case No. 2, termination types of motion lines are CNT1-100 and ED (end distance) termination types for spot instruction are CNT0 or FINE.

The automatic speed-up function increases motion speed step-by-step during learning until the learning percentage becomes 100%.

< Example 1: Speed up function works >



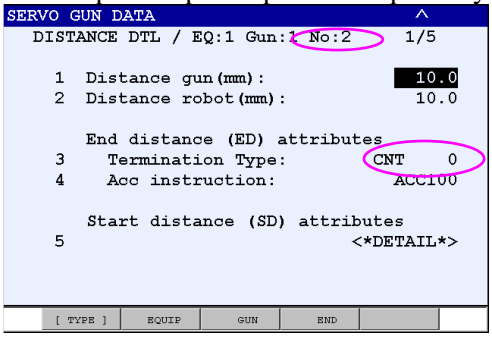


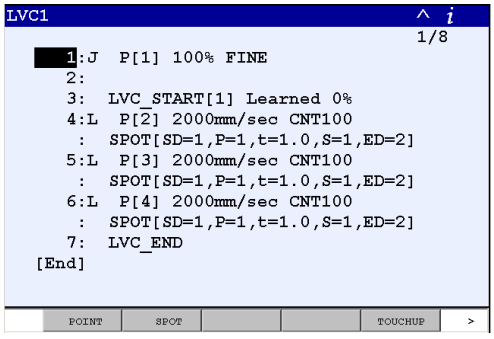
All speed up conditions are satisfied.

Left: ED No.1 position path options is CNT 1- 100

Right: Position path options is CNT 1-100

< Example 2: Speed up function partially works >





Speed up conditions are not satisfied.
Speed up function works without open gun motion.
Left:ED No.2 position path option is not CNT 1 - 100.

The following functions are not compatible with LVC:

- Stand-alone SPOT instruction
  - Automatic speed-up function cannot be applied to motion lines with stand-alone SPOT instructions.
- LVC_START command
  - LVC_START command cannot be used between LVC start/end instructions. When LVC instructions were executed with LVC_START command between LVC start/end instructions, alarm “INTP-683 LVC: LVC_START in block” would occur.
- Override command
  - If override is under 100%, robot motion is normal motion.

4.3 LVC INSTRUCTIONS

There are four LVC instructions, LVC_START, LVC_END, NORMAL_MOTION_START and NORMAL_MOTION_END. These instructions apply the LVC algorithm to motion lines between LVC_START and LVC_END. In order to select these instructions in the TP editor, press [INST] and select LVC. These instructions menu for selecting LVC_START, LVC_END, NORMAL_MOTION_START and NORMAL_MOTION_END will appear.

4.3.1 LVC_START

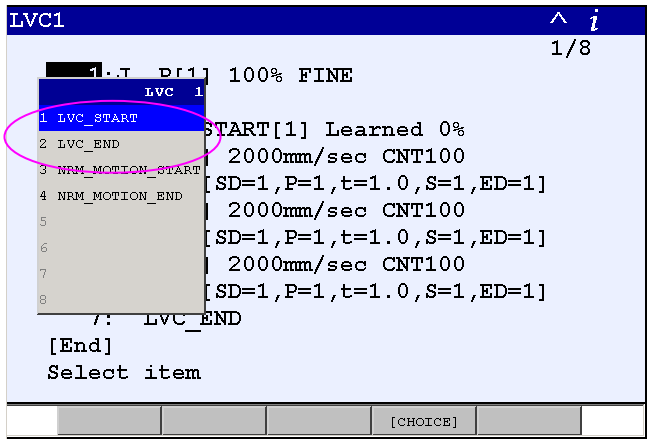
- The LVC_START command is displayed in TP programs as follows:
  LVC_START [x] Learned y%
- LVC_START starts learning mode or playback mode.
- x is the data ID number. Select a number from 1-15 (version 7DC3 or before) or from 1-20 (version 7DF1 or later).
- y is learning percentage. 100% means the learning process is complete.
- In the learning mode, the data measured by accelerometer and other motion data is recorded in memory.
- In playback mode, the LVC data is applied to the motion lines.

4.3.2 LVC_END

- The LVC_END command is displayed in TP programs as follows:
  LVC_END
- LVC_END stops the learning mode or playback mode.
- In the learning mode, motion data collection stops, and LVC data is generated based on this recorded motion data. When the learning percentage becomes 100%, LVC data is copied from D-RAM to F-ROM. (NOTE: Due to the intensive computation, it may take a minute to finish the LVC_END command during learning.) As for the relationship between LVC data and memory device, please refer to Section 5.
- LVC data is applied to the motion lines in the play back mode without collecting motion data or updating LVC data.

Procedure 4-2 Generating and Executing TP programs with LVC instructions.

1 In the program select menu, move the cursor to a TP program and select it. The editor screen appears.
2 Move the cursor to the line to add an LVC instruction.
3 Press F1 key, “[INST]”, and a menu for instructions appears. Select LVC in the menu.
4 The LVC instruction menu appears. “LVC_START” and “LVC_END” can be selected.
5 Select LVC_START or LVC_END, and the LVC instruction is added to the program line.



NOTE

In the case that main program starts subprogram as a task by using the “RUN” instruction, subprogram cannot perform learning motion if LVC instructions are only taught in main program. If the motion lines in subprogram are expected to perform learning motion, LVC instructions must be added in subprogram. However, when using the “CALL” instruction, adding LVC instructions only in main program is enough to perform learning of the subprogram.

4.3.3 NORMAL_MOTION_START

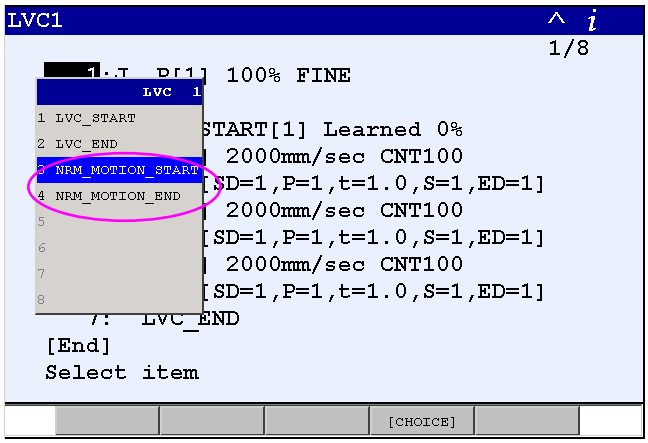
- The NORMAL_MOTION_START command is displayed in TP programs as follows:
  NORMAL_MOTION_START
- and displayed in TP menus as follows:
  NRM_MOTION_START
- NORMAL_MOTION_START starts a normal motion block.
- In this normal motion block, automatic speed-up function is not applied, but the vibration control function can be applied to the motion lines between NORMAL_MOTION_START and NORMAL_MOTION_END.
- These instructions can be applied only to motion lines between LVC start/end instructions. They cannot be applied without LVC start/end instructions.
- When the NORMAL_MOTION_START instruction is used before CNT1-100, the motion speed is smoothly changed to normal motion.

4.3.4 NORMAL_MOTION_END

- The NORMAL_MOTION_END command is displayed in TP programs as follows:
  NORMAL_MOTION_END
- and displayed in TP menus as follows:
  NRM_MOTION_END
- NORMAL_MOTION_END ends the normal motion block.
- In this normal motion block, automatic speed-up function is not applied, but the vibration control function can be applied to the motion lines between NORMAL_MOTION_START and NORMAL_MOTION_END.

Procedure 4-3 Generating and executing TP programs with NORMAL_MOTION instructions.

1 In the program select menu, move the cursor to a TP program and select it. The editor screen appears.
2 Move the cursor to the line to add an LVC instruction.
3 Press F1 key, “[INST]”, and a menu for instructions appears. Select LVC in the menu.
4 The LVC instruction menu appears. ” NRM_MOTION_START” and “NRM_MOTION_END” can be selected.
5 Select “NRM_MOTION_START” or “NRM_MOTION_END”, and the NORMAL_MOTION instruction is added to the program line.



4.4 TP PROGRAM CREATION AND EXECUTION

- Two modes of LVC instructions are defined according to learning percentage:
  1. Learning mode (when learning percentage is 0-99%)
  2. Playback mode (when learning percentage is 100%)

  - When LVC_START is executed with learning percentage of 0%, the data measured by accelerometer and other motion data is recorded in memory up to LVC_END. LVC data is generated at LVC_END.
  - When LVC_START is executed with learning percentage of 1-99%, LVC data from the previous iteration is applied to the motion, and the data measured by accelerometer and other motion data is recorded in the memory up to LVC_END. LVC data is regenerated at LVC_END.
  - As the iteration number of TP program increases, the learning percentage increases. When learning percentage reaches 100%, the learning process is complete.
  - If the termination types of the aircut motion except for SPOT instruction is CNT0/FINE, after the motion LVC wait for a short while and record the data. So in the learning mode cycle time might be slightly longer. This wait is not executed in the playback mode.
    In the playback mode, LVC data is applied to the motion lines. Motion data is not stored in the memory.

⚠ WARNING
In the learning mode and the playback mode, the robot motion becomes much faster than in normal mode at the override of 100%. LVC speed up is not applied when the override is less than 100%. Therefore, the motion speed becomes significantly different between override 95% and override of 100% in the learning mode and playback mode.

NOTE
Learning motion and playback motion are performed in T2 mode or Auto mode, at 100% override when LVC status and schedule is set to enable. Otherwise, learning motion and playback motion is not performed.

- LVC setup conditions
  - Accelerometer and other hardware should be installed correctly. (Please refer to Section 2.1 and 2.2)
  - The sensor frame and other necessary software settings for LVC should be set up correctly. (Please refer to Chapter. 3)

NOTE
1. Confirm if the necessary hardware and software for LVC are set up correctly.
2. If the alarm “MOTN-556 Wireless sensor timeout” or “MOTN-557 USB receiver removed” is displayed when communication start, apply the following procedure:
   - Reboot the accelerometer.
   - Disconnect/Connect the USB receiver.
   - Push LED2 reset button (please refer to Fig. 2.1.2 (c)) to turn off the wireless sensor, then restart sensor again.
   - Reboot the controller.
3. Only one robot group can be in learning mode at the same time, otherwise MOTN-549 LVC: Multi data in learning is issued. However, multiple robot groups can be in playback mode by using the “RUN” instruction.

Procedure 4-4 Creating and Executing TP programs with LVC instructions

As an example, the TP program for spot welding application as shown in Fig. 4.4(a) is considered.

1 Create a TP program.
2 Insert LVC_START just before motion lines to be learned, as shown in Fig. 4.4(b).
3 Enter data ID of LVC data at * in “LVC_START [*] Learned 0%”.
4 Insert LVC_END just after motion lines to be learned, as shown in Fig. 4.4(b).
5 Start the TP program and repeat running until the learning percentage becomes 100%.

Please refer to next section about automatic learning which allows TP programs to repeat automatically during learning.

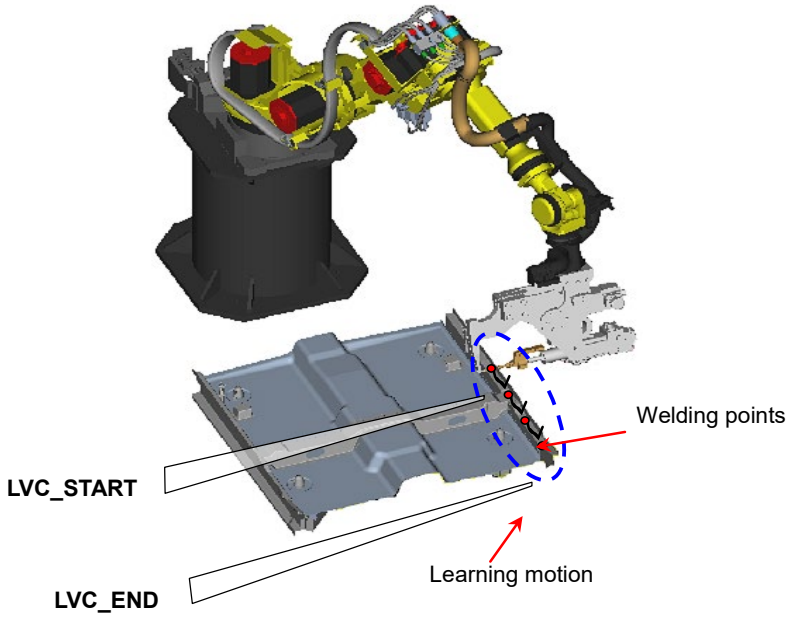


Fig. 4.4(a) An example motion with Spot & LVC instructions

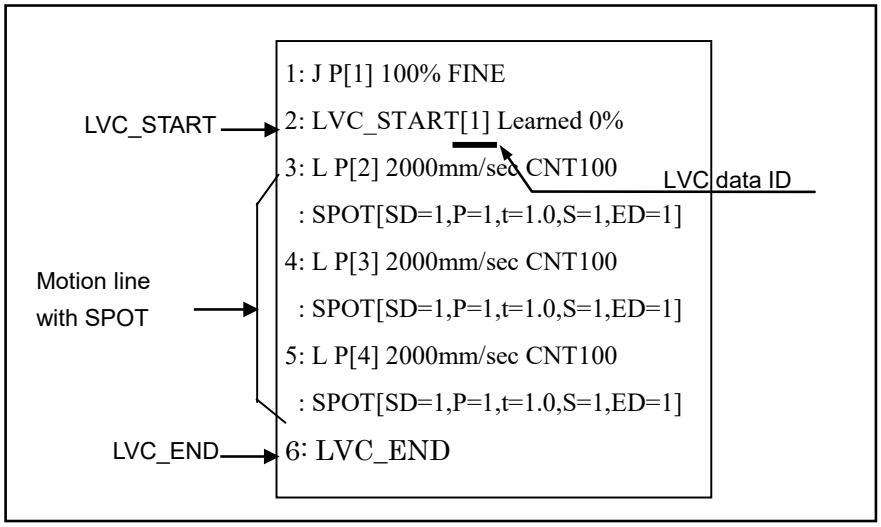


Fig. 4.4(b) An example TP program with Spot & LVC instructions

4.5 AUTOMATIC LEARNING

Automatic learning allows TP programs with LVC instructions to repeat automatically during learning. Automatic learning use system variable $LVCFG.$LVC_DONE. $LVCFG.$LVC_DONE is set to 0 in case of the learning non-completion and to 1 in case of learning completion at LVC_END instruction. The following are the examples of automatic learning program depending on the number of data to learn.

Procedure 4-5-1 Creating an automatic learning program (Learn one data)

1 Create a TP program (for example, LVC_MAIN.TP) to call the TP program with LVC instructions (for example, LVC1.TP) until complete learning.
2 After execute LVC_MAIN.TP, when the learning percentage becomes 100% in LVC1.TP, the program will finish automatically.

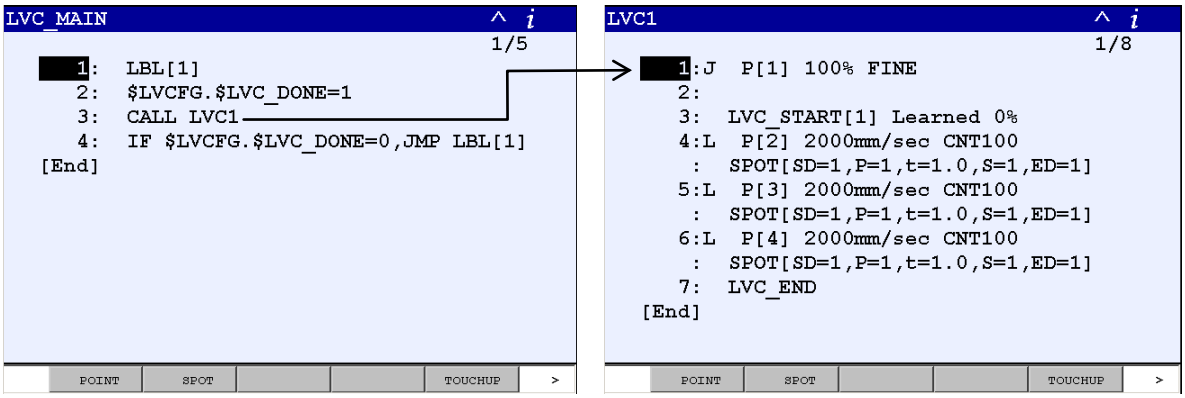


Fig. 4.5(a) An example of automatic learning program (Learn one data)

Procedure 4-5-2 Creating an automatic learning program (Learn two or more data)

1 Create a TP program to set to 1 in register when $LVCFG.$LVC_DONE is not 1. The Register number uses an unused number (for example, CHK_LVC_DONE.TP).
2 In the TP program with LVC instructions, call CHK_LVC_DONE.TP in the next line of each LVC_END (for example, LVC2.TP).
3 Create a TP program to call LVC2.TP repeatedly while register is 1 (for example, LVC_MAIN2.TP).
4 After execute LVC_MAIN2.TP, when the learning percentage becomes 100% at all LVC instructions in LVC2.TP, the program will finish automatically.

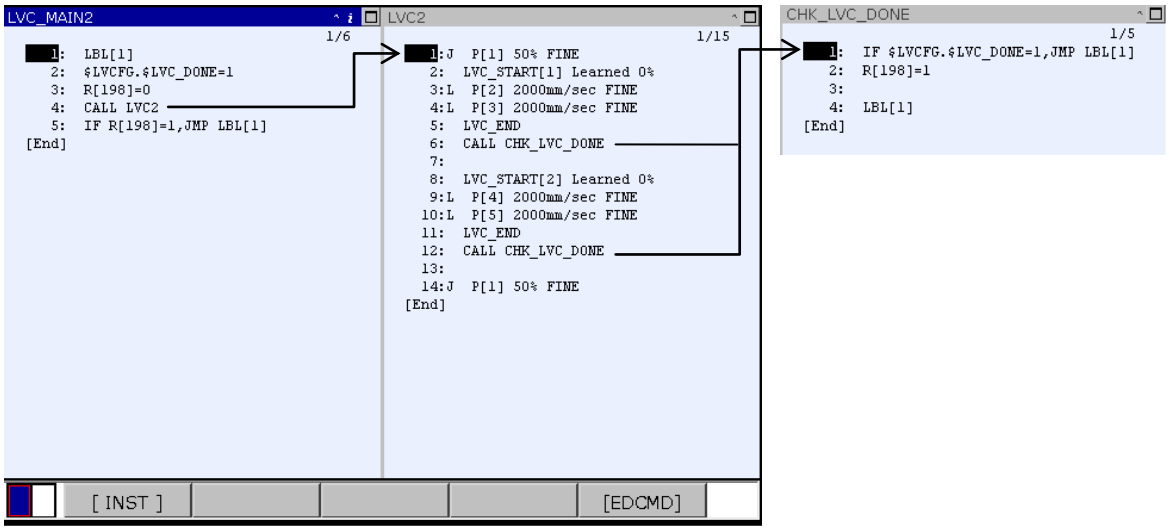


Fig. 4.5(b) An example of automatic learning program (Learn two or more data)

4.6 TOUCH-UP AND RE-LEARNING

LVC data is associated with the measured vibration data and other motion data specific to a TP program with LVC instruction. If touch-up modifies the motion after learning is complete, not learning motion or playback motion but normal motion is performed. For example, if motion type, taught position, or taught speed is changed, normal motion is performed. The other commands are below.

motion type	MAXSPEED instruction
start position	RT_LD value or AP_LD value
destination position	CR value
via position(circle motion only)	RTCP instruction
taught speed	Simultaneous EV instruction
termination type	Independent EV instruction
CNT value	move time
tool frame	move time of aux axis
user frame	filter length
override	filter type
payload	$MRR_GRP[g].$PRGOVERRIDE
ACC value	group number
PATH instruction	Break
WJNT instruction	NORMAL_MOTION instruction
INC instruction	extended axis motion
PSPD value	

However, as for taught position, the learning motion or playback motion is performed if the modification is in the range below:

- X, Y, Z of taught position is modified within 10mm.
- W, P, R of taught position is modified within 1 degree.

For example, suppose that you teach positions P1, P2, …, P5 as shown in Fig. 4.6 and the subsequence motion is learned. Then, if the taught position P3 is modified to P3', the LVC motion doesn't be switched to normal motion because the touch-up is within 10mm. On the other hand, if the taught position P3 is modified to P3", the LVC motion is switched to normal motion.

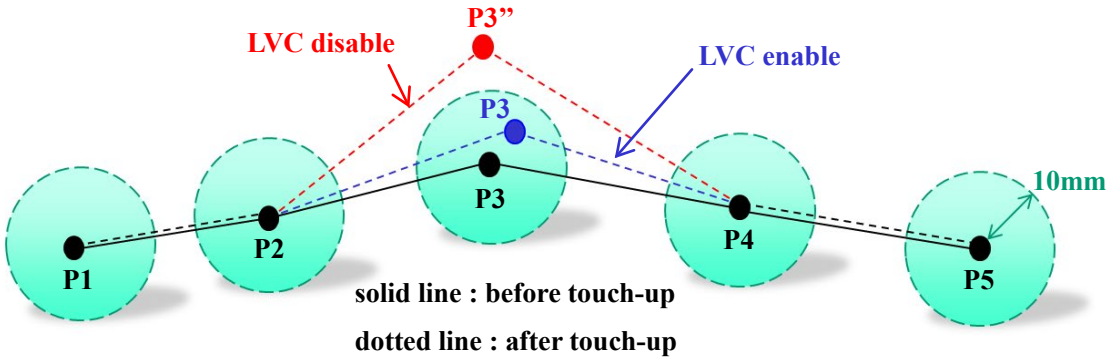


Fig. 4.6 touch-up X, Y, Z of taught position

4.6.1 Re-learning

- In learning mode, when a TP program with LVC instruction is executed after touch-up is done, alarm "MOTN-537 LVC: Changed motion" (as Fig.4.6.1), "MOTN-538" or "MOTN-539" is posted and the execution stops. When resuming program execution, the motion becomes normal (non-LVC) motion, neither learning motion nor playback motion. In this time, if "Disable state DO" item is set to the DO number, the DO signal is set ON.

- There are three parameters for alarm MOTN-537 to indicate how the motion instruction has changed. M is learning data ID, L is line number, P represents cause of motion changed (for example, taught position, taught speed, etc.). Please refer to Appendix A for the contents of the alarm. If the motion instruction has changed other cause, MOTN-538 or MOTN-539 will occur.

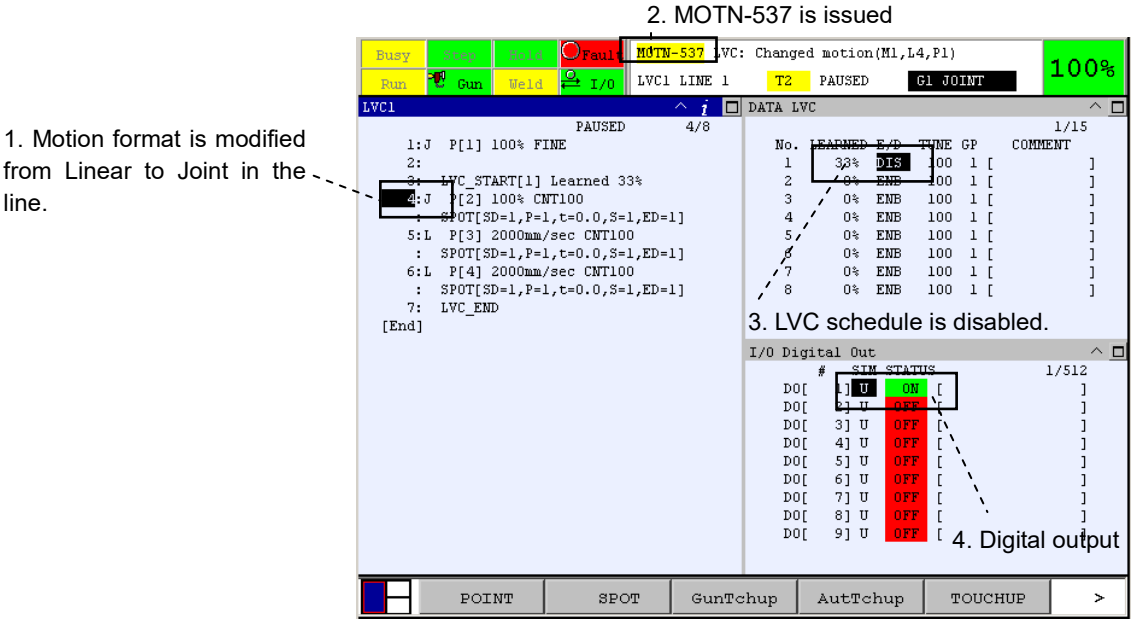


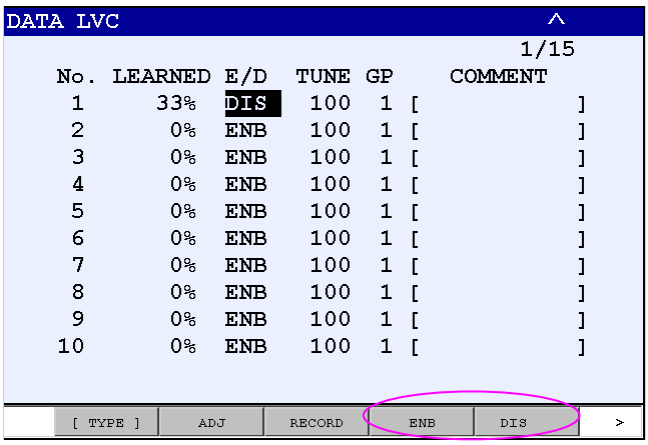
Fig. 4.6.1 An example of MOTN-537

- When it is necessary to execute learning motion or playback motion after MOTN-537, 538, and 539 occurs, follow these instructions:

1. Re-enable the LVC data.
   (Please refer to Procedure 4-6)
2. Delete the LVC data, and relearn the TP program starting from learning percentage of 0%.
   (Please refer to Procedure 4-7)

Procedure 4-6 Re-enable LVC data

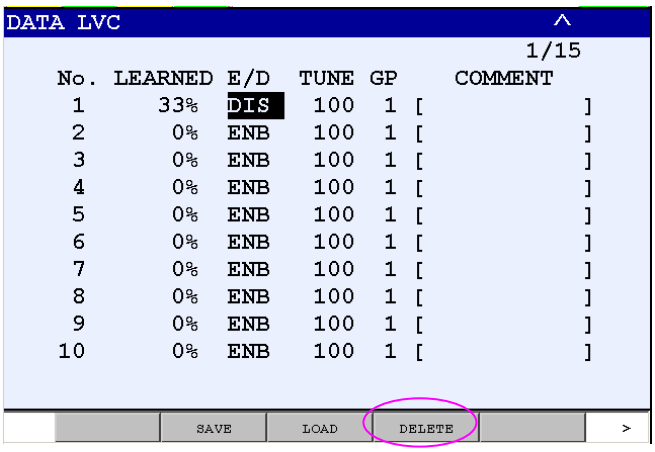
1 Go to the LVC data menu.
2 Move the cursor to enabled/disenabled item.
3 Please press F4 “enabled” to enable LVC data or press F5 “disabled” to disable LVC data.



NOTE
When LVC data is set to disable and a TP program with LVC instructions is executed, normal motion is performed with learning instructions disabled.

Procedure 4-7 Deleting LVC data

1 Go to the LVC data menu.
2 Move the cursor to the LVC data to be deleted.
3 Press [NEXT] key and press F4, “DELETE”.
4 Press “YES” to delete the data or “NO” to keep the data.



4.6.2 Switching Normal Motion

- In playback mode, when a TP program with LVC instructions is executed after touch-up is done, warning “MOTN-545 LVC: Switched to normal motion” is posted as Fig.4.6.2(a) for the modified motion lines. Then, robot motion becomes normal motion.
- Afterwards, when LVC data can apply to the subsequent robot motion, robot motion becomes playback motion with warning “MOTN-546 LVC: Restart LVC motion” posted as Fig. 4.6.2(b).

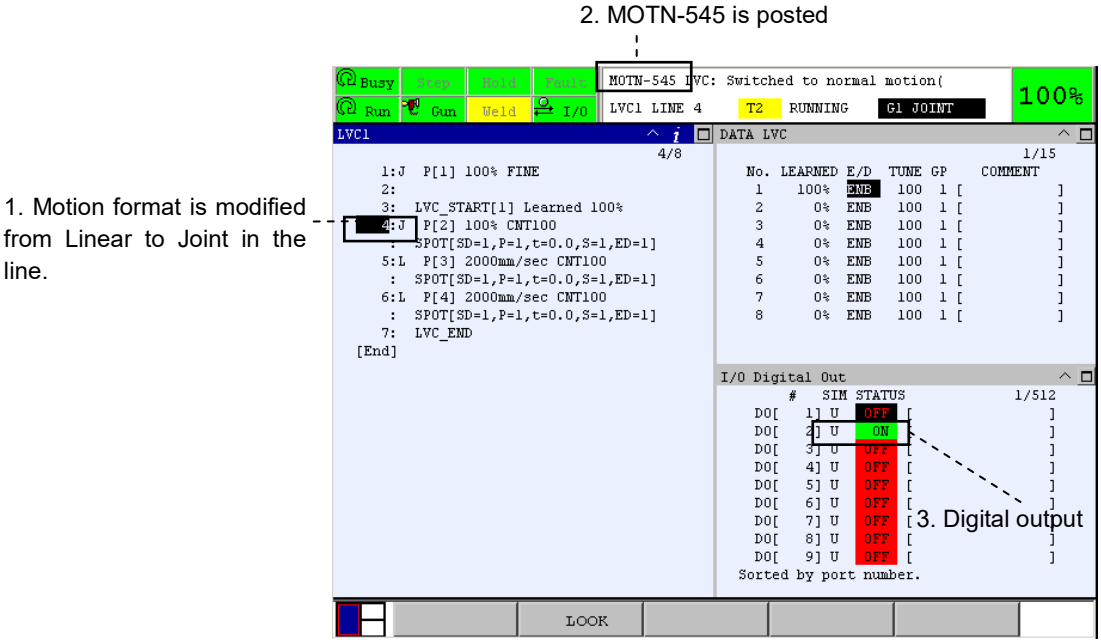


Fig. 4.6.2(a) An example of MOTN-545

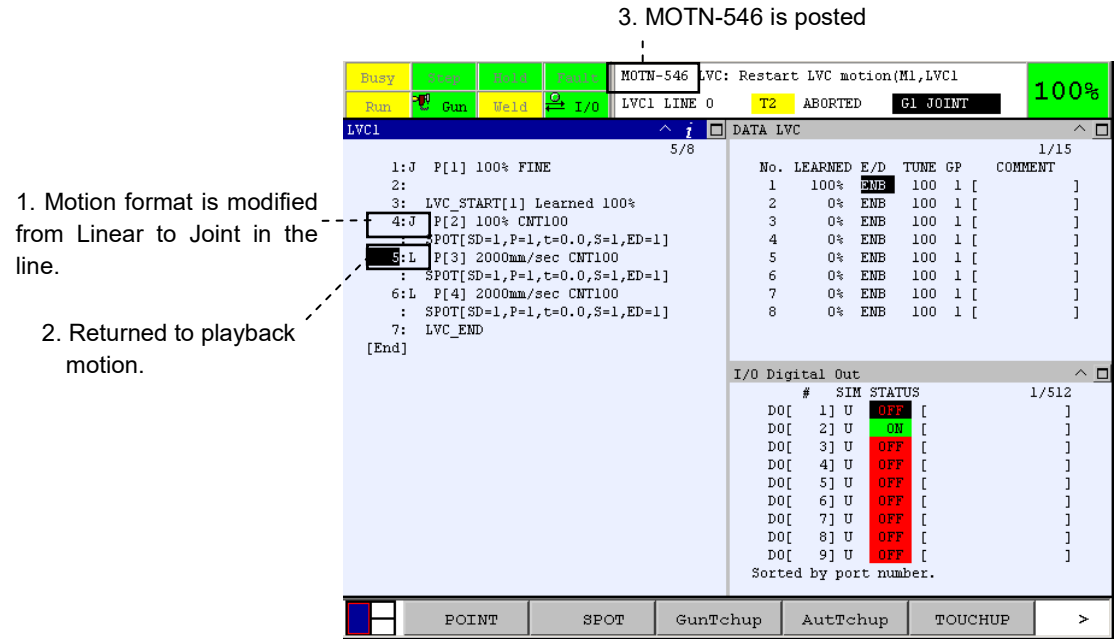


Fig. 4.6.2(b) An example of MOTN-546

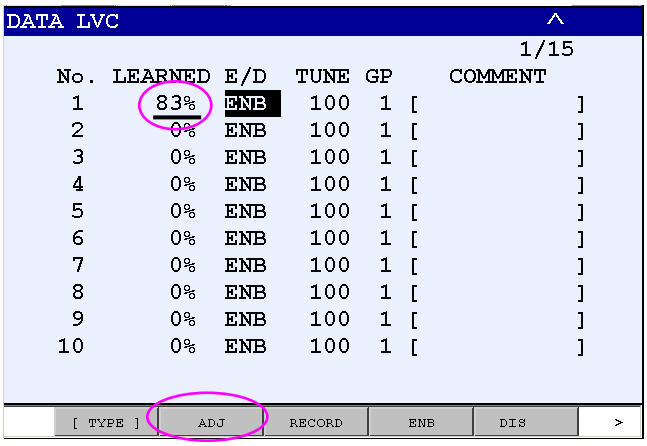
4.7 ADJUSTMENT

- LVC data is generated when LVC instruction is finished after executing TP programs with LVC instructions ten or so times.
- Normally, vibration from robot motion is reduced after learning is complete. However, sometimes the vibration cannot be suppressed enough because more iterations of learning are needed. Then, it is necessary to repeat LVC learning more to realize better performance.
- Pressing “ADJ” in the data menu can cause LVC to perform additional learning iterations, called “adjustment”. Pressing “ADJ” decreases the learning percentage.

NOTE
When “ADJ” key is pressed at the learning percentage of 100%, playback mode becomes learning mode since the learning percentage becomes less than 100%.

Procedure 4-8 Procedure for adjustment

1 Go to the LVC data menu.
2 Move the cursor to the LVC data.
3 Press F2, “ADJ”.
4 Press F4, “YES” to adjust, or press F5, “NO” to cancel.



Adjustment reduces the learning percentage. The figure on the left shows that one execution of adjustment reduces learning percentage from 100% to 83%.

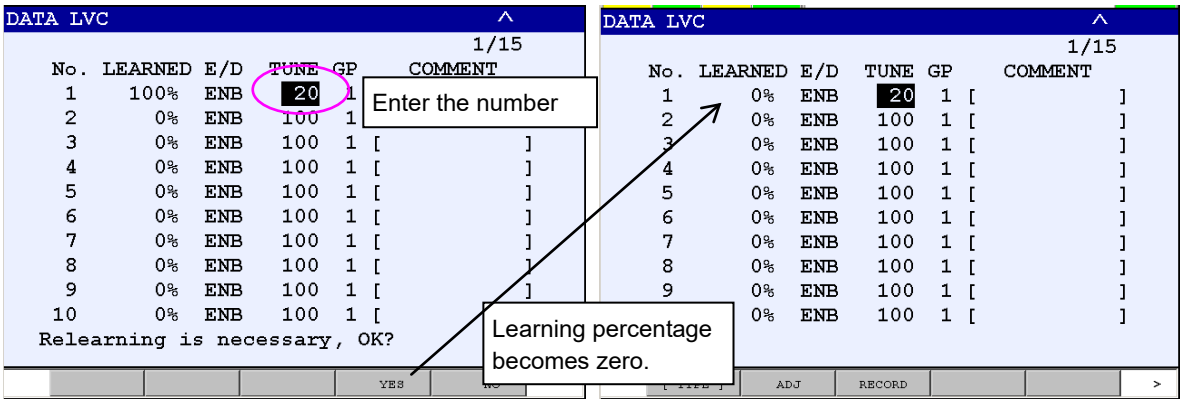
4.8 TUNE VALUE

- There is a possibility that the maximum speed of a robot is too high for some applications. The maximum speed (tune value) can be adjusted to eliminate these problems.
- The Tune value can be set from 0 to 100. 0 means that LVC does not speed up at all (the motion speed is the same as that of normal motion at 100% override). 100 means that speed up is fully applied.
- When the Tune value is 0, speed up is turned off but vibration suppression is applied.

NOTE
When the tune value is changed, the learning percentage becomes 0% and re-learning is necessary.

Procedure 4-9 Procedure for modifying tune value

1 Go to LVC data menu.
2 Move the cursor to the tune value of the LVC data.
3 Enter a new tune value.
4 “Re-learning is necessary, would that be ok?” pops up.
5 Press F4, “YES” to apply, or F5, “NO” to cancel.



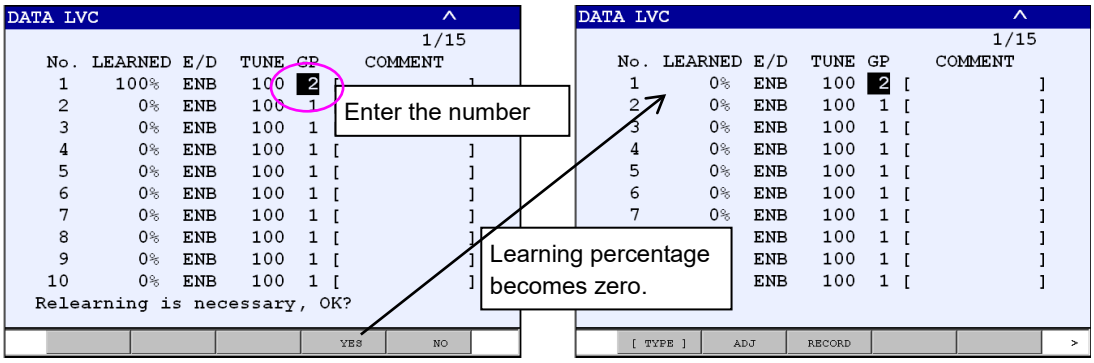
4.9 GROUP NUMBER

In multi-arm system, the group number of LVC data must be the same as the robot which is performing learning motion. If the group number of LVC data is wrong, MOTN-548 LVC: Group number mismatch is issued and the robot cannot start to learn.

NOTE
When the group number is changed, the learning percentage becomes 0% and re-learning is necessary.

Procedure 4-10 Procedure for modifying tune value

1 Go to LVC data menu.
2 Move the cursor to [GP] item of the LVC data.
3 Enter a new group number.
4 “Re-learning is necessary, would that be ok?” pops up.
5 Press F4, “YES” to apply, or F5, “NO” to cancel.

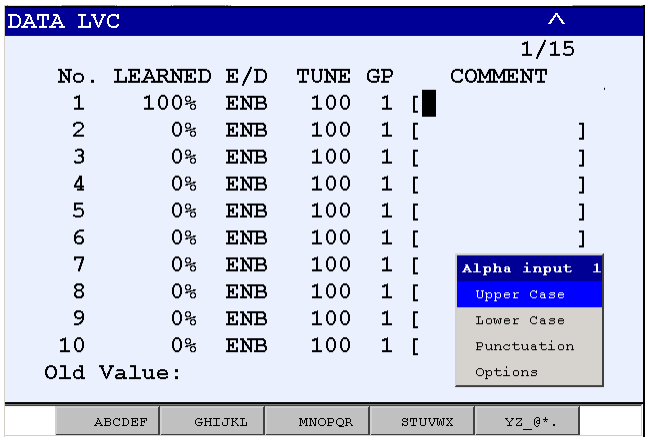


4.10 COMMENT FOR LVC DATA ID

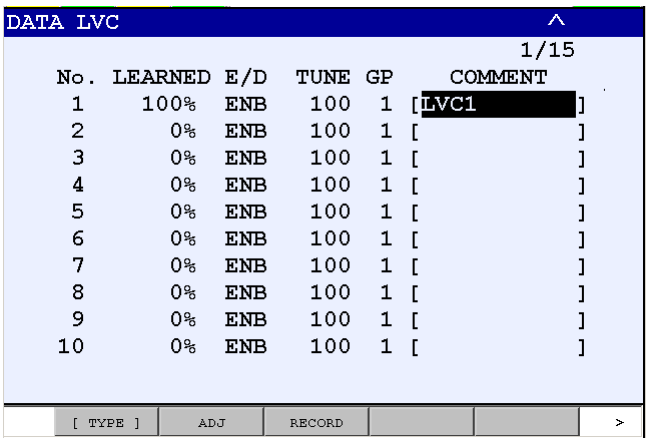
Comments can be added to LVC data ID in the LVC data menu.

Procedure 4-11 Procedure to change a comment

1 Go to the LVC data menu.
2 Move the cursor to the comment item in the LVC data.
3 Press the [ENTER] key.



4 Words or letters can be used for the comment.
5 After writing comments in the blank, press the [ENTER] key.



4.11 CASES WHERE LVC LEARNING AND PLAYBACK MOTION IS DISABLED

- LVC instructions are disabled in the following conditions. When LVC is disabled, robot motion becomes normal motion.
  - Less than override 100%LVC status is disabled in the setup menu. (Please refer to Section 3.1)
  - LVC data is disabled in the LVC data menu. (Please refer to Subsection 4.6.1)
  - T1 mode
  - Single step mode
  - Backward mode
  - Resumption of the robot motion after HOLD and ESTOP
  - Execution of a TP program from the line between LVC instructions
  - Power failure handling
- When override is changed during learning motion or playback motion, LVC motion switches to normal motion. Afterwards, robot motion in current iteration is normal motion even if override increases to 100%.
- When single step mode is enabled, the alarm MOTN-534 “LVC: Input SingleStep on LVC” is issued. Afterwards, robot motion becomes normal motion.
- When hold is enabled, the robot slows down and stops. Afterwards, robot motion becomes normal motion.
- When emergency stop occurs during learning motion or playback motion, the robot stops. Afterwards, robot motion becomes normal motion.
- If motion changes, alarm MOTN-545 “LVC: Switched to normal motion” is posted in the modified motion lines and switched normal motion. Afterwards, if playback motion can be restarted, robot motion becomes playback motion with alarm MOTN-546 “LVC: Restart LVC motion” posted.

4.12 TROUBLE SHOOTING

During learning, "SRVO-024 Move error excess" or "SRVO-050 Collision Detect alarm" may occur. Apply the following procedures.

1 Please lower tune value with the LVC data menu. (Please refer to Section 4.8)
2 Please add NORMAL_MOTION_START and NORMAL_MOTION_END instruction. (Please refer to Subsection 4.3.3 and 4.3.4)

5 LVC BACKUP

This chapter explains LVC backup.

5.1 GENERAL

- LVC data is stored in F-ROM after the learning process is completed. An "All files" backup or image backup can be performed to save the LVC data to an external memory device.
- In order to understand LVC data save and data restore, it is necessary to understand data flow among D-RAM, F-ROM, and external memory device, such as memory cards. The following figure shows the data flow.

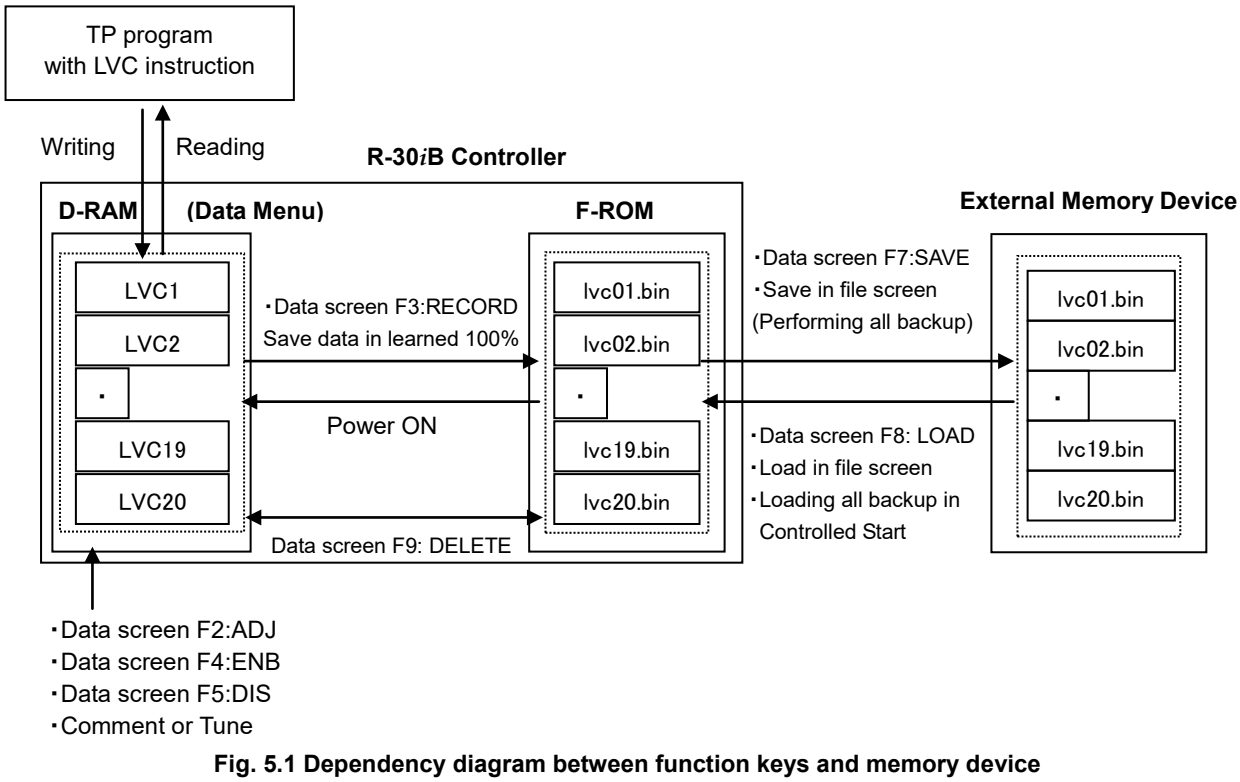


Fig. 5.1 Dependency diagram between function keys and memory device

5.2 ALL BACKUP

- In the file menu, when choosing "All files" backup, all LVC data (lvc**.bin) stored in F-ROM are saved in the designated external memory device.
- When restore is selected in the file menu at Controlled Start, the controller can read LVC data (lvc**.bin) to F-ROM.
- Loading individual LVC data files (lvc**.bin) can also be performed in the file menu after cold start.

5.3 IMAGE BACKUP

- An Image backup consists of image files of F-ROM and S-RAM.
- When LVC data are in F-ROM, the LVC data are stored in an image file by performing image backup.

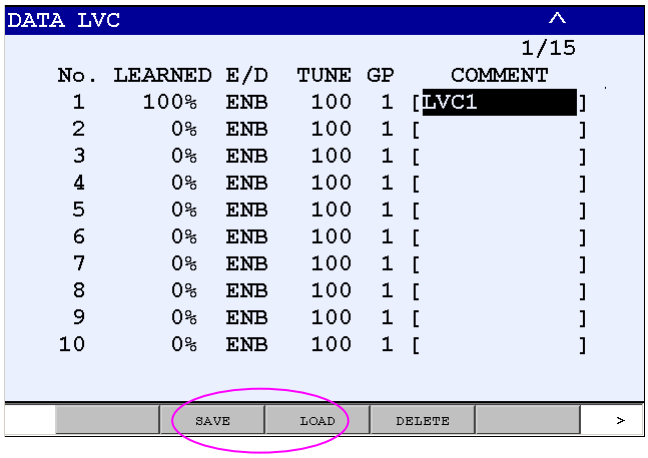
- When LVC data (lvc**.bin) are in the image file, the controllers can read the LVC data (lvc**.bin) to F-ROM.

5.4 SAVE AND LOAD IN DATA MENU

- LVC data files (lvc**.bin) in F-ROM are stored in the designated external memory device when all backup is selected in the file menu.
- LVC data files (lvc**.bin) in the external memory device are loaded into F-ROM when restore all is selected in the file menu after Controlled Start.
- LVC data files (lvc**.bin) in the external memory device can be loaded into F-ROM file in the file menu after Controlled Start.
- LVC data files (lvc**.bin) can be saved or loaded file by file between F-ROM and external device.

Procedure 5-1 Procedure for saving and loading LVC data

1 Display data menu (please refer to Ch. 4) and press [NEXT]. [SAVE] key appears in F2 and [LOAD] key appears in F3.

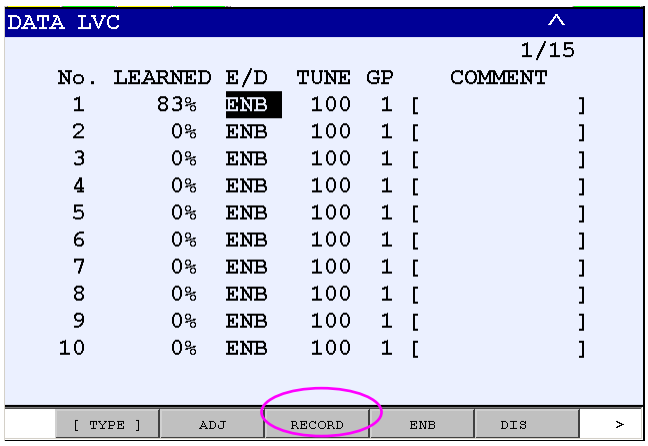


2 Move the cursor to the desired LVC data to be saved or loaded.
3 Press the F2[SAVE] key, LVC data (lvc**.bin) indicated by cursor is saved in the designated memory device selected in the file menu from F-ROM.
4 Press the F3[LOAD] key, LVC data (lvc**.bin) indicated by cursor is loaded into F-ROM from the designated memory device selected in the file menu.

NOTE
The Load operation copies LVC data into F-ROM from the designated external memory device. However, LVC data must be in D-RAM to be used for learned motion. Please cycle power to copy LVC data from F-ROM to D-RAM after the load operation.

5.5 RECORDING IN THE LVC DATA MENU

- Go to the LVC data screen (Please refer to Ch. 4) and press the [RECORD] key F3. The LVC data in D-RAM is saved as LVC data file (lvc**.bin) in F-ROM.
- Each LVC data ID can be saved separately.



NOTE

When learning is complete, the learning percentage becomes 100%, and LVC data in D-RAM is automatically saved in F-ROM when LVC_END is executed. Afterwards, when a backup is performed, the LVC data is saved in the external memory device.
However, the LVC data is not saved in F-ROM when LVC_END is executed during learning mode, so the LVC data is not saved in the external memory device when backup is performed. If it is necessary to save the LVC data during learning mode, press the [RECORD] key to save LVC data in F-ROM and perform backup.

APPENDIX

A ALARM CODES

This chapter contains warnings and alarms that may occur while using LVC.

ATTENTION
When an alarm occurs, saving Diagnostic log is recommended. It is useful for investigating some abnormal status or issues. Please send the saved Diagnostic log to FANUC. More information about saving Diagnostic log, please refer to OPERATOR'S MANUAL (Basic Operation) (B-83284EN) Appendix D.

MOTN-165 L%d %s Not support %s
Cause:
There is a conflict with option used.
Remedy:
Remove conflict options from motion line.

MOTN-524 LVC: Full memory (M%d, %s, L%d, S%x)
Cause:
The LVC data area on D-RAM is full, due to too much recorded motion data. M is the learning data ID. Second argument represents a program name that runs when MOTN-524 occurred and L represents line number of the program when MOTN-524 occurred. S represents type of LVC data area.
Remedy:
Memory for LVC data area is limited as follows:
- Standard motion lines are limited to about 600 lines. (Note: one spot-additional-instruction motion line is equivalent to 4 standard motion lines.)
- Total program execution time of LVC learning must be within 45 seconds.

Apply following procedure after knowing above causes:
Reduce the number of motion lines or logic instructions within LVC region.
Split the LVC region into two or more LVC regions, using multiple LVC data indices.

MOTN-525 LVC: Out of DRAM memory (M%d, Id%d)
Cause:
LVC failed to acquire D-RAM data area. M is the data ID, and Id represents error type.
(Id=1) Failed to acquire D-RAM for calculation data area.
(Id=2) Failed to acquire D-RAM for data translation when LVC_START executed.
(Id=3) Failed to acquire D-RAM data area for writing to F-ROM.
(Id=4) Failed to acquire D-RAM data area for reading from F-ROM.
Remedy:
1. Make sure system has 64MB (or more) D-RAM installed. LVC requires 64MB (or more) D-RAM.
2. If MOTN-525 occurs after 64MB (or more) D-RAM is installed, it is possible that other options use too much memory. It may be required to remove other options or reduce option memory configuration to use LVC.

MOTN-527 LVC: Failure of getting memory1
Cause:
LVC failed to acquire D-RAM for before-learning data area.
Remedy:
1. Make sure system has 64MB (or more) DRAM installed. LVC requires 64MB (or more) D-RAM.
2. If MOTN-527 occurs after 64MB (or more) D-RAM is installed, it is possible that other options use too much memory. It may be required to remove other options or reduce option memory configuration to use LVC.

MOTN-528 LVC: Failure of getting memory2
Cause:
LVC failed to acquire D-RAM for after-learning data area.
Remedy:
1. Make sure system has 64MB (or more) D-RAM installed. LVC requires 64MB (or more) D-RAM.
2. If MOTN-528 occurs after 64MB (or more) D-RAM is installed, it is possible that other options use too much memory. It may be required to remove other options or reduce option memory configuration to use LVC.

MOTN-529 LVC: This isn't allowed (L%d, Id%d)
Cause:
The taught line contains a motion instruction that is incompatible with LVC. L is line number, and ID represents instruction ID that conflicts with LVC instruction. Refer to ID meaning in the below table.

ID	Instruction
1	External path optimization
2	KAREL
3	Weaving
4	Line Tracking
5	Touch Sensor
6	Coordinated Motion
7	Continuous Turn
9	Skip instruction are taught after the motion except FINE or CNT0
10	LVC or APC instruction is taught doubly
11	Soft Float Function
12	Tracking related function
13	Skip instruction

Remedy:
Remove either LVC instruction or other instruction that is incompatible with LVC.

MOTN-531 LVC: Learning %d% (M%d)
Cause:
The LVC learning percentage. The first argument is the learning percentage. M is the data ID number of the learning data.
Remedy:
Informational message, no action required.

MOTN-532 LVC: Internal error 2(M%d, Id%d)
Cause:
Internal error in LVC calculation. M is the data ID number of the learning data, Id(=2-8) represents error type.
(Id=2) The travel time of LVC “Block” (CNT0/FINE to CNT0/FINE) exceeded 15 sec.
(Id=3-8) Others
Remedy:
(Id=2) Reduce the number of motion lines or logic instructions within the LVC “Block”.
(Id=3-8) Contact your local FANUC representative.

MOTN-534 LVC: Input SingleStep on LVC
Cause:
STEP mode was entered during LVC execution. LVC does not work with single step.
Remedy:
Reset to clear alarm, and resume program. After resuming, normal motion takes place without LVC function.

MOTN-537 LVC: Changed motion (M%d, %s, L%d, P%d)
Cause:

A motion line in the LVC region was modified by re-teaching. M is learning data ID, %s is program name, L is line number, P represents cause of Motion changed. Refer to P number at the table below.

P value	Cause	P value	Cause
1	motion type	65536	MAXSPEED instruction
2	start position	131072	RT_LD value or AP_LD value
4	destination position	262144	CR value
8	via position(circle motion only)	524288	RTCP instruction
16	taught speed	1048576	Simultaneous EV instruction
32	termination type	2097152	Independent EV instruction
64	CNT value	4194304	move time
128	tool frame	8388608	move time of aux axis
256	user frame	16777216	filter length
512	override	33554432	filter type
1024	payload	67108864	$MRR_GRP[g].$PRGOVERRIDE
2048	ACC value	134217728	group number
4096	PATH instruction	268435456	Break
8192	WJNT instruction	536870912	NORMAL_MOTION instruction
16384	INC instruction	1073741824	extended axis motion
32768	PSPD value		

Remedy:
1. Undo the changes that were reported as cause.
2. Start LVC learning again.

MOTN-538 LVC: Changed motion (M%d, %s, L%d, P%d)
Cause:
Touch up was done in the motion lines between LVC instructions. M is learning data ID, %s is program name, L is line number, P represents cause of motion changed. See the following table for the more detailed information of P number.

P	Instruction
1	Path changed
2	WAIT condition changed
4	Occurrence time of “SRVO-171 MotorSpd lim/DVC” alarm between LVC instructions changed

Remedy:
1. Undo the changes that were reported as cause.
2. Remove the learning data and re-learn again.
3. (P4) Touch up program to remove DVC alarm.

MOTN-539 LVC: Changed motion (M%d, %s, P%d)
Cause:
Touch up was done in a motion line between LVC instructions. M is learning data ID, %s is program name, P represents cause of motion changed. See the following table for the more detailed information of P number.

P	Instruction
1	Motion-line which is before LVC_END deleted
2	WAIT condition changed

Remedy:
1. Undo the changes that were reported as cause.
2. Remove the learning data and re-learn again.

MOTN-540 LVC: Internal error 1

Cause:
Internal error in LVC function.
Remedy:
Contact your local FANUC representative.

MOTN-541 LVC: Fatal error of memory (M%d, S%x)
Cause:
Internal error in LVC function. M is learning data ID, S is section of LVC data area.
Remedy:
Contact your local FANUC representative.

MOTN-542 LVC: Full memory (M%d, S%x)
Cause:
The LVC data area on D-RAM is full, due to too much recorded motion data. M is the learning data ID. S represents type of LVC data area.
Remedy:
Memory for LVC data area is limited as follows:
- Standard motion lines are limited to about 600 lines. (Note: one spot-additional-instruction motion line is equivalent to 4 standard motion lines.)
- Total program execution time of LVC learning must be within 45 seconds.

Apply following procedure after knowing above causes:
Reduce the number of motion lines or logic instructions within LVC region.
Split the LVC region into two or more LVC regions, using multiple LVC data indices.

MOTN-543 LVC: No learned data (M%d, S%x)
Cause:
No LVC data found while trying to load LVC data from storage. LVC learning process may not be done correctly. M is LVC data ID. S represents type of LVC data area.
Remedy:
1. Re-do LVC learning.
2. If the problem could not be resolved, contact your local FANUC representative.

MOTN-544 LVC: Learned data empty (M%d, S%x)
Cause:
No LVC data found while trying to load LVC data from storage. LVC process may not be done correctly, or motion line may be inserted just before LVC_END line while LVC learning percentage larger than 0%. M represents data ID number of learning data. S represents kinds of LVC data area.
Remedy:
1. If you are in the middle of the learning process, un-do any program changes to return program to the original state
2. Re-do LVC learning.
3. If the problem could not be resolved, contact your local FANUC representative.

MOTN-545 LVC: Switched to normal motion (M%d, %s, L%d)
Cause:
LVC motion switched to normal motion because learned motion was changed.
M represents data ID number of learning data. The second argument represents the program name. L is line number.
Remedy:
Informational message, no action required.

MOTN-546 LVC: Restart learned motion (M%d, %s, L%d)
Cause:
LVC motion restarted.

M represents data ID number of learning data. The second argument represents the program name. L is line number.
Remedy:
Informational message, no action required.

MOTN-547 LVC: Sync motion not supported (M%d,L%d)
Cause:
LVC cannot support synchronous motion in case that a program has two or more robot groups.
M represents data ID number of learning data. L is line number.
Remedy:
In playback mode, please use the "RUN" instruction in TP program to make two or more robots to perform learning motion in the same time.

MOTN-548 LVC: Group number mismatch (M%d,G%d,L%d)
Cause:
Group number of the robot which is in learning is not match the setup in LVC DATA setup screen.
M represents data ID number of learning data. G is group number. L is line number.
Remedy:
Please set the correct group number in LVC DATA screen.

MOTN-549 LVC: Multi data in learning (M%d,L%d)
Cause:
Only one robot group can be in learning mode at the same time.
M represents data ID number of learning data. L is line number.
Remedy:
Please perform and finish learning one after another. If multitasking motion is necessary, you can comment out other LVC instructions or disable other the LVC data in LVC DATA screen.

MOTN-550 LVC: Switched to normal motion (M%d,%s,L%d)
Cause:
LVC motion switched to normal motion. M represents data ID number of learning data. The second argument represents the program name. L is line number.
Remedy:
Informational message, no action required.

MOTN-553 LVC: Communication ready
Cause:
Communication between wireless sensor and USB receiver is ready.
Remedy:
Informational message, no action required.

MOTN-554 LVC: Wireless data not enough
Cause:
The wireless sensor data is not recorded enough for LVC during the learning.
Remedy:
Re-learn again. If the problem could not be resolved, contact your local FANUC representative.

MOTN-555 LVC: Sensor battery error
Cause:
LVC can't be executed because the wireless sensor battery is almost empty.
Remedy:
Charge the sensor battery.

MOTN-556 LVC: Wireless sensor timeout
Cause:

The wireless sensor has been failed to connect.
Remedy:
1. Push LED at the left to turn off the wireless sensor, then start sensor again.
2. Restart the robot

MOTN-557 LVC: USB receiver removed
Cause:
The USB receiver has not been connected to the iPendant.
Remedy:
Disconnect/connect the USB receiver. The USB receiver is not available with tablet TP. Please connect *i*Pendant in using wireless accelerometer.

MOTN-558 LVC: Sensor battery is low
Cause:
The battery of wireless sensor is weakening.
Remedy:
Charge the battery of wireless sensor.

MOTN-559 LVC: Serial port timeout err
Cause:
The configuration of serial port is incorrect.
Remedy:
Verify the configuration of serial port.

MOTN-581 LVC: Internal calc err (Er:%d)
Cause:
Sensor frame automatic setting function failed to calculate the sensor frame.
Remedy:
Apply the following procedure.
1. Make sure sensor type (wired or wireless) is selected correctly and retry sensor frame automatic setting function.
2. Make sure whether the accelerometer is fixed firmly to an end-of-arm tool or servo gun, and retry sensor frame automatic setting function.
3. Set the sensor frame by six point method.

MOTN-582 LVC: Set payload set
Cause:
Sensor frame automatic setting function was executed with incorrect payload setting.
Remedy:
Apply the following procedure and retry the sensor frame automatic setting function.
1. Display “Motion Performance” screen by pressing [MENU] key-“0 NEXT”-“6 SYSTEM”-F1[TYPE]-“Motion”. Then press F5,[SETIND] and set active payload number to other than 0.
2. Display “Motion Performance” screen by pressing [MENU] key-“0 NEXT”-“6 SYSTEM”-F1,[TYPE]-“Motion”. Then move the cursor to the active payload number and press F3,”DETAIL”. Enter the correct value of weight, gravity center position of the load, and inertia about its gravity center.

MOTN-583 LVC: Large calc err (Er:%d)
Cause:
In sensor frame automatic setting function, the accuracy of the calculated sensor frame is not sufficient.
Remedy:
Apply the following procedure and retry sensor frame automatic setting function. If the problem cannot be resolved, set the sensor frame by six point method.
1. Verify whether the accelerometer is fixed firmly to an end-of-arm tool or servo gun.

2. Display “Motion Performance” screen by pressing [MENU] key-“0 NEXT”-“6 SYSTEM”-F1[TYPE]-“Motion”.
3. Verify the active payload number. Display “Motion Performance” screen by pressing [MENU] key-“0 NEXT”-“6 SYSTEM”-F1,[TYPE]-“Motion”. Then move the cursor to the active payload number and press F3,”DETAIL”. Verify the value of weight, gravity center position of the load, and inertia about its gravity center.
4. Set the base position for sensor frame automatic setting function as close to the recommended posture as possible.

MOTN-584 LVC: Changed override
Cause:
The execution was interrupted because the override has been changed during the fast movements of sensor frame automatic setting function.
Remedy:
Retry sensor frame automatic setting function. Please do not change the override during the fast movements.

MOTN-585 LVC: Set calibration data
Cause:
Calibration data for wireless accelerometer is wrong.
Remedy:
Contact your local FANUC representative.

MOTN-586 LVC: Need Learning %d more time(s)
Cause:
Required learning iterations are insufficient to do this operation.
Remedy:
Execute more learning instruction.

MOTN-587 LVC: Reboot controller
Cause:
The connect setting with the wireless sensor is not right.
Remedy:
Restart the robot.

SRVO-098 ACC sensor DTERR alarm
Cause:
The acceleration sensor has not been connected. Otherwise, an error occurred during communication between the acceleration sensor and the main board.
Remedy:
1. Check connection of the connector of the connecting cable.
2. Replace the above cable.
3. Replace the acceleration sensor.

SRVO-099 ACC sensor CRCERR alarm
Cause:
Data changed during transfer from the acceleration sensor.
Remedy:
Refer to the SRVO-098 Remedy.

SRVO-100 ACC sensor STBERR alarm
Cause:
A stop bit error of the data from the acceleration sensor occurred.
Remedy:
Refer to the SRVO-098 Remedy.

SRVO-108 ACC sensor livecode error
Cause:
An error occurred in communication of the force sensor.
Remedy:
Refer to the SRVO-098 Remedy.

SRVO-109 ACC sensor ID mismatch %d
Cause:
The possible cause may be determined as follows by the shown conflict ID number:
Conflict ID number 1: No pulse module unit.
Conflict ID number 2: A sensor other than accelerometer is detected.
Remedy:
1. Secure connection between controller and ACC sensor.
2. Connect accelerometer sensor.

SRVO-110 ACC sensor disabled %d (G%d, A%d)
Cause:
The possible cause may be determined as follows by the shown error number:
1. Invalid number assigned for port number of tracking board.
2. Accelerometer sensor port number is disabled.
3. Assigned port number of Accelerometer conflicted with another purpose, such as line tracking or secondary encoders.
4. Setting of Accelerometer is incorrect.

Remedy:
Contact your local FANUC representative.

SRVO-470 Wireless sensor data error
Cause:
Wireless data sequence number is wrong.
Remedy:
Contact your local FANUC representative.

INTP-680 LVC: GP No. in acc_frm mismatch
Cause:
Group number set in sensor frame is different from robot group which is in learning.
Remedy:
Please choose the correct sensor frame number whose group number is the same as learning group.

INTP-683 LVC: LVC_START in block
Cause:
A LVC_START instruction is started while another LVC_START or APC_START instruction is executed.
Remedy:
Delete one of LVC_START or APC_START instructions.

INTP-687 LVC: NORMAL_MOTION_END is missing
Cause:
NORMAL_MOTION_END is missing between NORMAL_MOTION_START and LVC_END instruction.
Remedy:
Add NORMAL_MOTION_END instruction.

INTP-688 LVC: duplicated NORMAL_MOTION_START
Cause:
NORMAL_MOTION_START is duplicated.

Remedy:
Delete one of NORMAL_MOTION_START instructions.

INTP-689 LVC: Invalid SENSOR Frame
Cause:
The setup of ACC SENSOR Frame is not correct. SENSOR frame number is 0 or all the values of X, Y, and Z are 0 in the configured SENSOR frame.
Remedy:
Please check ACC SENSOR Frame setup.

INTP-697 LVC: Wireless Sensor CONFMOD
Cause:
LVC_START cannot be executed while Wireless Confirm Mode is TRUE.
Remedy:
Please change Wireless Confirm Mode to FALSE then re-do LVC learning.

INTP-698 LVC: Numerous wireless data lost
Cause:
Data lost due to unstable wireless communication,
Remedy:
1. Put a sensor and a USB receiver as close as possible to each other.
2. Set a sensor and a USB receiver with good visibility (such as a USB receiver can be seen from a sensor).
3. Avoid setting sensor and USB receiver in the environment as follows.
   - Put a sensor in the center of metallic part or enclosed by metal
   - Put the *i*Pendant with USB receiver on a metal such as a controller, or hang on the hook on the controller.
   - Put a metal obstacle such as a fence between communication path sensor and a USB receiver.
4. Avoid using Wi-Fi communication in 2.4GHz band (especially a large amount of data communication such as watching movie) and microwave near a sensor and a USB receiver.

INTP-699 LVC: Cannot learn in this environment
Cause:
Data lost three times in a row due to unstable wireless communication,
Remedy:
1. Put a sensor and a USB receiver as close as possible to each other.
2. Set a sensor and a USB receiver with good visibility (such as a USB receiver can be seen from a sensor).
3. Avoid setting sensor and USB receiver in the environment as follows.
   - Put a sensor in the center of metallic part or enclosed by metal
   - Put the *i*Pendant with USB receiver on a metal such as a controller, or hang on the hook on the controller.
   - Put a metal obstacle such as a fence between communication path sensor and a USB receiver.
4. Avoid using Wi-Fi communication in 2.4GHz band (especially a large amount of data communication such as watching movie) and microwave near a sensor and a USB receiver.

TPIF-256 USB receiver is not supported in this TP.
Cause:
The firmware for the ***i***Pendant does not support wireless accelerometer for LVC.
Remedy:
Updating the firmware is necessary. If F-ROM size is 64MB or more, update by the following procedure. If F-ROM size is less than 64MB, Contact your local FANUC representative.
1. For safety, make sure that the E-stop button is pressed down, then power off the controller.
2. Confirm that MC card and USB memory are NOT inserted to the controller.
3. Power on the controller with pressing PREV and NEXT.

4. After displaying CONFIGURATION MENU, select [3.Controlled start] to perform Controlled Start.
5. After displaying Controlled Start Menu, press FCTN and select [1 START (COLD)] to perform Cold Start.
6. Updating the firmware starts. Updating the firmware takes several minutes. Never power off while updating.

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REVISION RECORD

Edition	Date	Contents
07	Apr., 2021	• 4.12 TROUBLE SHOOTING has been added. • Specification has been modified in some functions. • Some errors in writing have been corrected.
06	Mar., 2020	• Specification has been modified in some functions. • Some errors in writing have been corrected.
05	Dec., 2018	• Specification has been modified in some functions.
04	Mar., 2017	• Addition of R-30*i*B Plus Controller. • 2.1.2 Wireless accelerometer has been added. • Specification has been modified in some functions. • Some errors in writing have been corrected.
03	Feb., 2016	• 3.6.1 Sensor Frame Automatic Setting Function has been added. • Specification has been modified in some functions. • Some errors in writing have been corrected.
02	Nov., 2013	• 4.9 GROUP NUMBER has been added. • Specification has been modified in some functions. • Some errors in writing have been corrected.
01	Feb., 2013	

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