FANUC Robot series

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

Sensor Mechanical Unit/Control Unit

OPERATOR'S MANUAL

B-83984EN/04

- **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.

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 the “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. Work 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.

PREFACE

1 OVERVIEW

This manual describes the maintenance and connections for the following sensors:

Mechanical section	Ordering information
Force Sensor FS-15*i*A (Rated 15kgf)	A05B-1407-B002
Force Sensor FS-40*i*A (Rated 40kgf)	A05B-1407-B101
Force Sensor FS-100*i*A (Rated 100kgf)	A05B-1407-B201
Force Sensor FS-250*i*A (Rated 255kgf)	A05B-1407-B301
3-axis force sensor FS-15***i***Ae (Rated 15kgf)	A05B-1421-B001
Grayscale camera	A05B-1426-K001
Color camera	A05B-1426-K002
Camera package (grayscale)	A05B-1426-B102
Camera package (color)	A05B-1426-B112
Camera package (with red LED)	A05B-1426-B103
Camera package (with grayscale white LED)	A05B-1426-B104
Camera package (color with white LED)	A05B-1426-B114
3D Laser Vision Sensor	A05B-1405-B133
3D Area Sensor	A05B-1422-B103
3D Vision Sensor 3DV/70	A05B-1426- K152
3D Vision Sensor 3DV/200	A05B-1426- K142
3D Vision Sensor 3DV/400 (without LED light)	A05B-1426- K101
3D Vision Sensor 3DV/400 (with LED light)	A05B-1426- K102
3D Vision Sensor 3DV/600	A05B-1426- K122
3D Vision Sensor 3DV/1600	A05B-1426-K132

Refer to the manual of the mechanical unit for each robot model.

2 SAFETY INSTRUCTIONS FOR 3D LASER VISION SENSOR

3D Laser Vision Sensor systems detect the position orientation of an object using a semiconductor laser.

> Safety guidelines and measures conforming to national and regional safety standards and regulations should be established and exercised to ensure the safety of personnel using the sensor system. Ensure that changes in related safety standards and regulations are incorporated into the established guidelines and measures.

The class is using this sensor.

Semiconductor laser → Class 3R laser (IEC Pub. 60825-1/JIS C 6802)
Class IIIa laser (FDA Pub. 1040.10)

2.1 LASER LIGHT

The semiconductor laser emits visible light with a wavelength of 0.65 μm. Although the maximum output of the laser is 4.5 mWx2, care is nevertheless necessary when handling the laser sensor. Never look directly at the laser light. Avoid looking at diffused laser light for extended periods.

2.2 EMISSION PATH

Laser light is generated by the semiconductor element of the laser module. It is emitted from the front of the sensor.

2.3 MAINTENANCE AND CONNECTION

Turning off the 3D Laser Vision Sensor
Semiconductor laser light, either direct or diffused, is hazardous. Over exposure to laser light can cause serious eye damage.
When performing maintenance or connection work, turn off the laser output, double-checking that it has been turned off before entering the robot operation area.

1 Turn off the robot controller power if you are not operating the robot.
2 To view programs and data from the teach pendant, press the EMERGENCY STOP button or turn off the ENBL signal for peripheral equipment control interface A. This disables the robot.

2.4 WARNING LABELS

Warning labels are affixed to all sections of the 3D Laser Vision Sensor system where laser light radiation can be expected. Warning labels conforming to U.S. FDA, standards are available as options.

Fig. 2.4 (a) shows the locations where warning labels are affixed. Fig. 2.4 (b) and (c) show the warning labels affixed to the laser sensor.

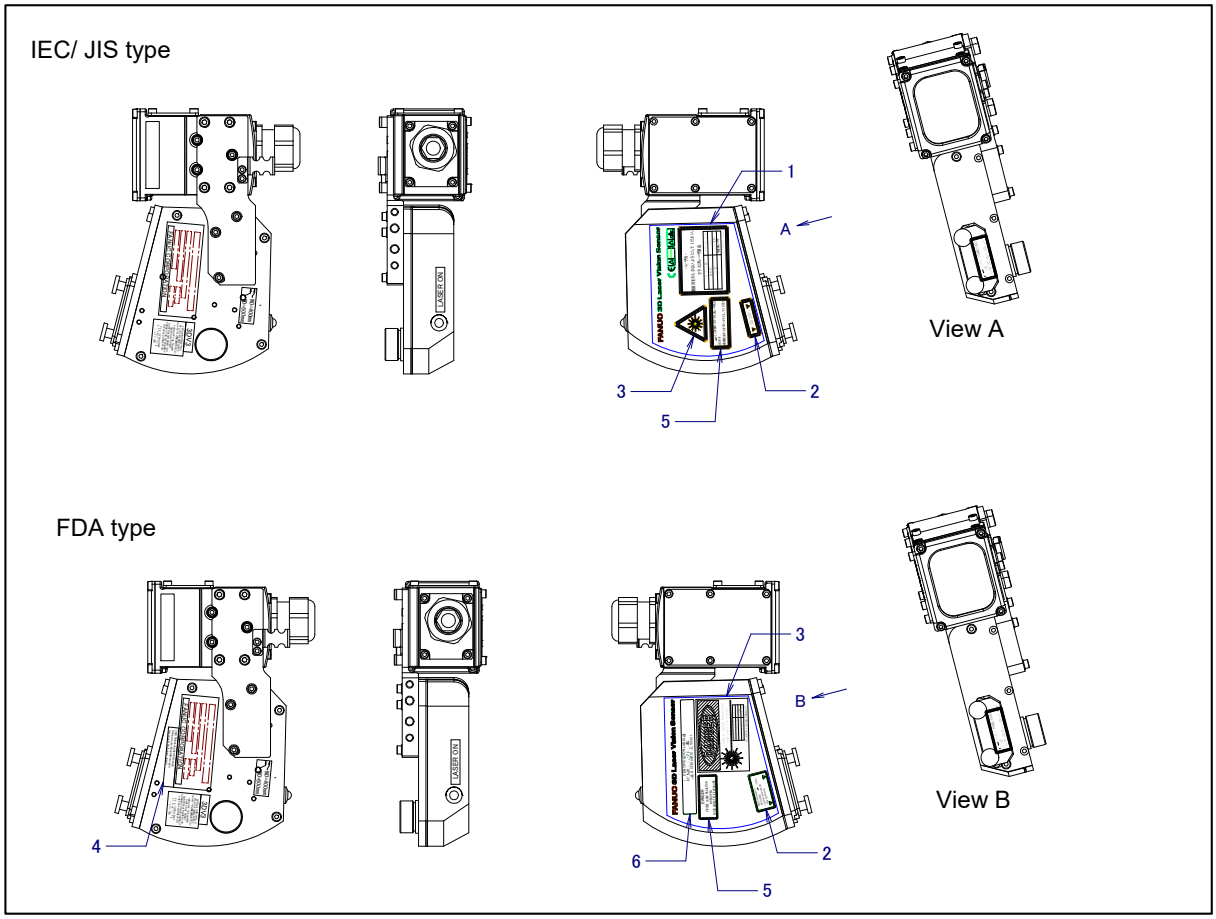
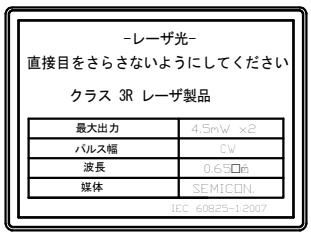
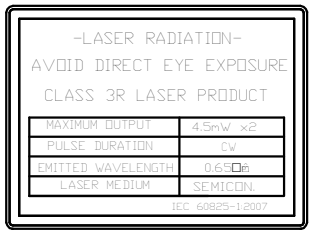


Fig. 2.4 (a) Locations of warning labels (IEC, JIS, and FDA) (standard)

1 Explanatory label

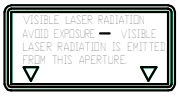


JIS (general type)



IEC (general type)

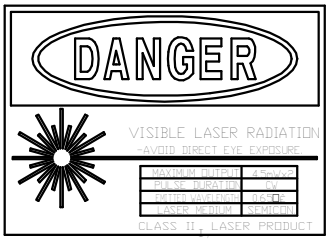
2 Aperture label



JIS (general type) IEC (general type) FDA (general type)

3 Warning label

IEC/JIS



FDA

Fig. 2.4 (b) Warning label (1)

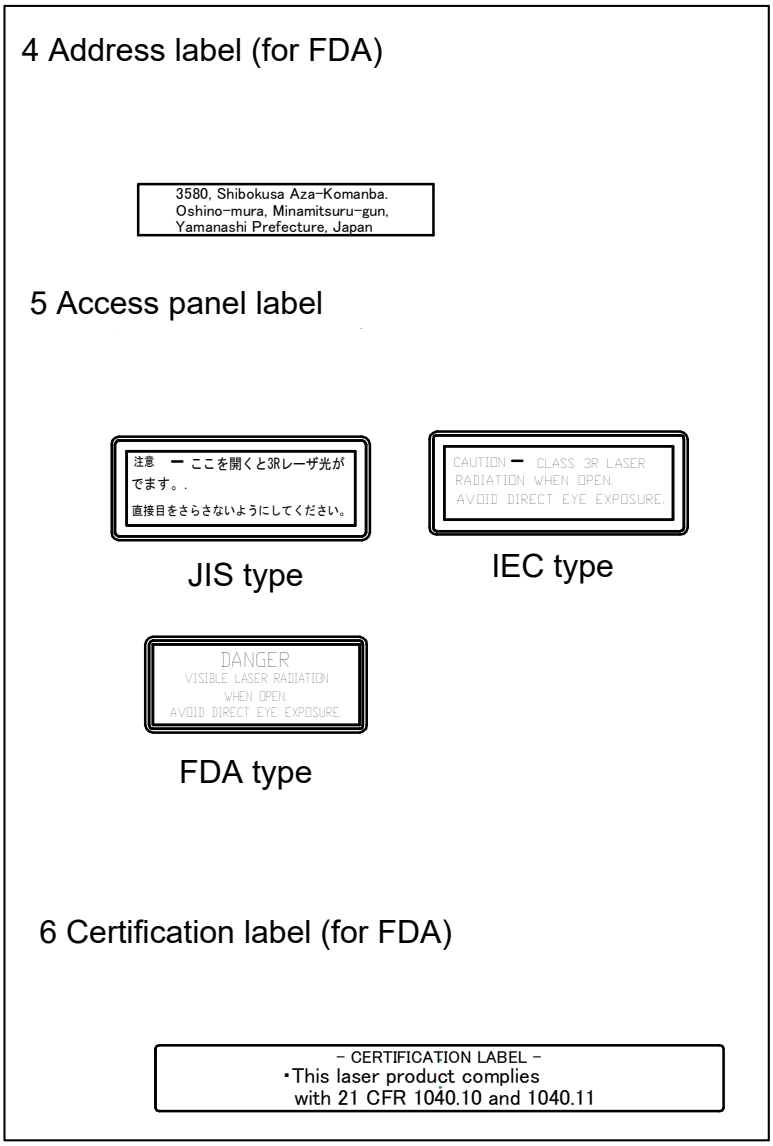


Fig. 2.4 (c) Warning label (2)

2.5 BEAM STOPS

The 3D Laser Vision Sensor has two beam stops to protect operator's eyes from laser beams.

Beam stop 1

When the target application requires no 3D Laser Vision Sensor, attach beam stop 1 to the opening of the 3D Laser Vision Sensor.
Before using the 3D Laser Vision Sensor, detach beam stop 1.

Beam stop 2

Beam stop 2 is a projector cover.
Do not detach beam stop 2 from the base plate of the 3D Laser Vision Sensor.

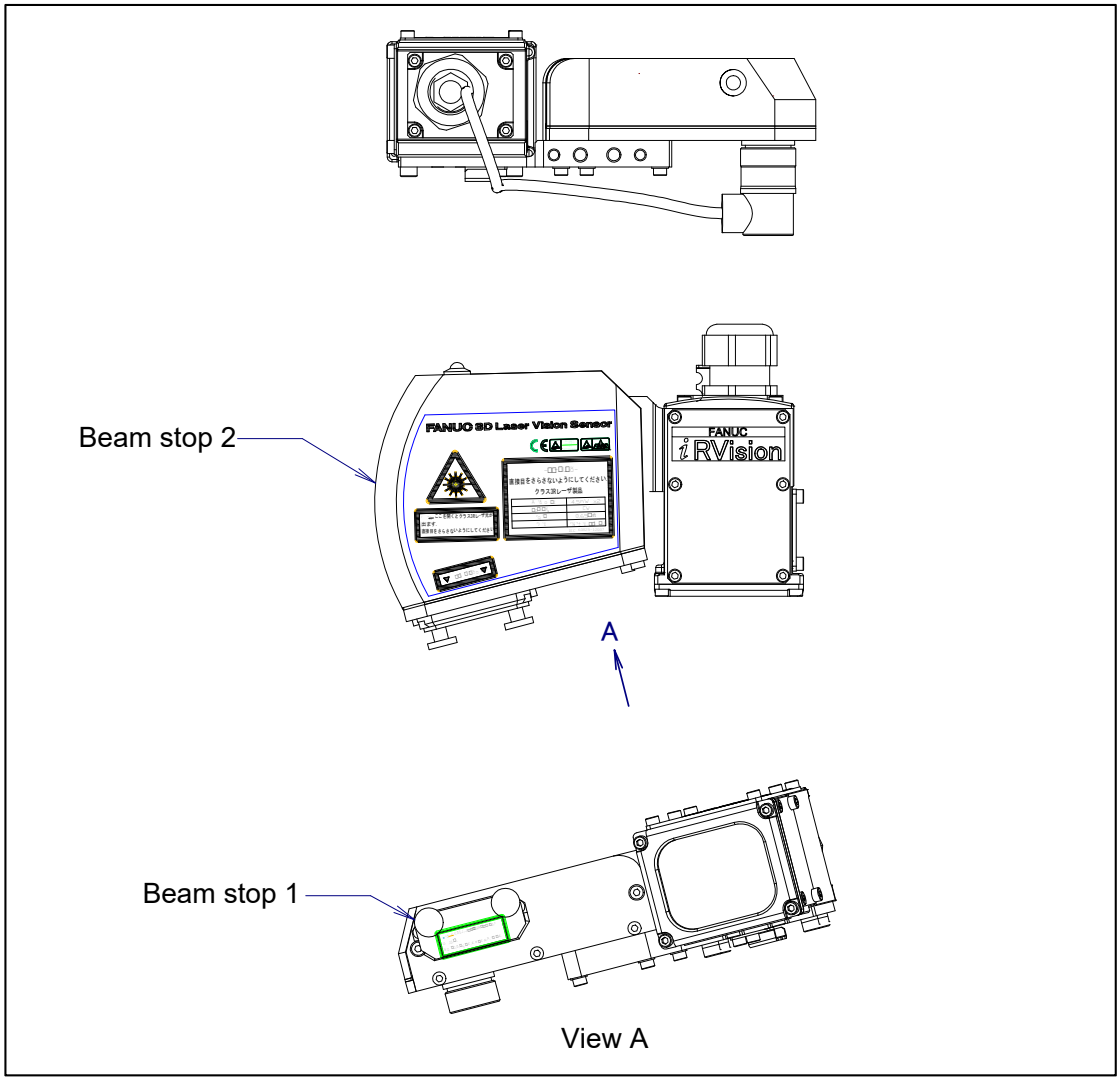


Fig. 2.5 (a) Beam stop (Standard)

3 SAFETY INSTRUCTIONS FOR 3D VISION SENSOR 3DV/70, 3DV/200, 3DV/400, 3DV/600 AND 3DV/1600

3D Vision Sensor 3DV/70, 3DV/200, 3DV/400, 3DV/600 and 3DV/1600 detect the position orientation of an object using a projection with LED light source.

Classification of Beam of a LED light source used at this sensor
Risk Group 2 (complied with IEC 62471-2)

3.1 ILLUMINATED LED LIGHT

Do not stare at operation lamp. May be harmful to the eyes.

3.2 LABEL

Label below is affixed on the projector of the 3D Vision Sensor. Fig.3.2 (a), Fig.3.2 (b) and Fig.3.2 (c) show locating of labels. Fig. 3.2 (d) shows affixed labels.

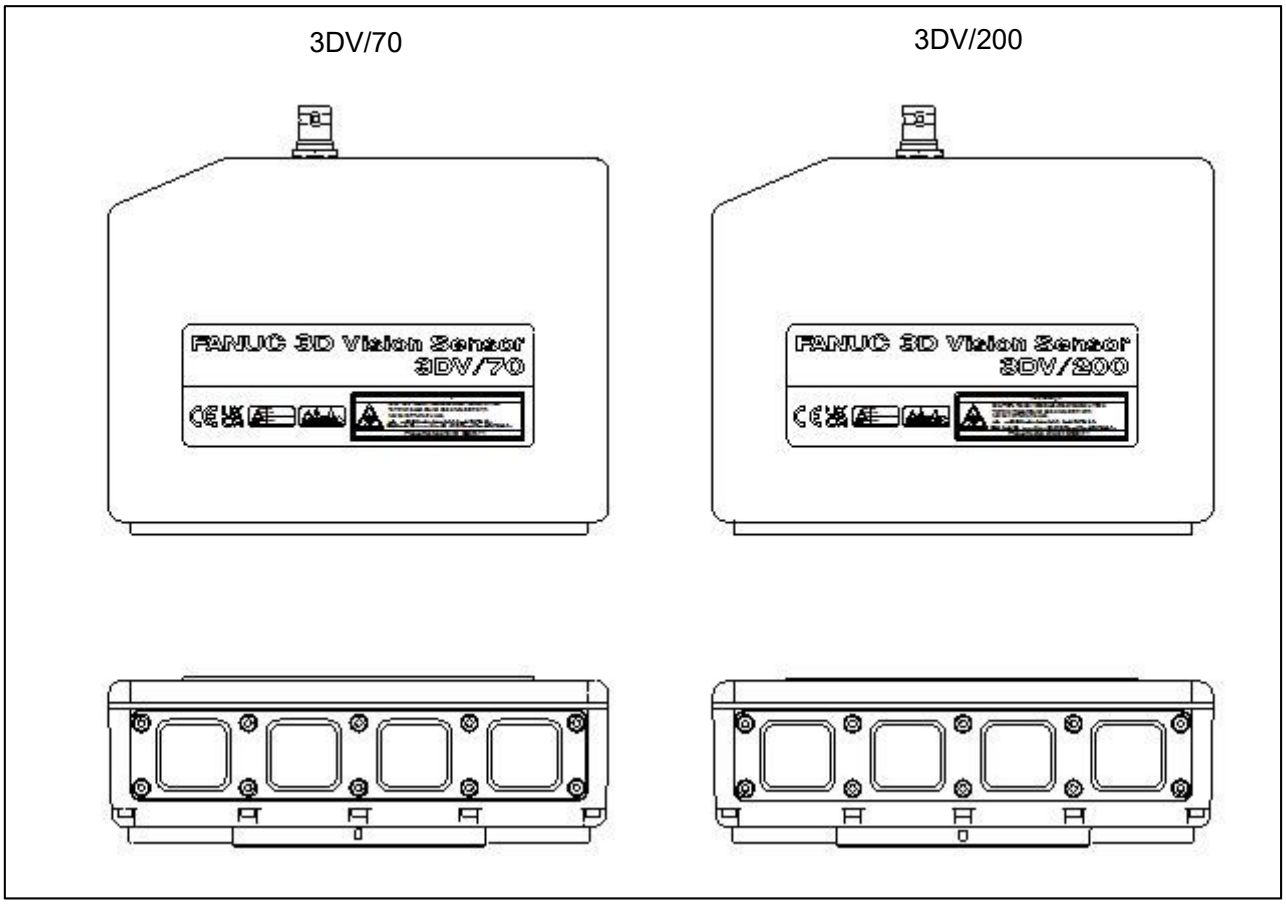


Fig. 3.2 (a) Locating of labels

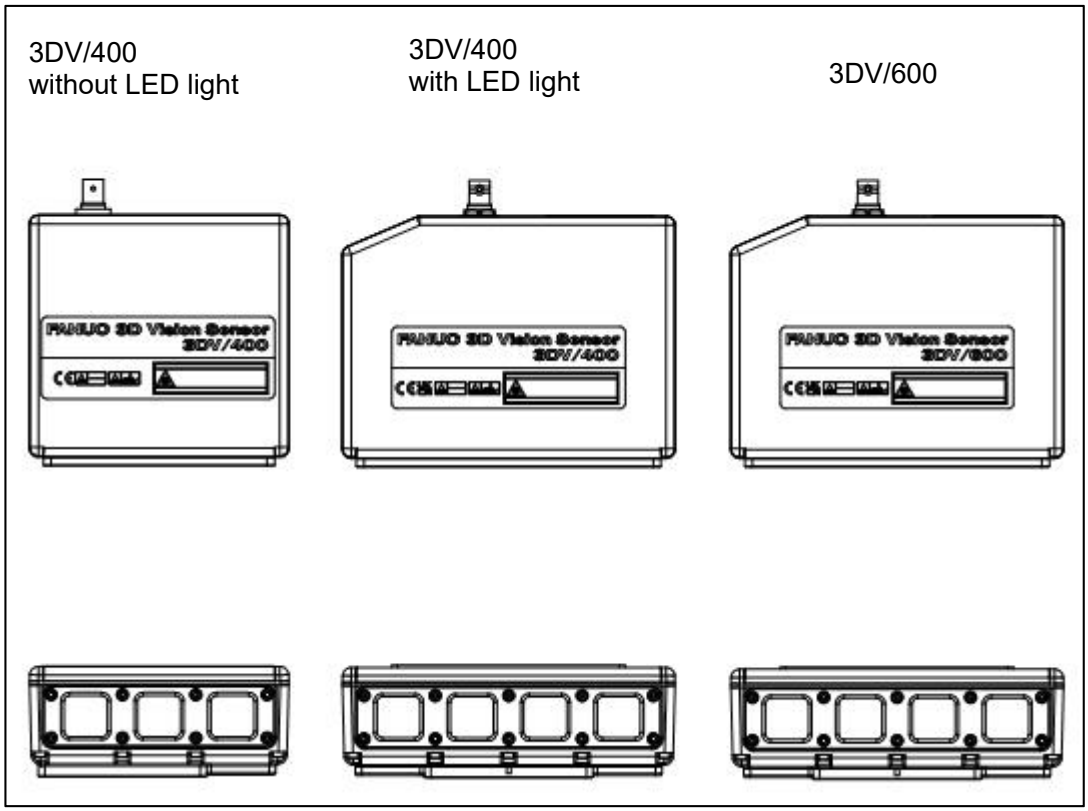


Fig. 3.2 (b) Locating of labels

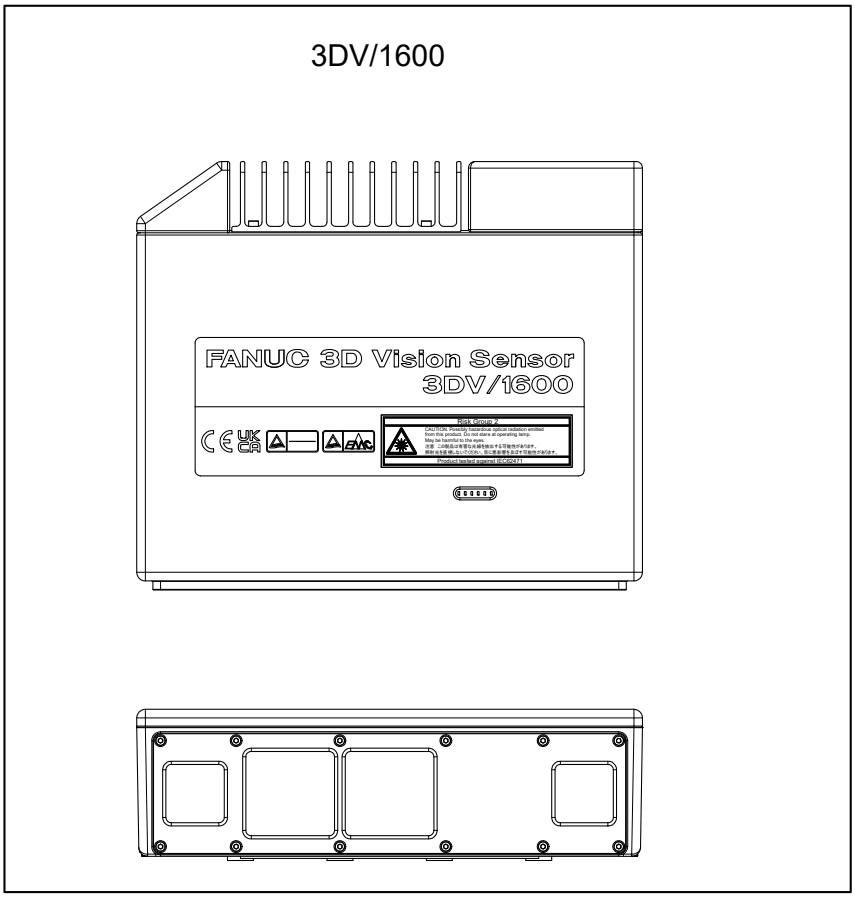


Fig. 3.2 (c) Locating of labels

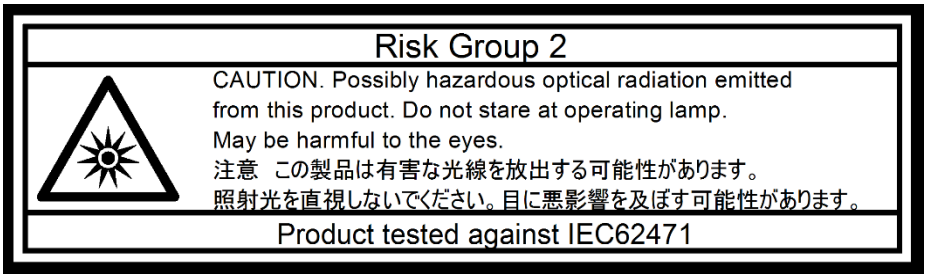


Fig. 3.2 (d) Label

4 RELATED MANUALS

This section introduces related manual.

R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus CONTROLLER OPERATOR'S MANUAL (Basic Operation) B-83284EN

This is the main manual of Controller. This manual describes the following items for manipulating workpieces with the robot:

- Setting the system for manipulating workpieces
- Operating the robot
- Creating and changing a program
- Executing a program
- Status indications
- Backup and restore robot programs.

This manual is used on an applicable design, robot installation, robot teaching.

R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL B-83195EN

This manual describes the maintenance and connection of R-30*i*B/R-30*i*B Plus controller.

R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL B-83525EN

This manual describes the maintenance and connection of R-30*i*B Mate/R-30*i*B Mate Plus controller.

R-30*i*B Compact Plus CONTROLLER MAINTENANCE MANUAL B-84035EN

This manual describes the maintenance and connection of R-30*i*B Compact Plus controller.

R-30*i*B Mini Plus CONTROLLER MAINTENANCE MANUAL B-84175EN

This manual describes the maintenance and connection of R-30*i*B Mini Plus controller.

R-30*i*B/R-30*i*B Mate /R-30*i*B Plus/R-30*i*B Mate Plus /R-30*i*B Compact Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List) B-83284EN-1

This manual describes the error code listings, causes, and remedies of R-30*i*B Controller.

R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Reference) B-83914EN

This manual is the reference manual for *i*RVision on the R-30*i*B controller. This manual describes each functions which are provided by *i*RVision. This manual describes the meanings (e.g. the items on *i*RVision setup screen, the arguments of the instruction, and so on.

R-30*i*B Plus CONTROLLER *i*RVision 2D CAMERA OPERATOR'S MANUAL B-83914EN-1

This manual is desired to first refer to when you start up systems of *i*RVision 2D Compensation and 2.5D Compensation. This manual describes startup procedures of *i*RVision 2D Compensation and 2.5D Compensation system, creating programs, caution, technical know-how, response to several cases, and so on.

R-30*i*B Plus CONTROLLER *i*RVision 3DV Sensor Application OPERATOR'S MANUAL B-83914EN-3

This manual is desired to first refer to when you start up systems with *i*RVision 3DV Sensor. This manual describes startup procedures of *i*RVision 3D Compensation system, creating programs, caution, technical know-how, response to several cases, and so on.

R-30*i*B Plus CONTROLLER *i*RVision 3D Laser Vision OPERATOR'S MANUAL B-83914EN-4

This manual is desired to first refer to when you start up systems with *i*RVision 3D Laser Vision. This manual describes startup procedures of *i*RVision 3D Compensation system, creating programs, caution, technical know-how, response to several cases, and so on.

R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER *i*RVision Inspection Application OPERATOR'S MANUAL B-83914EN-5

This manual is desired to first refer to when you start up systems of inspection which uses *i*RVision. This manual describes startup procedures of inspection system which uses *i*RVision, creating programs, caution, technical know-how, response to several cases, and so on.

R-30*i*B Plus /R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus CONTROLLER *i*RPicktool OPERATOR'S MANUAL B-83924EN

This manual is desired to first refer to when you start up systems of *i*RVision Bin Picking.
This manual describes startup procedures of *i*RVision Bin Picking system, creating programs, caution, technical know-how, response to several cases, and so on.

R-30*i*B Plus/ R-30*i*B Mate Plus CONTROLLER FORCE SENSOR OPERATOR'S MANUAL B-83934EN

This manual is desired to first refer to when you start up systems of precise fitting, grinding and deburring with force sensor.

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION REQUIREMENTS

1.1 TRANSPORTATION

For the other cautions related to transportation, refer to mechanical unit manuals for each robot.

Caution

For transport the robot with sensors, cover the sensor head section with an air cap, or the like, to protect the sensor, as shown in Fig. 1.1 (a).

> ⚠ **CAUTION**
> To transport over a long distance, avoid keeping the hand and other parts mounted on the force sensor as much as possible, as vibration that occurs during transportation might damage the force sensor.

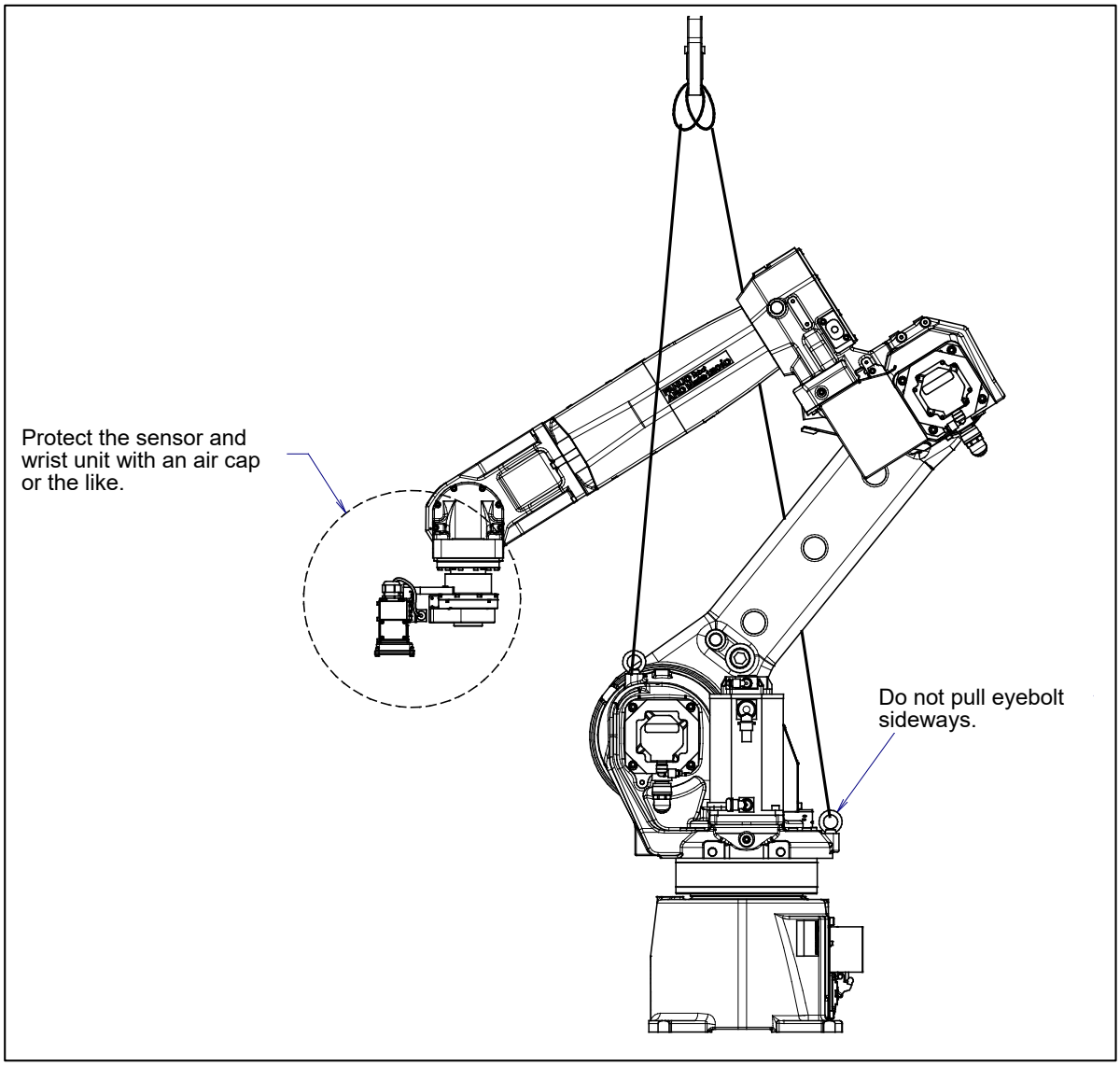


Fig. 1.1 (a) Caution of transportation posture

1.2 USED ENVIRONMENT

Table 1.2 (a) lists the installation requirements of the force sensor and various vision sensors.

Table 1.2 (a) Installation requirements

Item	Requirements
Allowable ambient temperature range	0 to 45°C
Allowable ambient humidity range	Regular use: Relative humidity of 75% or less with no condensation Short-period use (within one month): Relative humidity of 95% or less with no condensation
Atmosphere	No corrosive gas

NOTE
1 Contact your local FANUC representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign substances.
2 Camera does not have waterproofness, so if it is used in environment with much moisture, perform appropriate measures such as attaching a cover to a camera.
3 When a force sensor and various vision sensors are mounted on the robot hand, the sensor will not be damaged by the load that is received during the acceleration / deceleration operation of the robot or the load is received by the stop operation of the robot.

2 CONFIGURATION

2.1 CONFIGURATION OF THE SENSOR INSTALLED ROBOT

When provided with a force sensor, the robot is usually configured by combining the sensors with the mechanical unit and controller of the robot.
The total system is then configured as a combination of the robot, a peripheral device, and an external controller. Fig. 2.1 (a) to (c) shows the configuration of the robot loaded with the force sensor, the 3D Laser Vision Sensor, the camera package and 3D Vision Sensor.

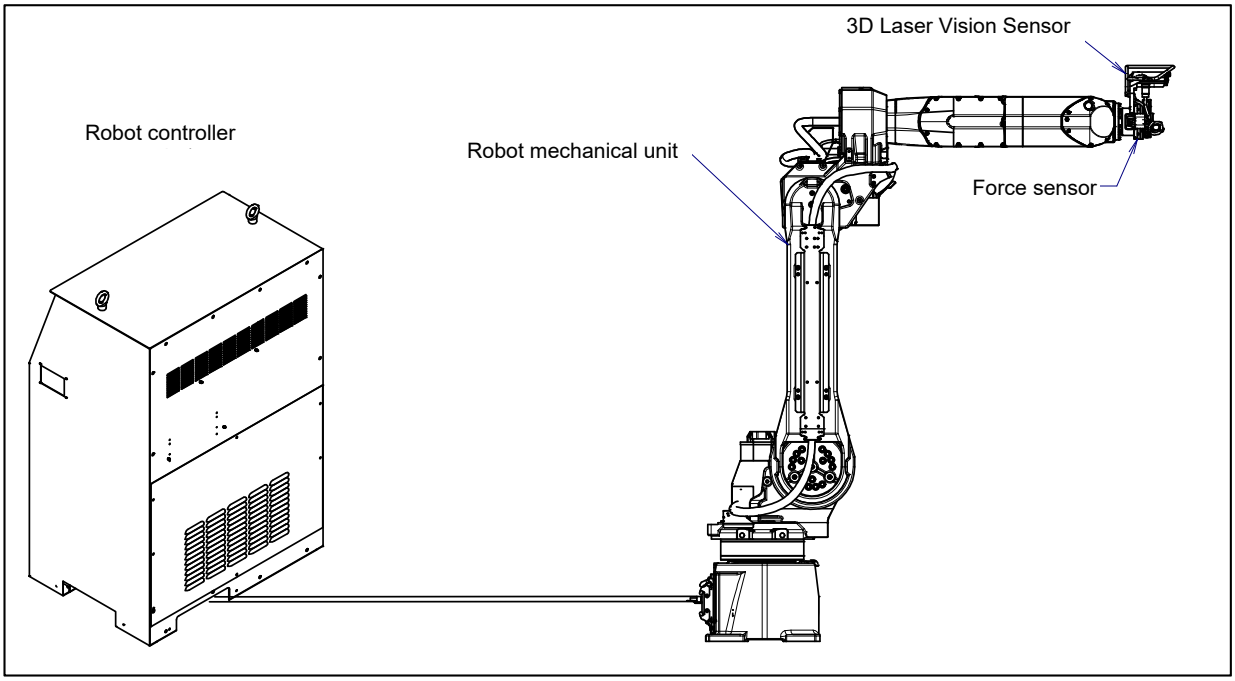


Fig. 2.1 (a) Configuration of the robot loaded with the force sensor

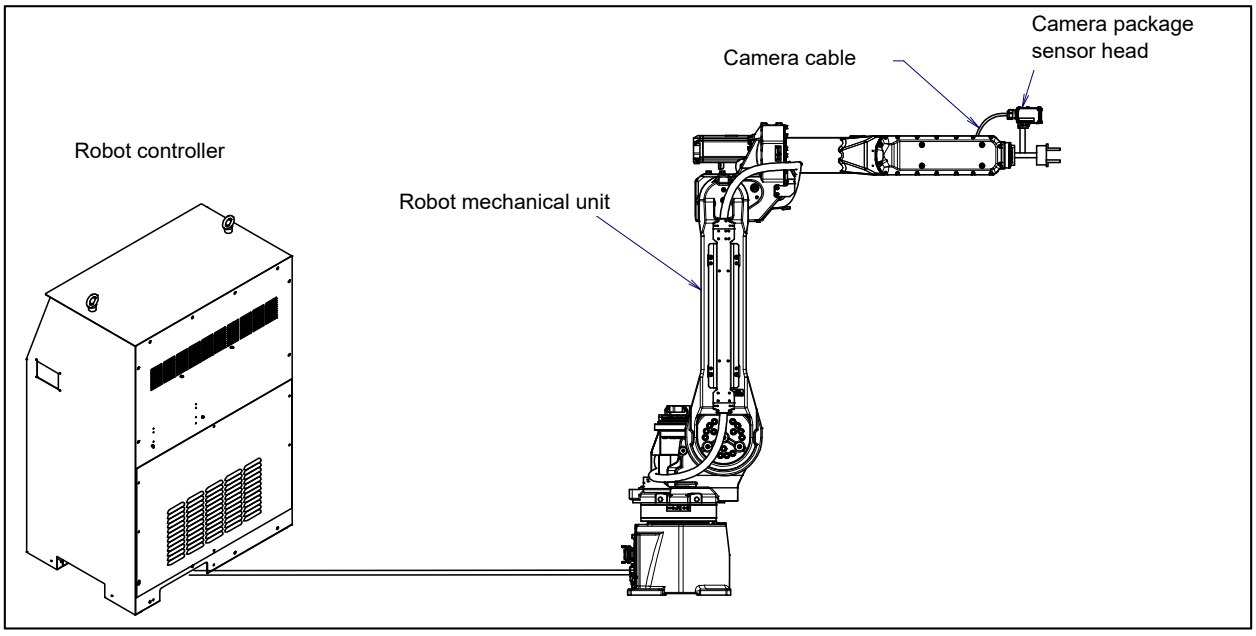


Fig. 2.1 (b) Configuration of the robot loaded with the camera package

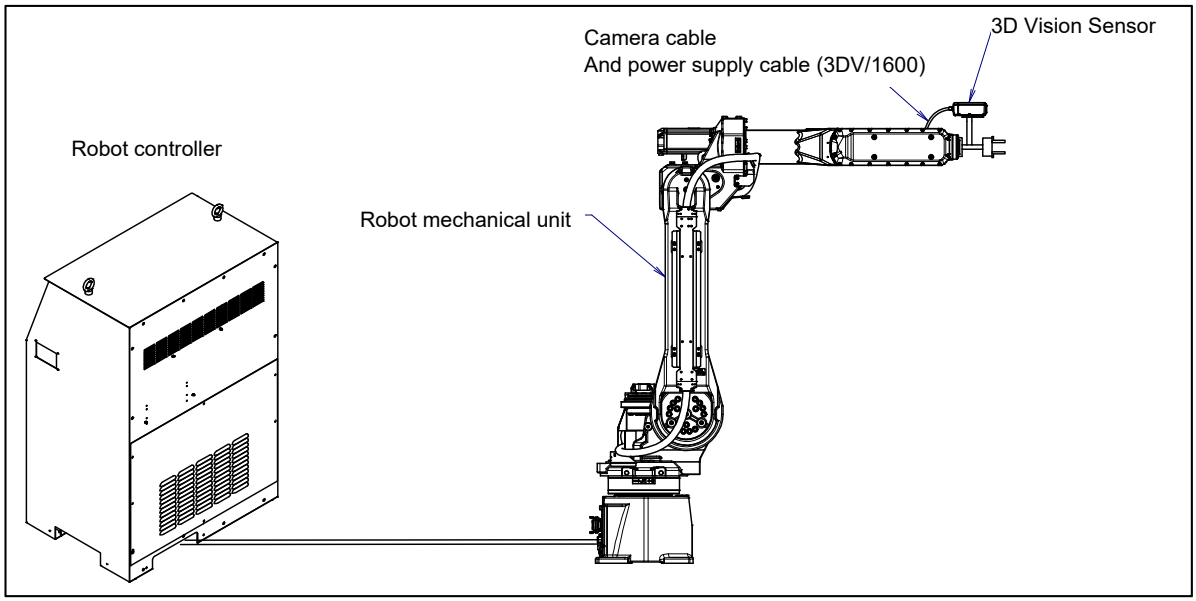


Fig. 2.1 (c) Configuration of the robot loaded with the 3D Vision Sensor

2.2 CONFIGURATION OF THE FORCE SENSOR MECHANICAL SECTION

The force sensor consists of a sensor head, sensor adapter, and sensor cable.

The sensor head consists of a load support, fixed portion, and electronic circuit (head PCB).

The sensor adapter electrically isolates the sensor head from the robot main body to protect against noise from the robot main body.

The sensor cable is a shielded, twisted-multiple-conductor cable having a high noise resistance.

Fig. 2.2 (a) shows the configuration of the force sensor head.

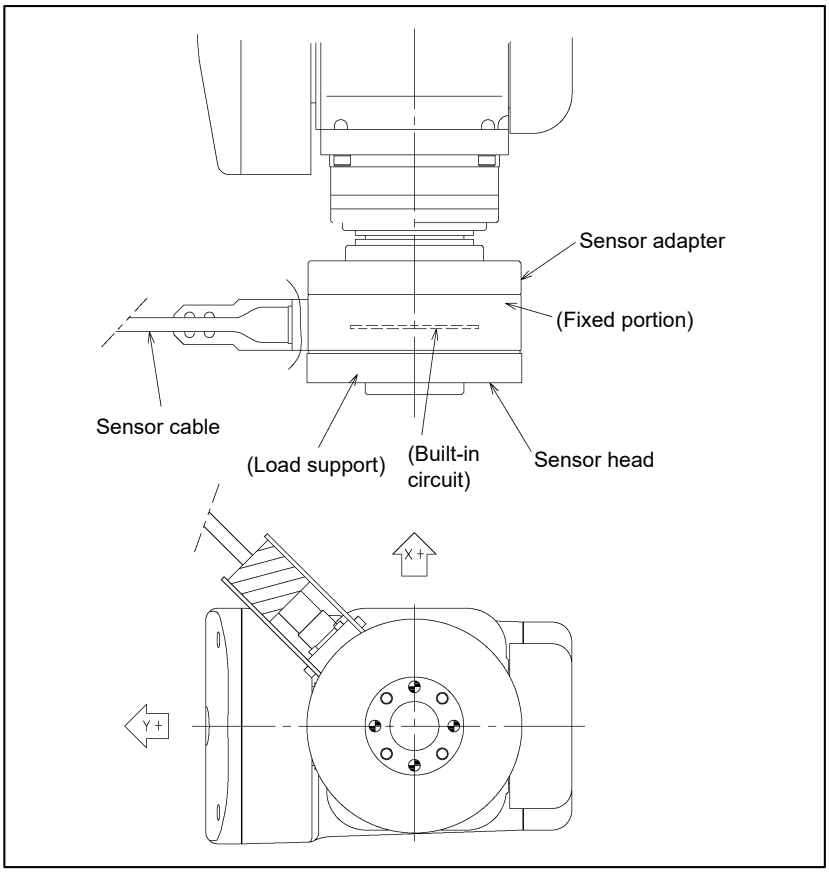


Fig. 2.2 (a) Configuration of the force sensor head

2.3 CONFIGURATION OF THE CAMERA MECHANICAL UNIT

The camera consists of a sensor head, lens and sensor cable. A coaxial cable is used for the camera cable. There is the case that imaging is distracted due to a noise from the outside. In that case, intercept conduction between a stand for camera and housing of the sensor head, insulate those.

2.4 CONFIGURATION OF THE CAMERA PACKAGE

Camera package is composed of sensor head and camera cable.

When sensor head of camera package is set up as hand camera, install it to the hand of the robot wrist. Fig.2.4 (a) shows the configuration of camera package (hand camera).

When sensor head of camera package is set up as fixed camera, prepare stand and install to it. Fig.2.4 (b) shows the configuration of camera package (Fixed installation).

Take measures to electrically isolate the sensor head from for the robot or the stand. In addition, verify the sensor head is electrically isolated from the earth cable for the robot controller.

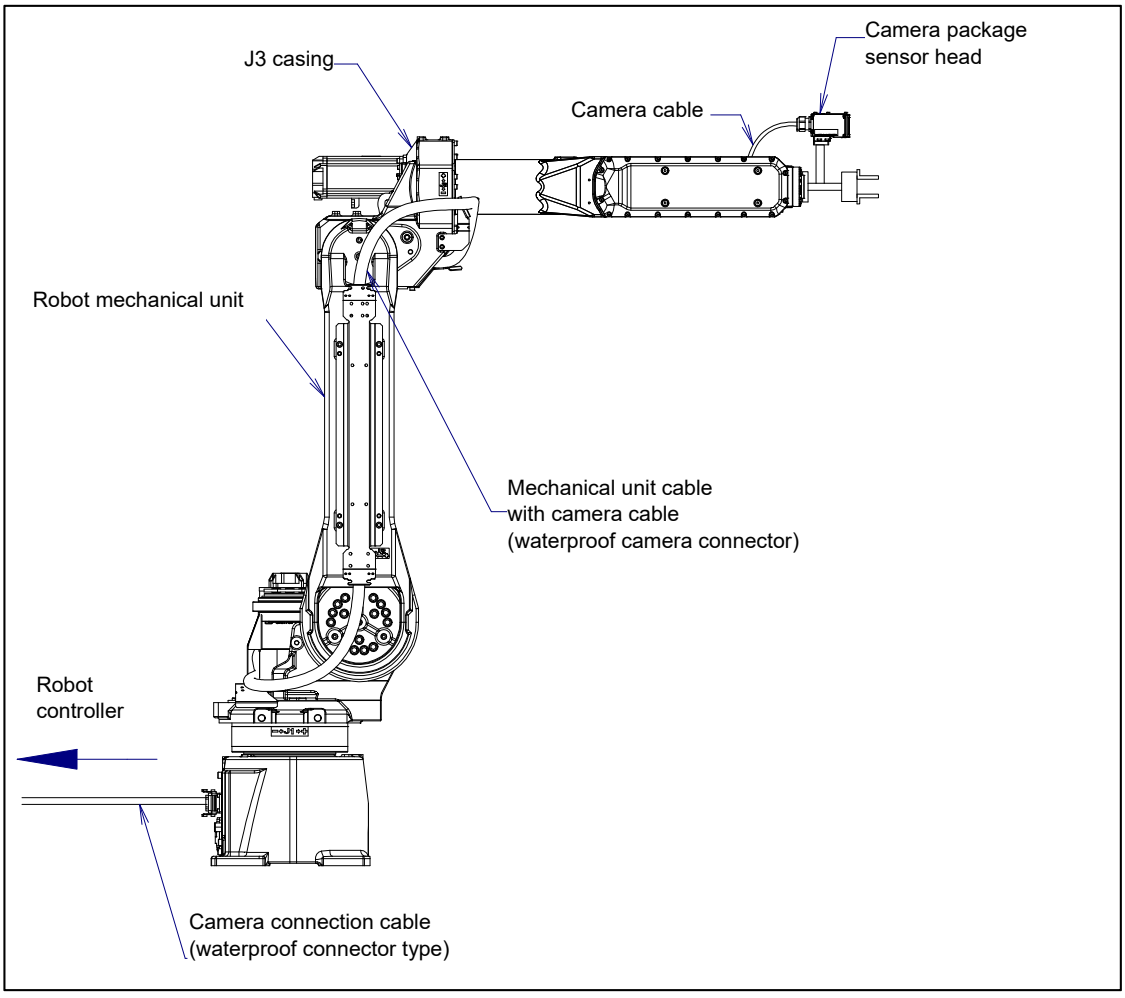


Fig. 2.4 (a) Configuration of the camera package (hand camera)

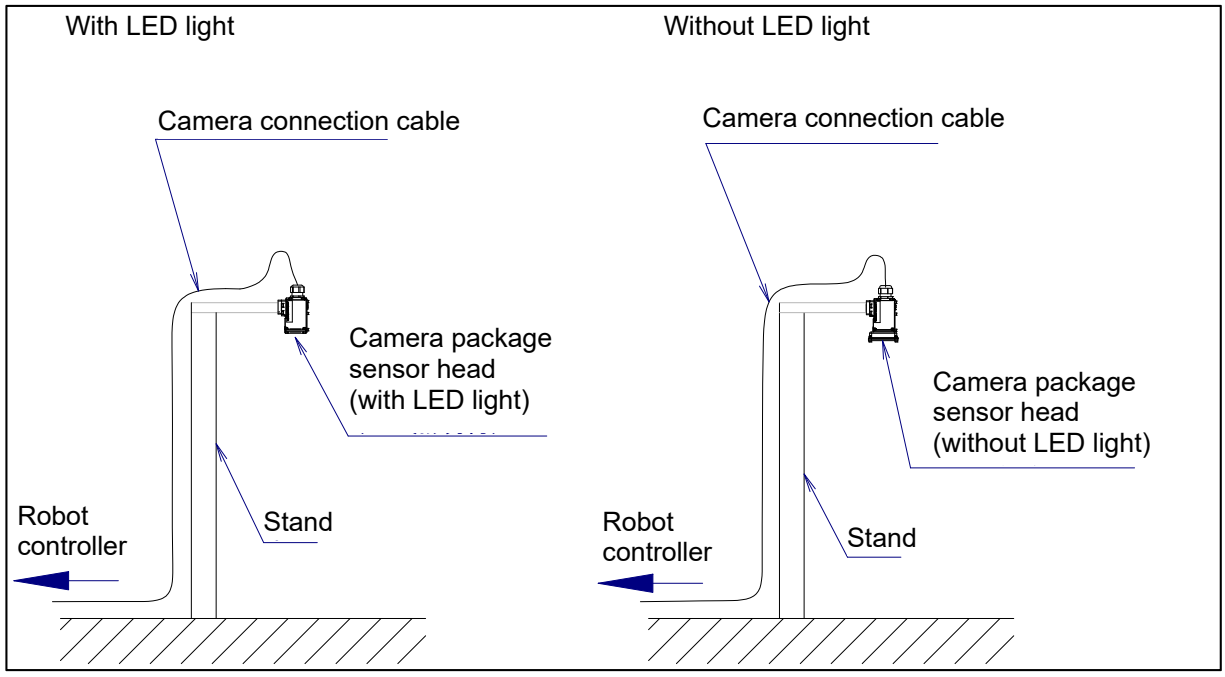


Fig. 2.4 (b) Configuration of the camera package (fixed camera)

Configuration of the camera package sensor head

The sensor head is composed of CCD camera, lens, cover and LED light.
The front adapter is installed when there is no LED light installed.
Fig.2.4 (c) shows the configuration of camera package.

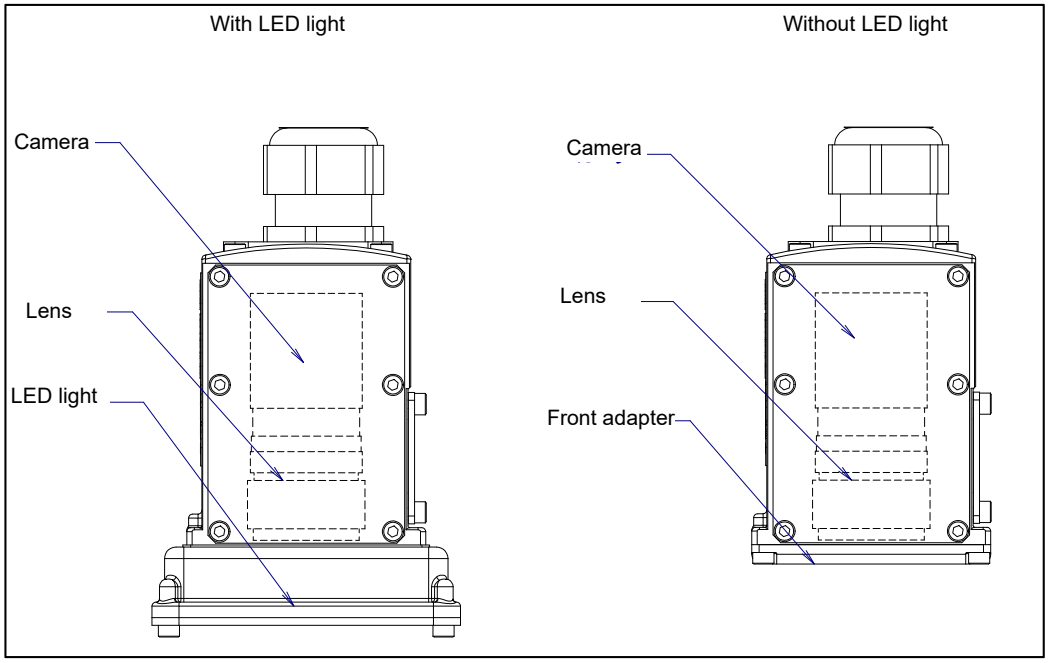


Fig. 2.4 (c) Configuration of sensor head of camera package

2.5 CONFIGURATION OF THE 3D LASER VISION SENSOR

The 3D Laser Vision Sensor consists of a sensor head, sensor cable and camera cable.
The sensor head and robot main body are linked with the sensor adapter, but electrically isolated from each other with an insulating member in the sensor adapter.
Fig. 2.5 (a) shows the configuration of the 3D Laser Vision Sensor.

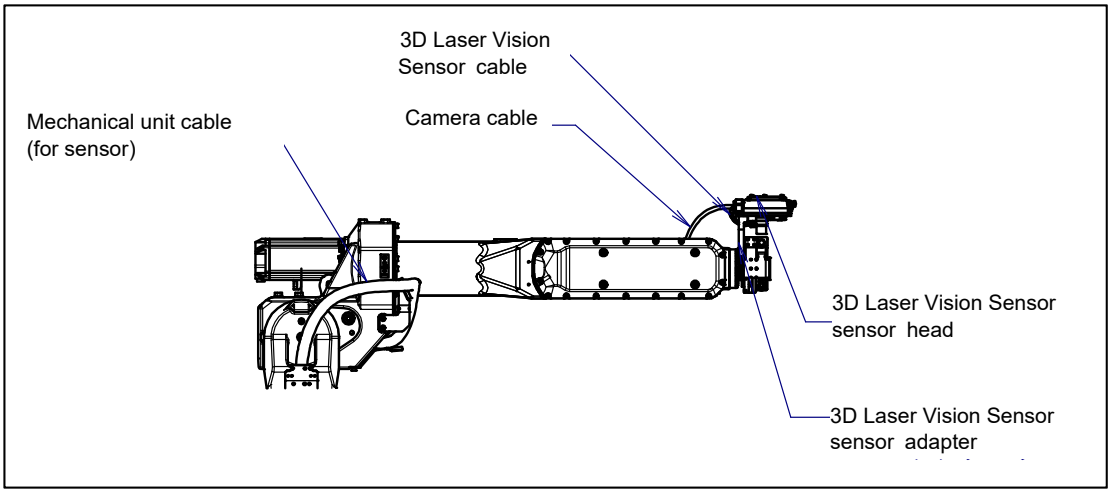


Fig. 2.5 (a) Configuration of the 3D Laser Vision Sensor

Configuration of the sensor head of the 3D Laser Vision Sensor

The 3D Laser Vision Sensor head mainly consists of a laser projector, light receiving device, PCB in the sensor head, base plate and cover. It consists of the laser projector unit and the light receiving unit.
Fig. 2.5 (b) shows the configuration of the 3D Laser Vision Sensor head.

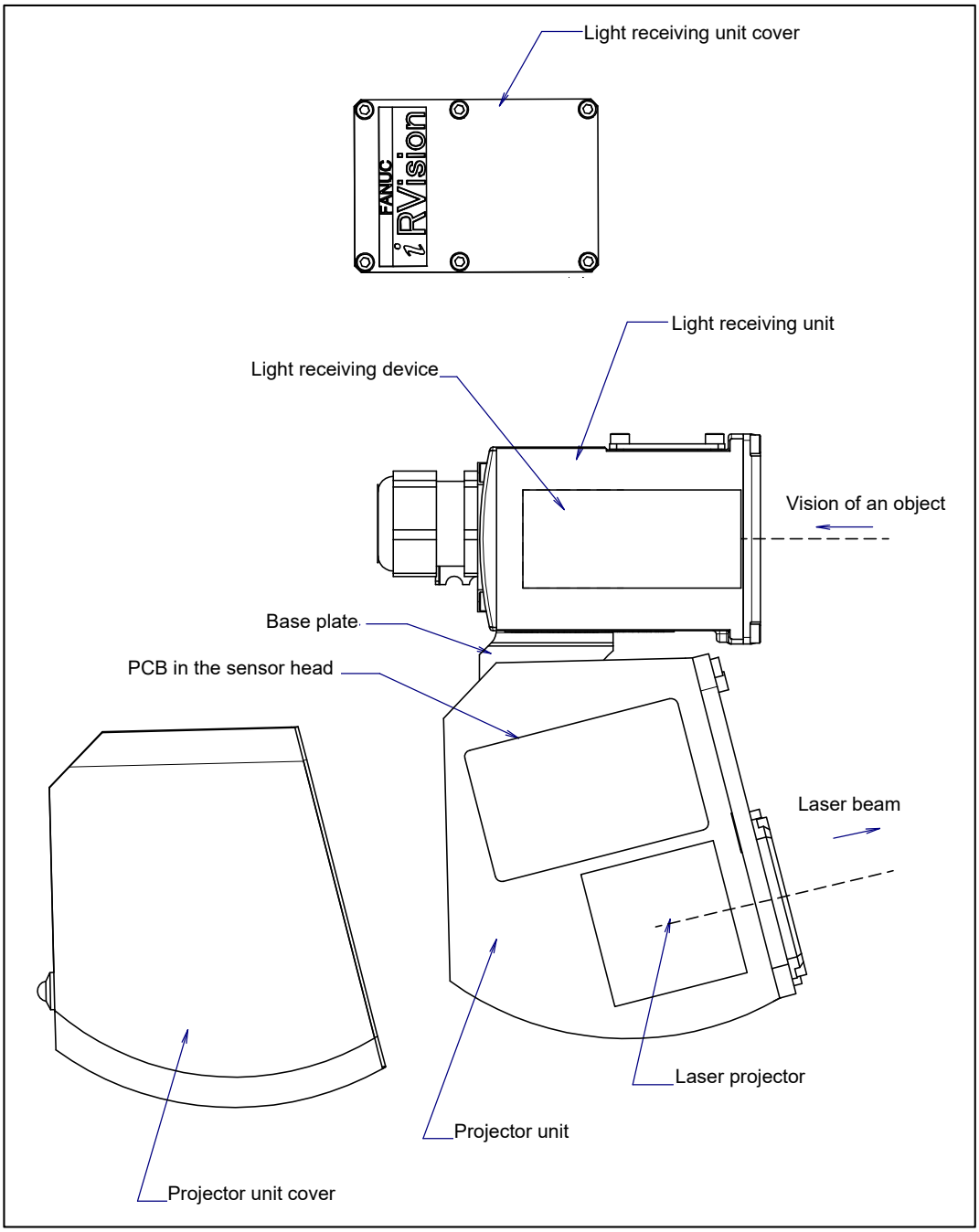


Fig. 2.5 (b) Configuration of the sensor head of the 3D Laser Vision Sensor (standard)

2.6 CONFIGURATION OF THE 3D AREA SENSOR

3D Area Sensor is composed of projector unit and camera unit. Install projector unit and camera unit with a stand. Fig 2.6 (a) shows the configuration of 3D Area Sensor.

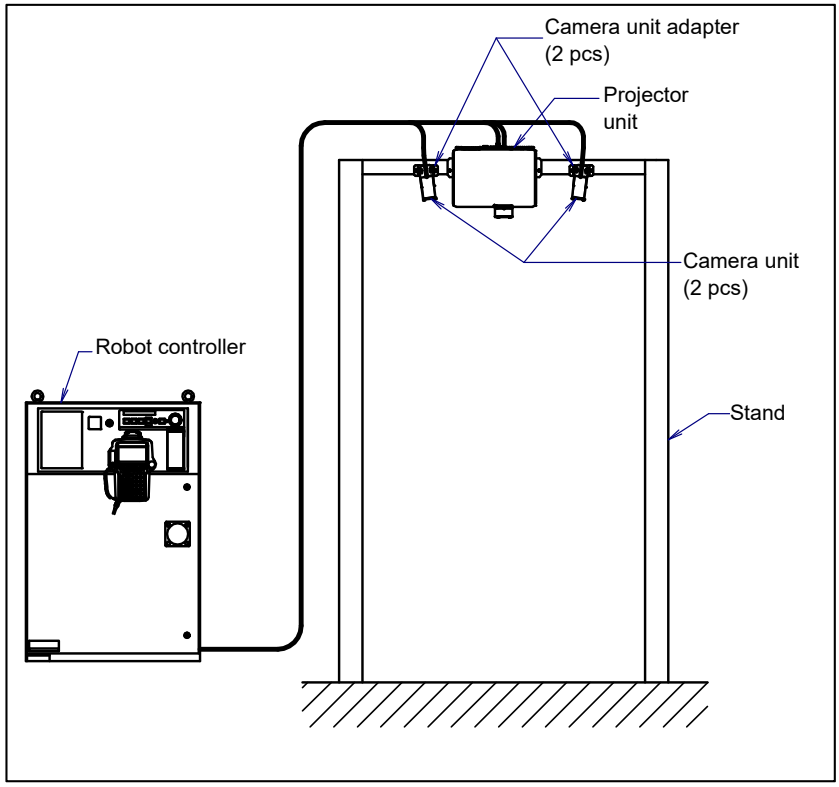


Fig. 2.6 (a) Configuration of the 3D Area Sensor (3DA/1300)

Configuration of the 3D Area Sensor projector unit

Projector unit is composed of case, cover and adapter. Lower side of the projector, window is fixed by the window holder, light is thrown from here. The top surface has input connector and output connector.
Fig.2.6 (b) shows the configuration of the projector unit.

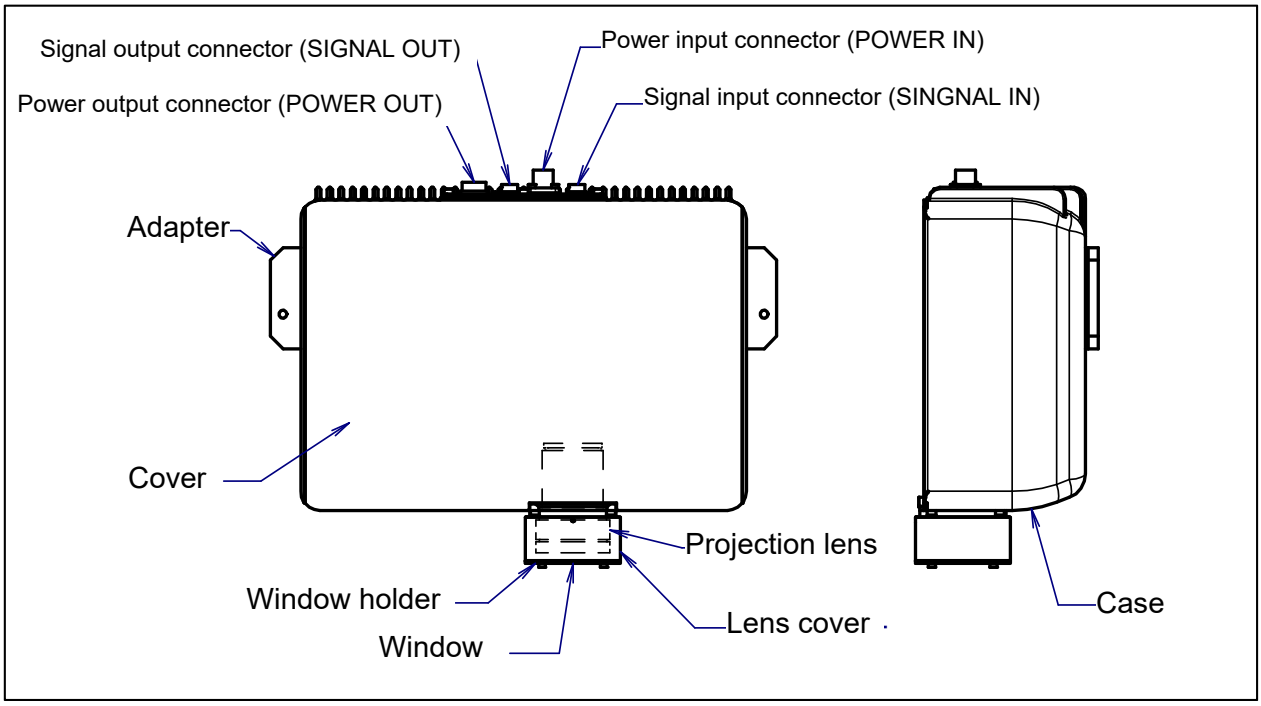


Fig. 2.6 (b) Configuration of the 3D Area Sensor projector unit (3DA/1300)

Configuration of the 3D Area Sensor camera unit

Camera unit is composed of camera, lens and cover.
Fig 2.6 (c) shows the configuration of the camera unit.

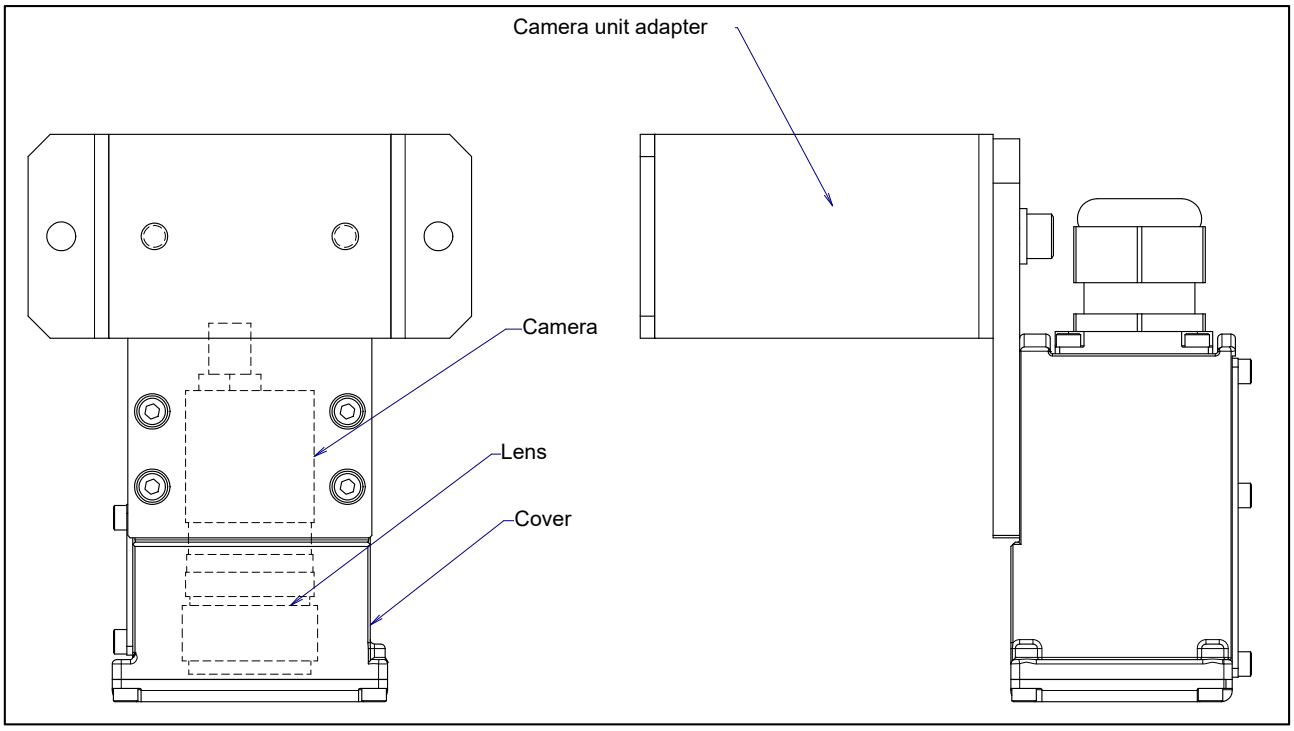


Fig. 2.6 (c) Configuration of the 3D Area Sensor camera unit (3DA/1300)

2.7 CONFIGURATION OF THE 3D VISION SENSOR

2.7.1 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400, 3DV/600

The 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400 and 3DV/600 consists of a sensor head and camera cable.
If the sensor head of 3DV/70, 3DV/200, 3DV/400 or 3DV/600 is set as the hand camera, attach it to the hand of the robot wrist. Fig. 2.7.1 (a) shows configuration of 3DV/70, 3DV/200, 3DV/400 and 3DV/600 (hand camera).

If the sensor head of 3DV/70, 3DV/200, 3DV/400 or 3DV/600 is set as fixed camera, prepare a stand ant install it.
Fig. 2.7.1 (b) shows configuration of 3DV/70, 3DV/200, 3DV/400 and 3DV/600 (fixed camera).

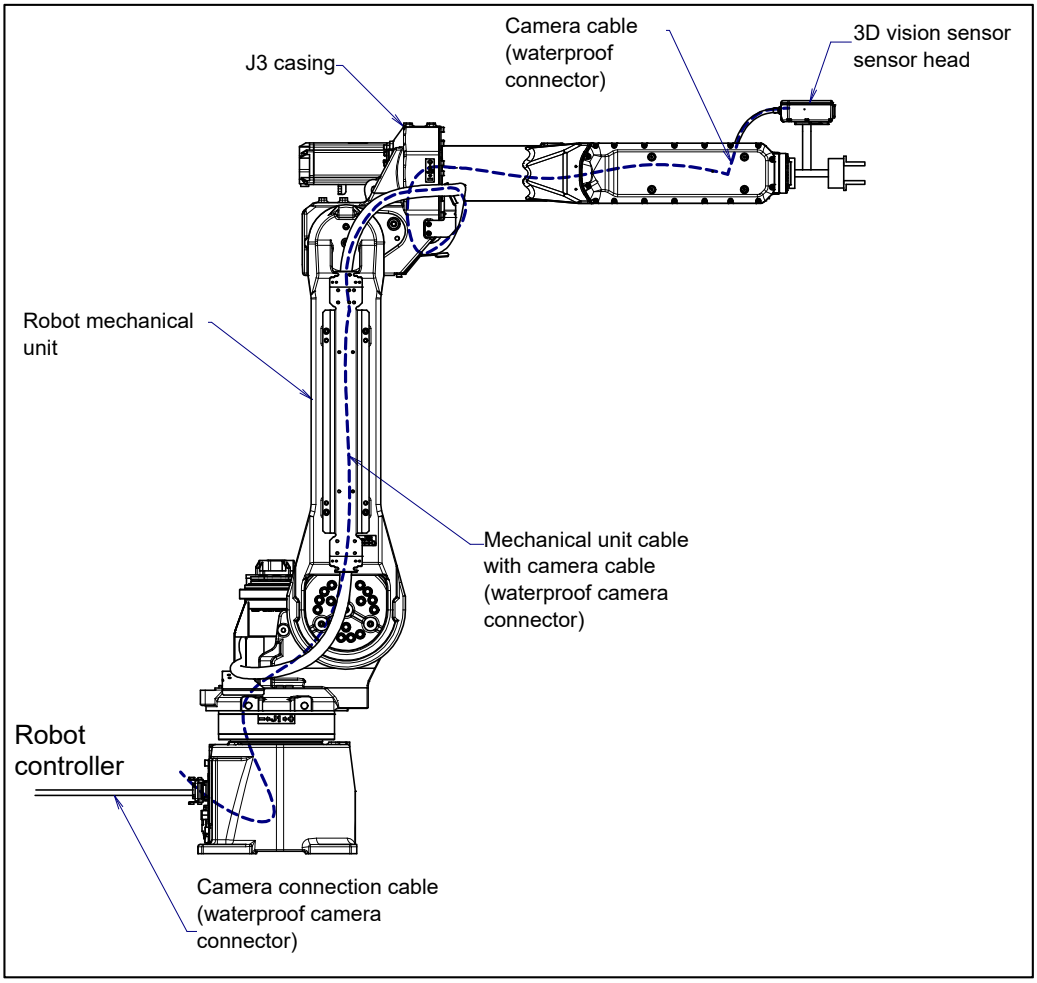


Fig. 2.7.1 (a) Configuration of 3DV/70, 3DV/200, 3DV/400 and 3DV/600 (hand camera)

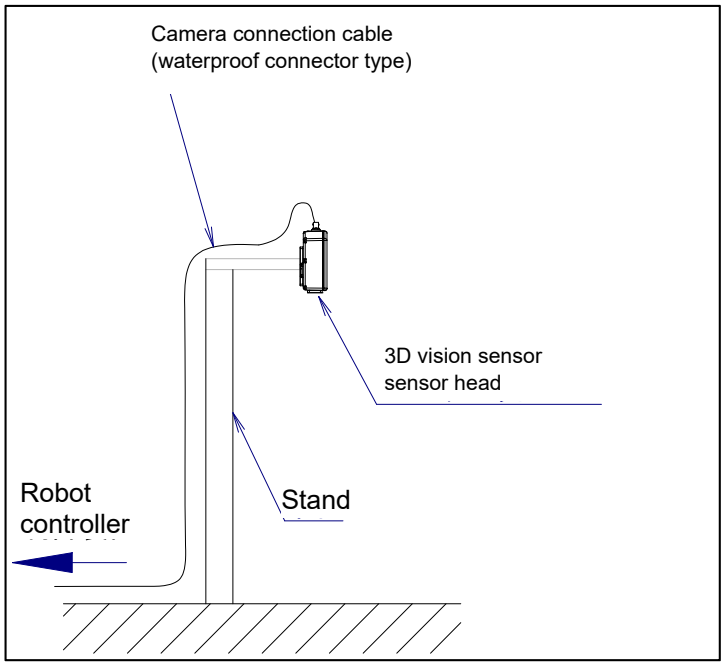


Fig. 2.7.1 (b) Configuration of 3DV/70, 3DV/200, 3DV/400 and 3DV/600 (fixed camera)

Configuration of the 3DV/70, 3DV/200, 3DV/400 and 3DV/600 Sensor head

3DV/70, 3DV/200, 3DV/400 and 3DV/600 is composed of the light receiving unit, the project unit, the cover, the front adapter and the LED light. Fig. 2.7.1 (c) and Fig. 2.7.1 (d) show configuration of 3DV/70, 3DV/200, 3DV/400 and 3DV/600.

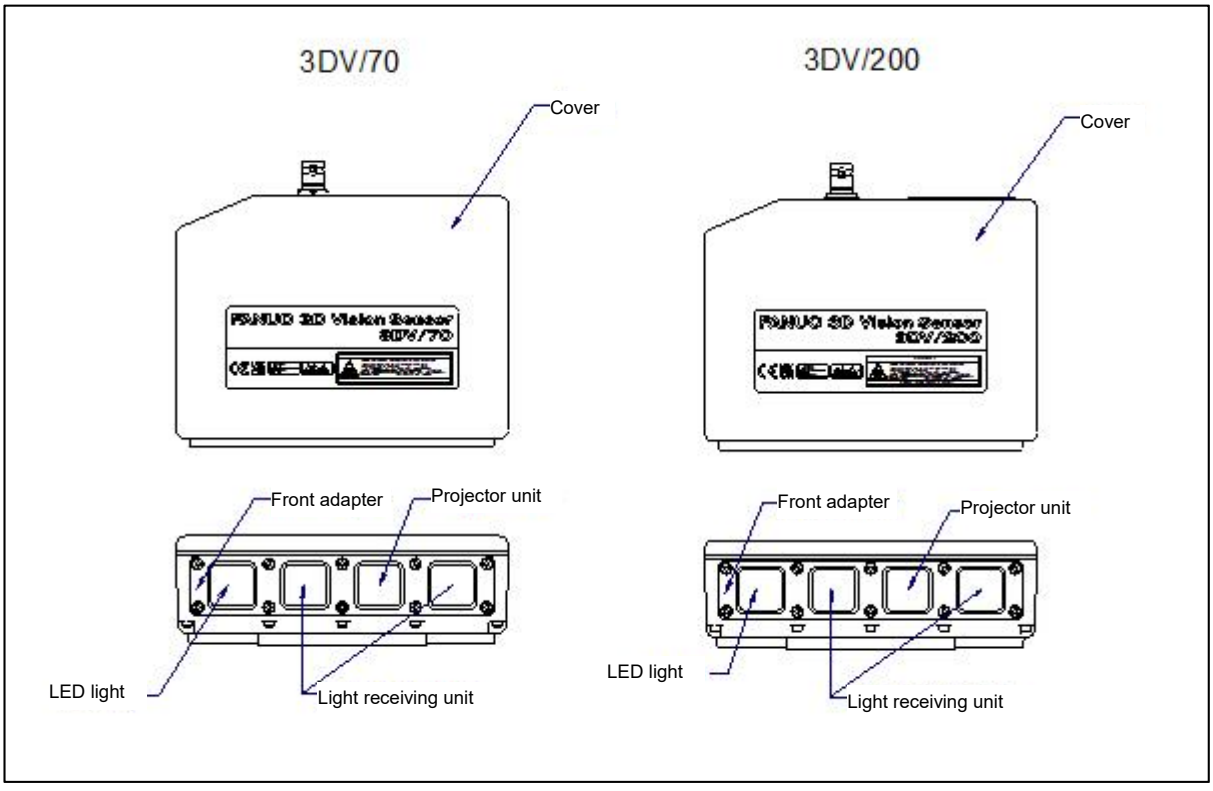


Fig. 2.7.1 (c) Configuration of 3DV/70 and 3DV/200

Fig. 2.7.1 (d) shows configuration of 3DV/400 and 3DV/600.

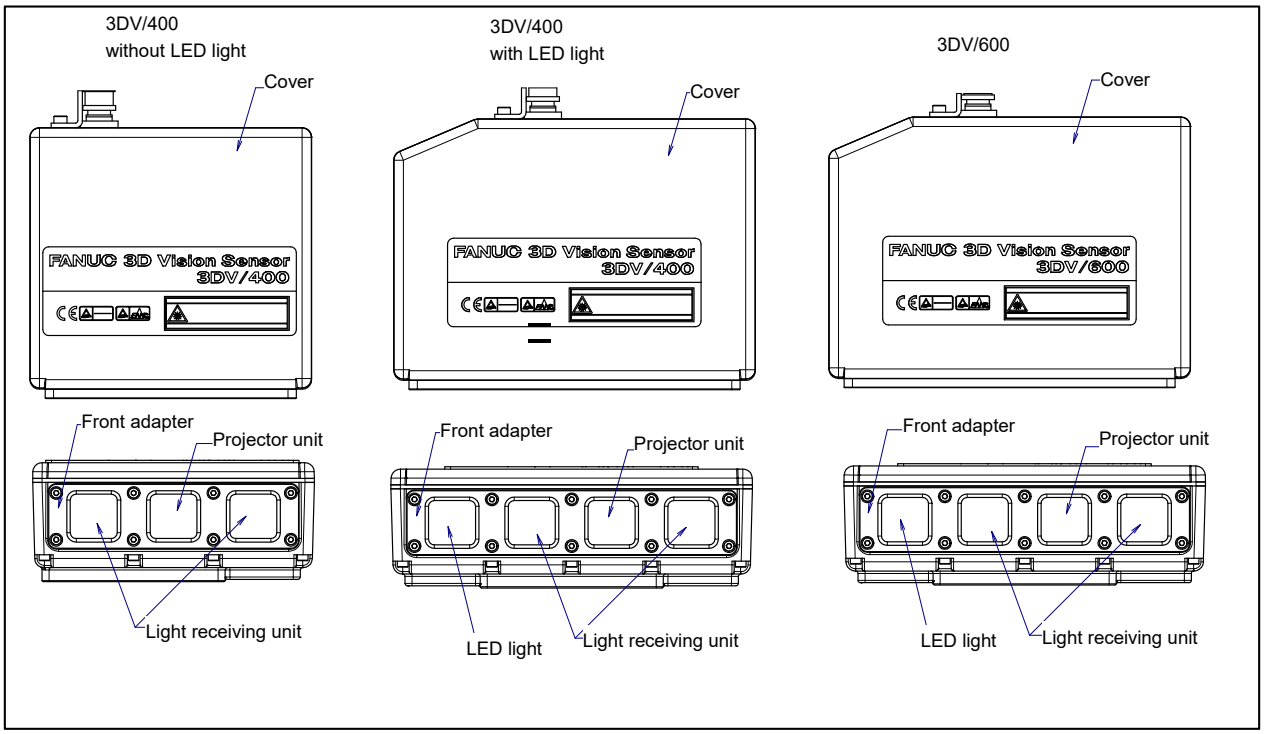


Fig. 2.7.1 (d) Configuration of 3DV/400 and 3DV/600

2.7.2 3D Vision Sensor 3DV/1600

The 3D Vision Sensor 3DV/1600 consists of a sensor head, camera cable and power supply cable.
If the sensor head is set as the hand camera, attach it to the hand of the robot wrist. Fig. 2.7.2 (a) shows configuration of 3DV/1600 (hand camera).

If the sensor head is set as fixed camera, prepare a stand ant install it.
Fig. 2.7.2 (b) shows configuration of 3DV/1600 (fixed camera).

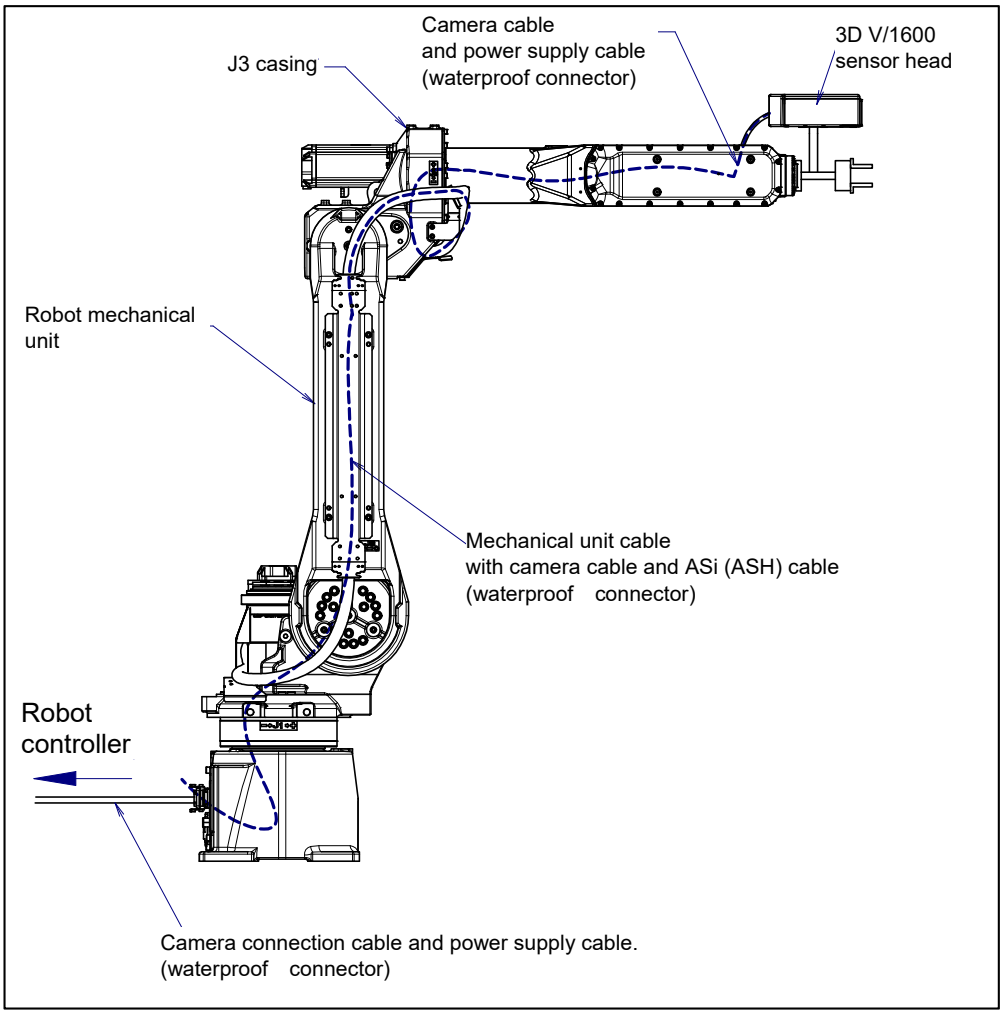


Fig. 2.7.1 (a) Configuration of 3DV/1600 (hand camera)

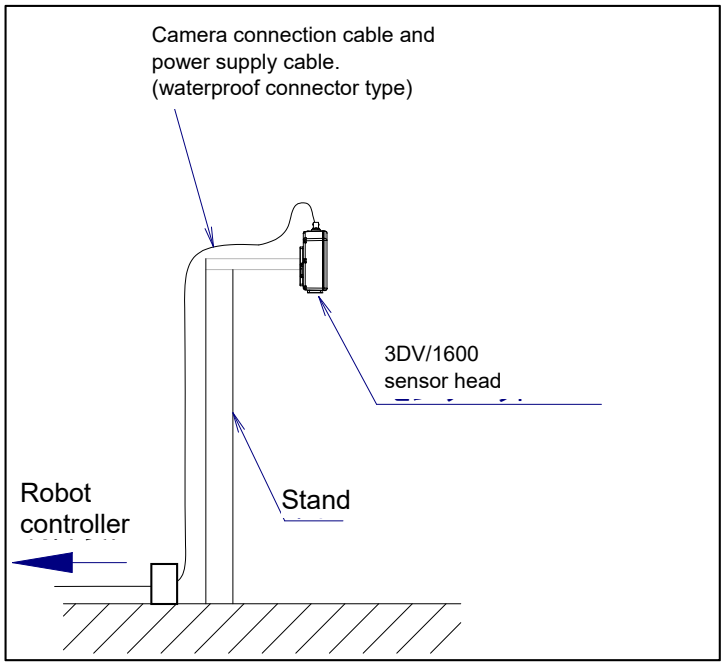


Fig. 2.7.2 (b) Configuration of 3DV/1600 (fixed camera)

Configuration of 3DV/1600 sensor head

3DV/1600 is composed of the light receiving unit, the project unit, the cover, the front adapter and the LED light. Fig. 2.7.2 (c) shows configuration of 3DV/1600.

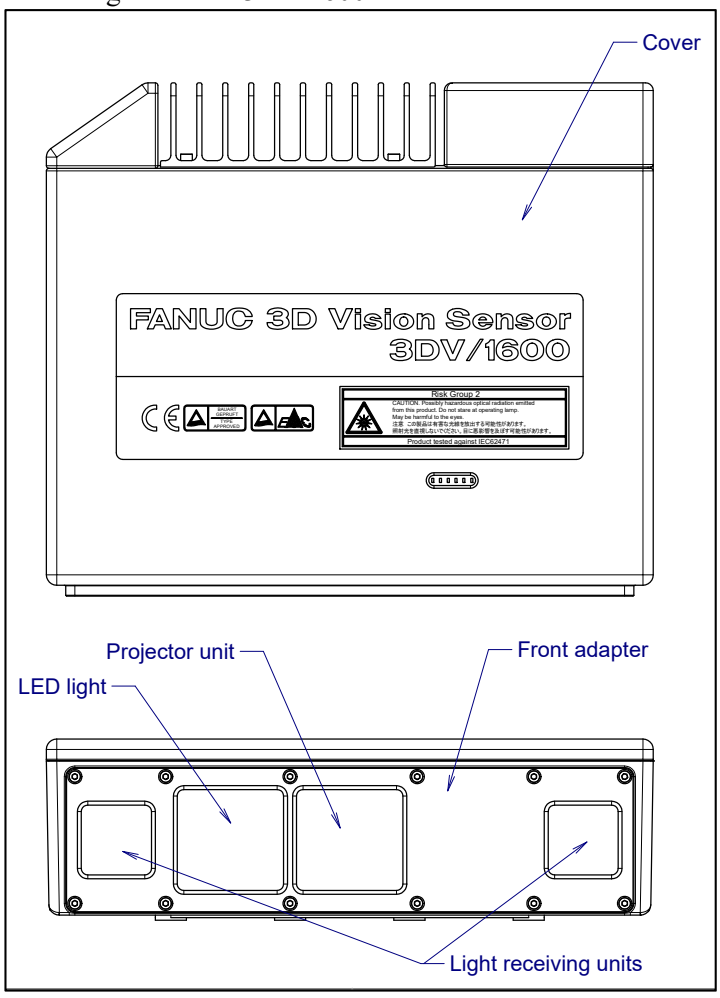


Fig. 2.7.2 (c) Configuration of 3D/1600 sensor head

2.7.2.1 LED indicator of sensor

3DV/1600 sensor head is equipped with 5 LED lamps that indicate the sensor status. Fig 2.7.2.1(a) shows the location of the lamp and Table 2.7.2.1 (a) shows the information that the lamp has on.

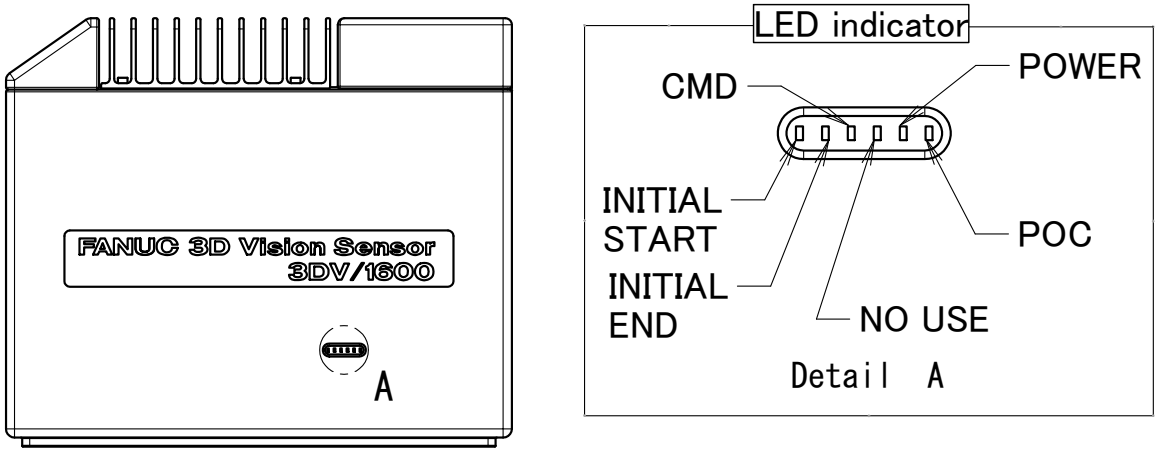


Fig 2.7.2.1 (a) Status display LED lamp with 3DV/1600

Table 2.7.2.1 (a) Status display LED lamp with 3DV/1600

LED indication	Description
POC	This LED is continuously ON. It means that the camera cable is normal.
POWER	This LED is continuously ON. It means that the power cable is normal.
NO USE	This LED is continuously OFF.
CMD	This LED blinks only while processing commands from the robot controller.
INITIAL START	This LED is continuously ON after the start of 3DV/1600 startup process.
INITIAL END	This LED is continuously ON after the end of 3DV/1600 startup process.

If 3DV/1600 starts normally, POC, POWER, INITIAL START, INITIAL END are always ON.

2.8 CONFIGURATION OF THE FORCE SENSOR CONTROLLER

2.8.1 Camera connection cable (A-cabinet)

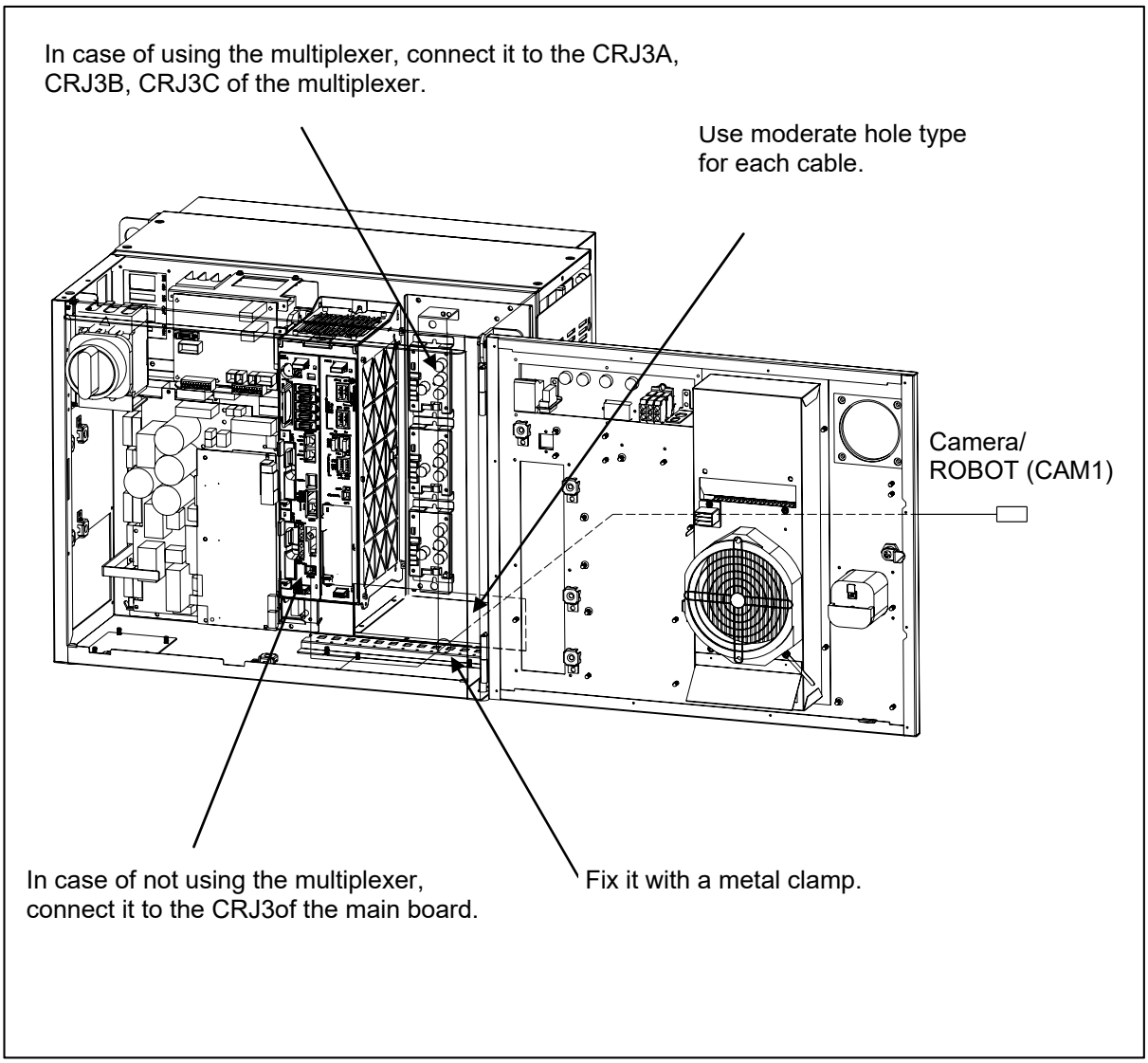


Fig. 2.8.1 (a) Camera connection cable (A-cabinet)

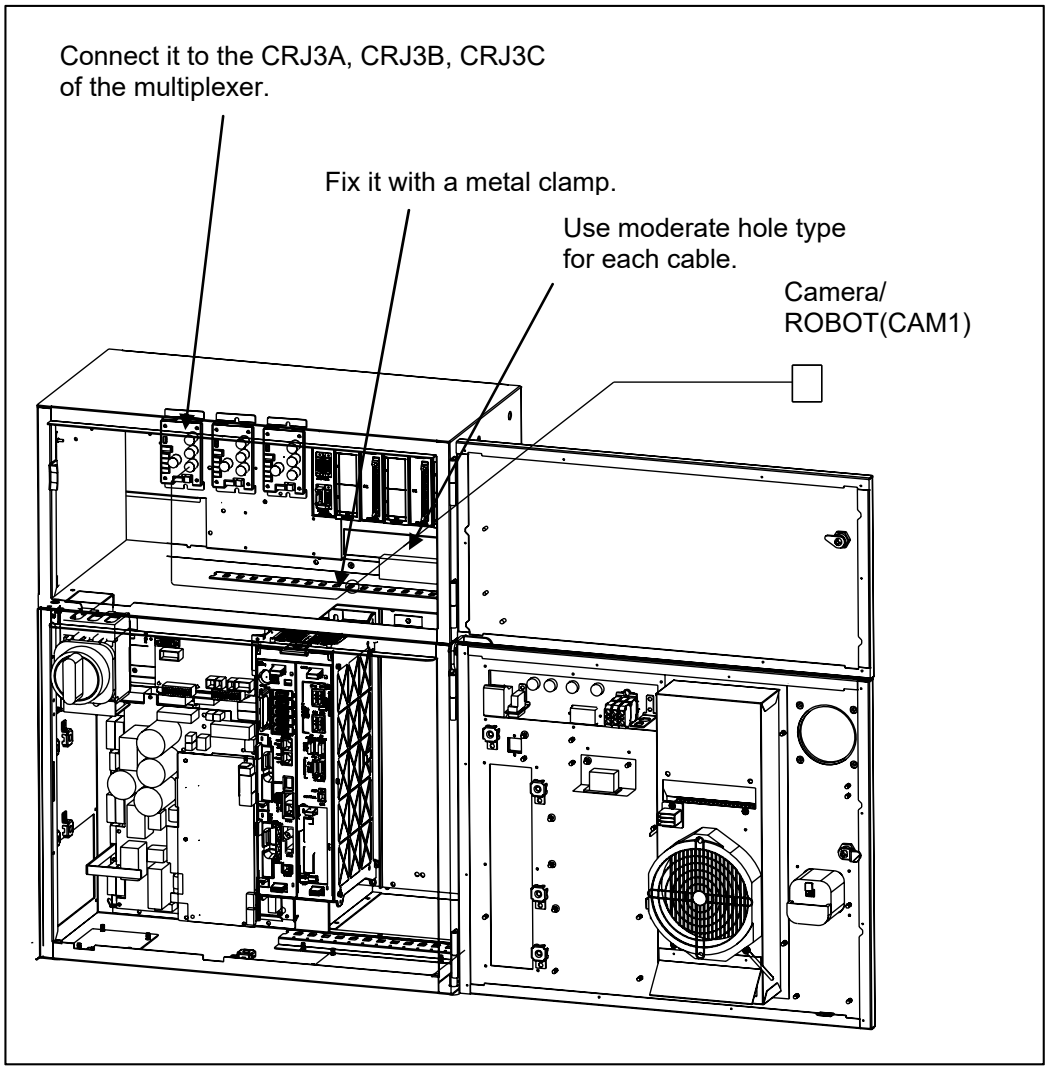


Fig. 2.8.1 (b) Camera connection cable (A-cabinet top box)

NOTE
If the camera multiplexer is installed to the A-cabinet top box, projector unit connection cable cannot be connected.

For fixation part

Order spec.	Old cable spec.	New cable spec.	Fit hole type	Length (m)
A05B-2671-J060	A660-2008-T223#L7R003A	A660-2008-T534#L7R003A	#E	7
A05B-2671-J061	A660-2008-T223#L14R03A	A660-2008-T534#L14R03A	#E	14
A05B-2671-J062	A660-2008-T223#L20R03A	A660-2008-T534#L20R03A	#E	20
A05B-2671-J063	A660-2008-T223#L25R03A	A660-2008-T534#L25R03A	#E	25

For rail axis (when it is connected to the main board)

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2671-J040	A660-2008-T435#L7R003A	#C	7
A05B-2671-J041	A660-2008-T435#L14R03A	#C	14
A05B-2671-J042	A660-2008-T435#L20R03A	#C	20
A05B-2671-J043	A660-2008-T435#L25R03A	#C	25

For rail axis (when it is connected to the multiplexer)

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2671-J050	A660-2008-T435#L7R003G	#C	7
A05B-2671-J051	A660-2008-T435#L14R03G	#C	14
A05B-2671-J052	A660-2008-T435#L20R03G	#C	20
A05B-2671-J053	A660-2008-T435#L25R03G	#C	25

NOTE
For note of the cables for rail axis, refer to “5.2.4 Wiring of the connection cable for the sensor “.

2.8.2 Projector unit connection cable (A-cabinet)

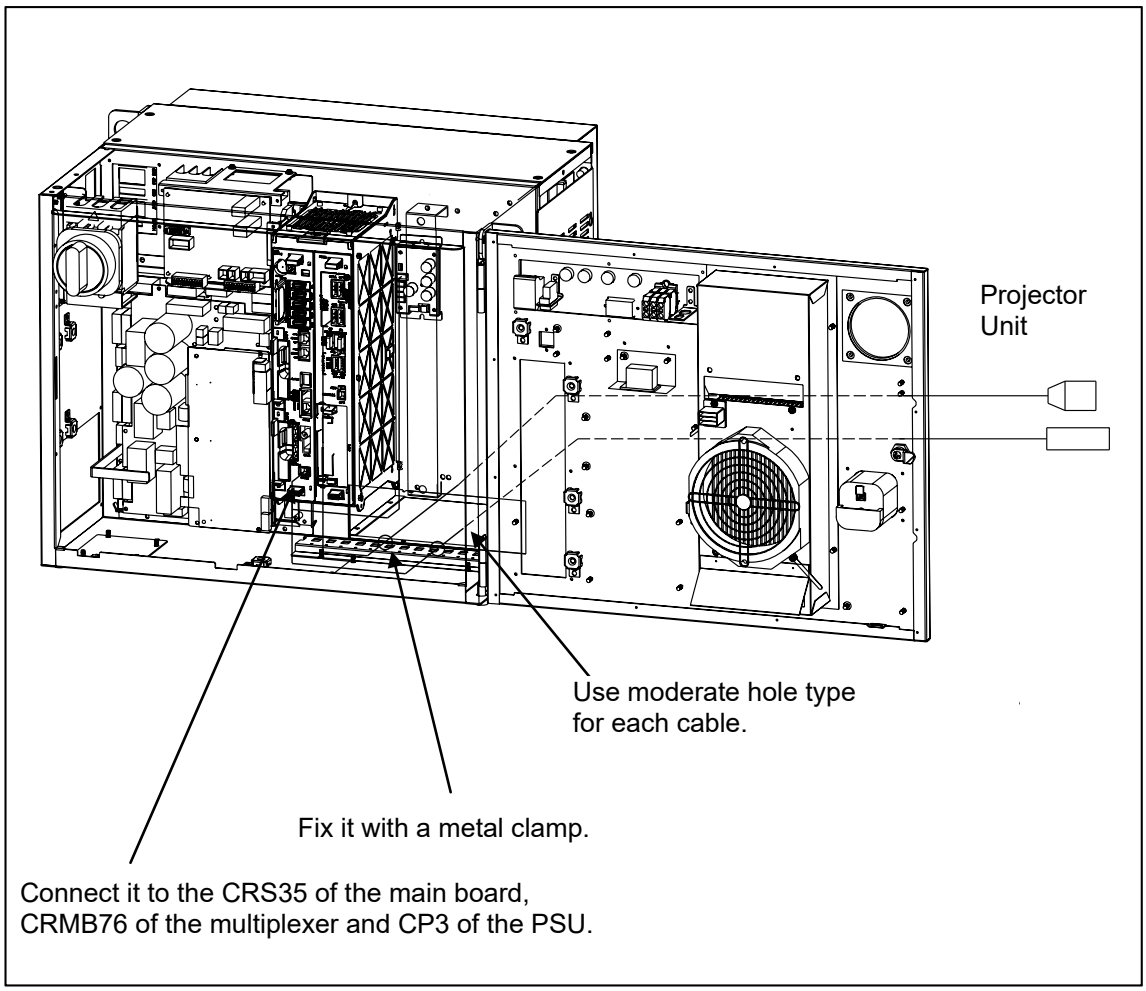


Fig. 2.8.2 (a) Projector unit connection cable

For fixation

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2601-J090	A660-2007-T519#L7R303A A660-4005-T307#L7R303A	#E #E	7
A05B-2601-J091	A660-2007-T519#L14R33A A660-4005-T307#L14R33A	#E #E	14
A05B-2601-J092	A660-2007-T519#L20R33A A660-4005-T307#L20R33A	#E #E	20
A05B-2601-J093	A660-2007-T519#L25R33A A660-4005-T307#L25R33A	#E #E	25

For rail axis

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2602-J090	A660-2007-T519#L7R303A A660-4005-T519#L7R303A	#E #E	7
A05B-2602-J091	A660-2007-T519#L14R33A A660-4005-T519#L14R33A	#E #E	14
A05B-2602-J092	A660-2007-T519#L20R33A A660-4005-T519#L20R33A	#E #E	20
A05B-2602-J093	A660-2007-T519#L25R33A A660-4005-T519#L25R33A	#E #E	25

2.8.3 Force sensor connection cable (A-cabinet)

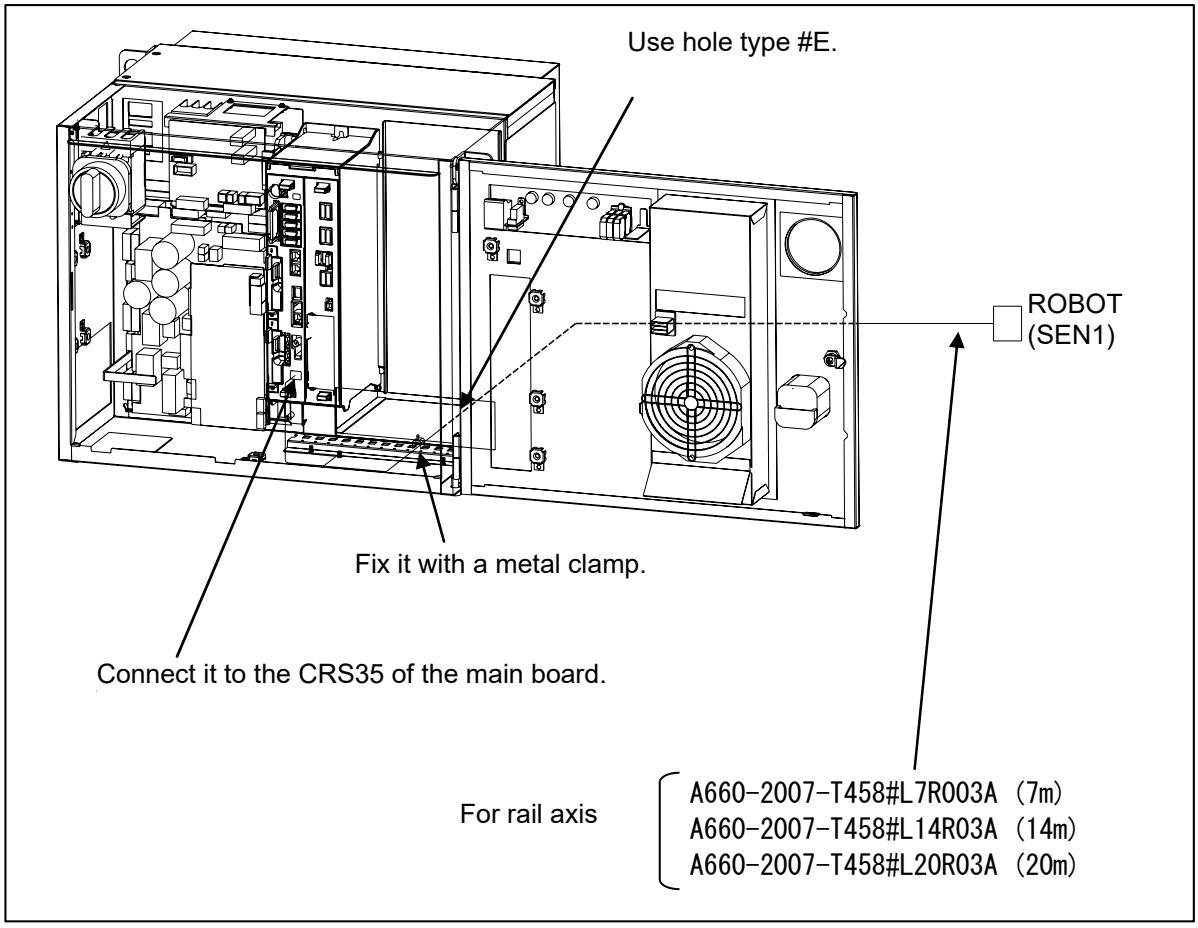


Fig. 2.8.3 (a) Force sensor connection cable

2.8.4 3DV/1600 power cable (A-cabinet)

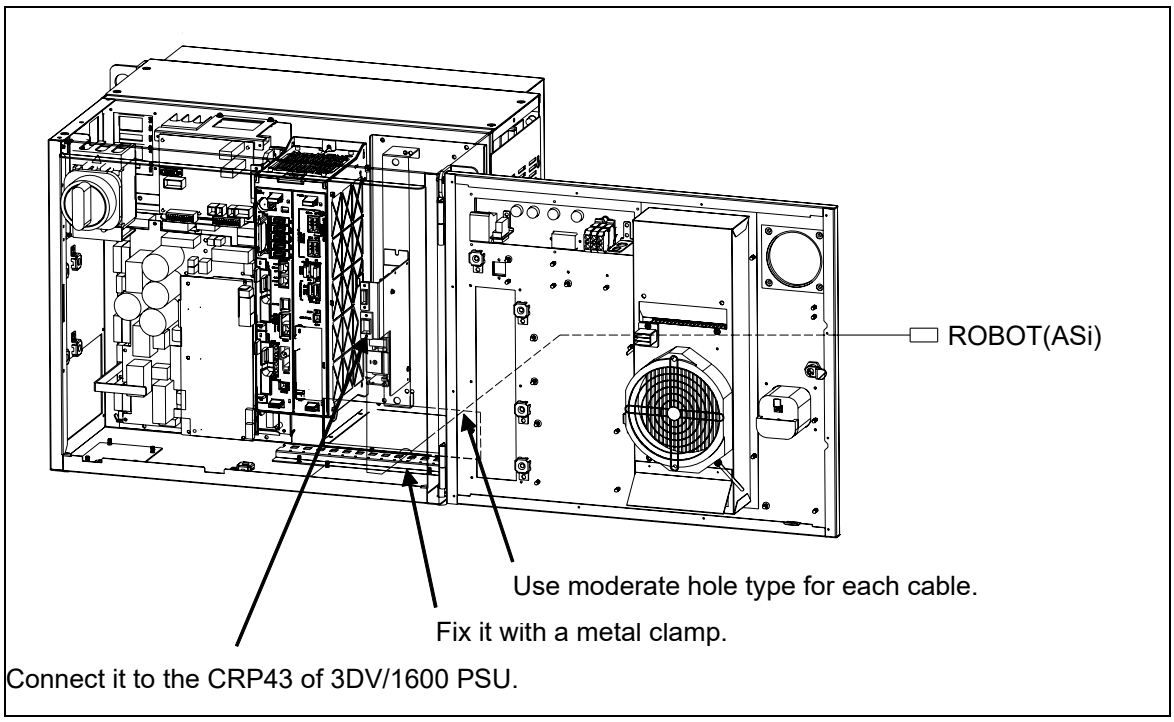


Fig. 2.8.4 (a) 3DV/1600 power cable

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2671-J120	A660-2008-T613#L7R003A	#C	7
A05B-2671-J121	A660-2008-T613#L14R03A	#C	14
A05B-2671-J122	A660-2008-T613#L20R03A	#C	20
A05B-2671-J123	A660-2008-T613#L25R03A	#C	25

Cable entrance of the A-cabinet

When inserting a cable into an A-cabinet, use moderate cable hole type. Refer to FANUC Robot series R-30*i*B/R-30*i*B Plus Controller maintenance manual (B-83195EN) for details.

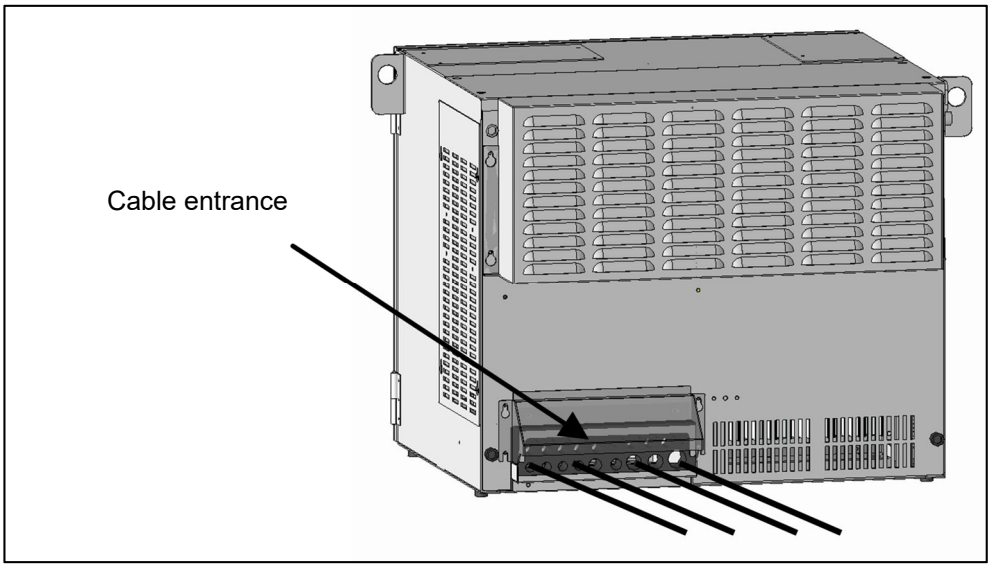


Fig. 2.8.4 (b) Cable entrance of the A-cabinet

2.8.5 Camera Connection Cable (B-cabinet)

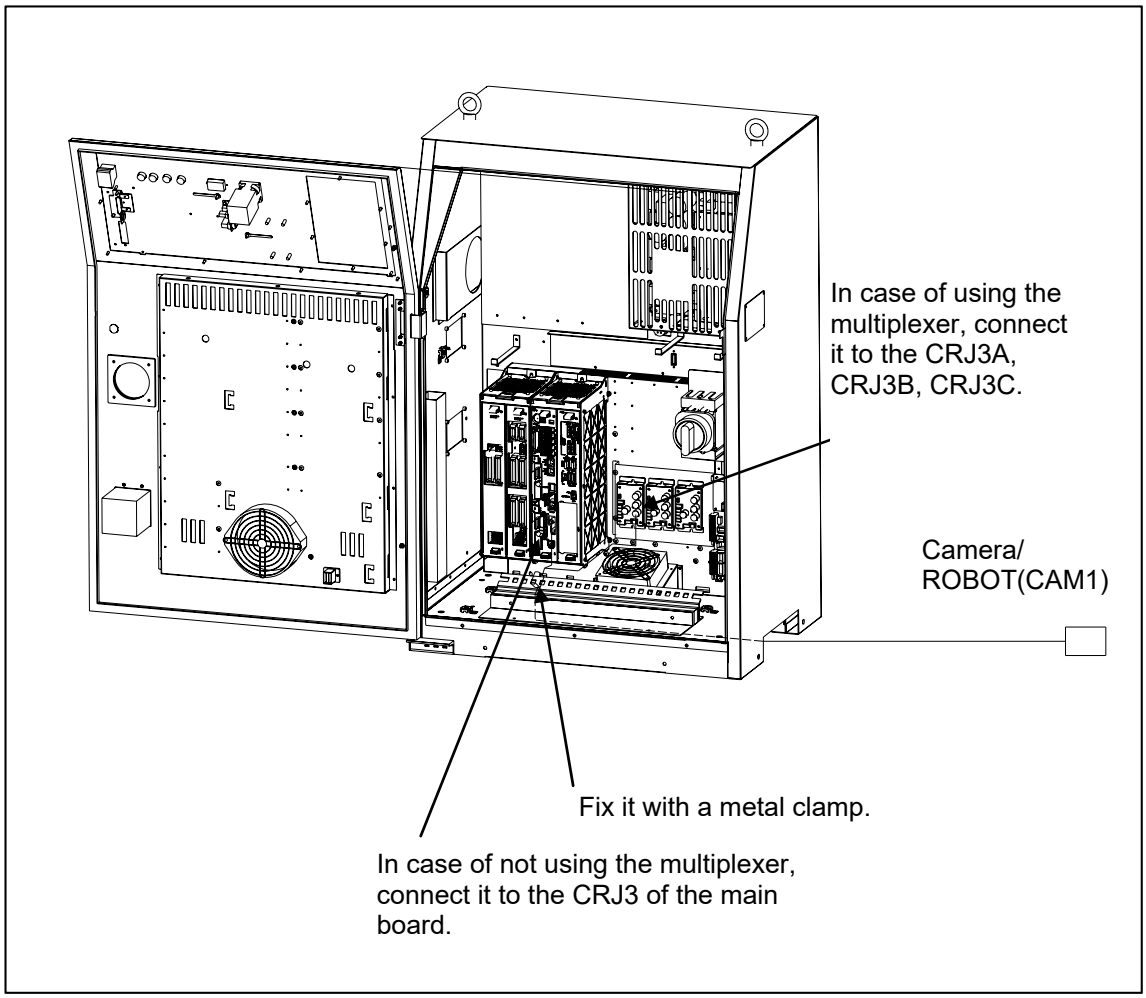


Fig. 2.8.5 (a) Camera connection cable

For fixation part

Order spec.	Old cable spec.	New cable spec.	Length (m)
A05B-2672-J060	A660-2008-T223#L7R003B	A660-2008-T534#L7R003B	7
A05B-2672-J061	A660-2008-T223#L14R03B	A660-2008-T534#L14R03B	14
A05B-2672-J062	A660-2008-T223#L20R03B	A660-2008-T534#L20R03B	20
A05B-2672-J063	A660-2008-T223#L25R03B	A660-2008-T534#L25R03B	25

For rail axis

Order spec.	Cable spec.	Length (m)
A05B-2672-J040	A660-2008-T435#L7R003B	7
A05B-2672-J041	A660-2008-T435#L14R03B	14
A05B-2672-J042	A660-2008-T435#L20R03B	20
A05B-2672-J043	A660-2008-T435#L25R03B	25

2.8.6 Projector unit connection cable (B-cabinet)

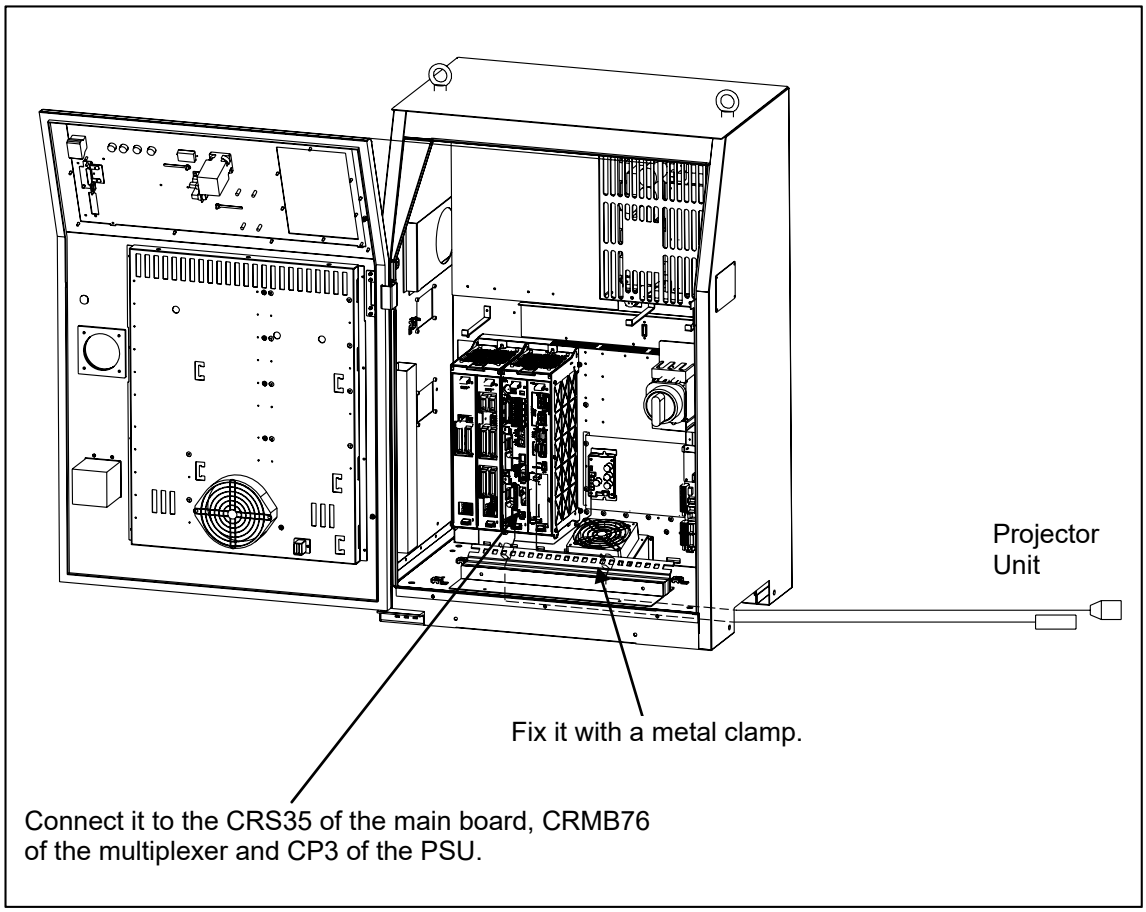


Fig. 2.8.6 (a) Projector unit connection cable

For fixation part

Order spec.	Cable spec.	Length (m)
A05B-2603-J090	A660-2007-T519#L7R503B A660-4005-T307#L7R503B	7
A05B-2603-J091	A660-2007-T519#L14R53B A660-4005-T307#L14R53B	14
A05B-2603-J092	A660-2007-T519#L20R53B A660-4005-T307#L20R53B	20
A05B-2603-J093	A660-2007-T519#L25R53B A660-4005-T307#L25R53B	25

For rail axis

Order spec.	Cable spec.	Length (m)
A05B-2604-J090	A660-2007-T519#L7R503B A660-4005-T519#L7R503B	7
A05B-2604-J091	A660-2007-T519#L14R53B A660-4005-T519#L14R53B	14
A05B-2604-J092	A660-2007-T519#L20R53B A660-4005-T519#L20R53B	20
A05B-2604-J093	A660-2007-T519#L25R53B A660-4005-T519#L25R53B	25

2.8.7 Force Sensor Connection Cable (B-cabinet)

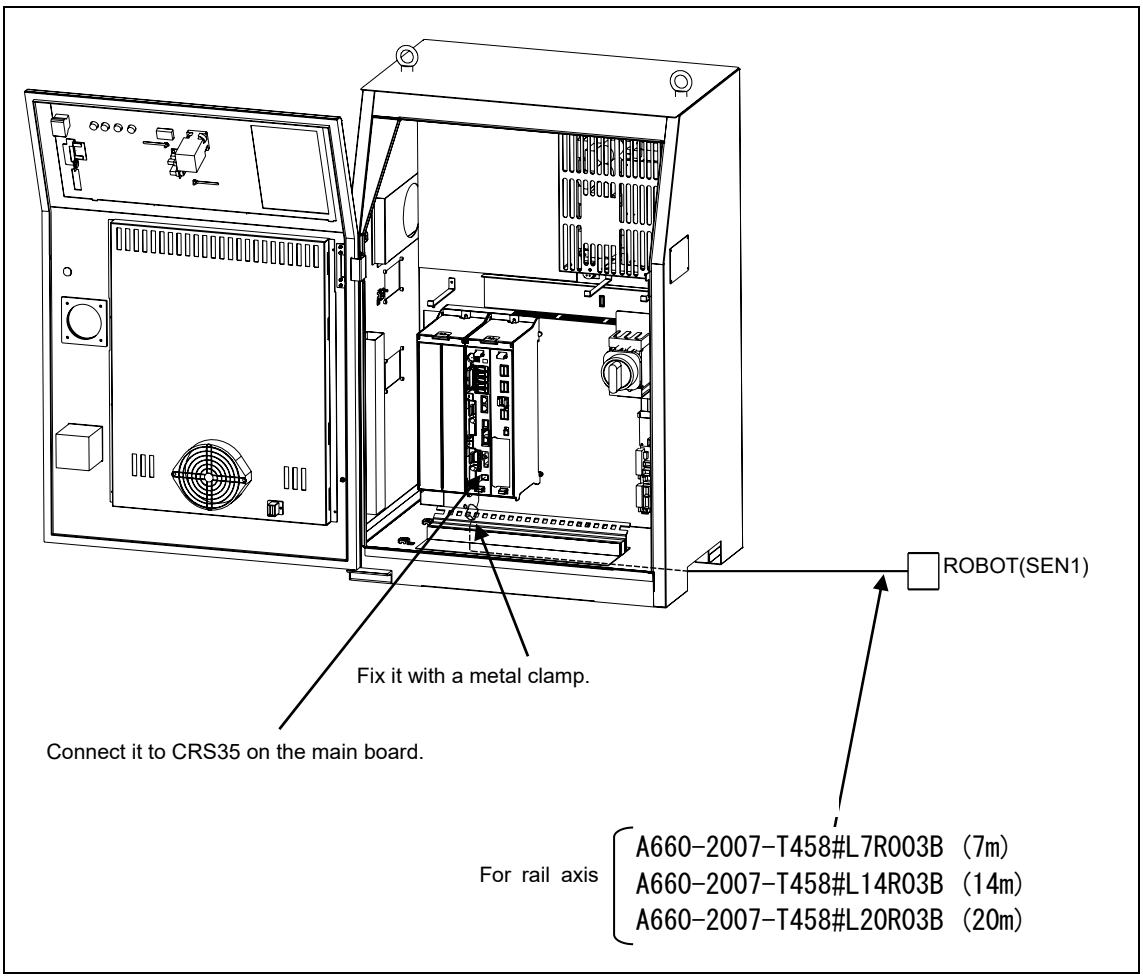


Fig. 2.8.7 (a) Force sensor connection cable

2.8.8 3DV/1600 power cable (B-cabinet)

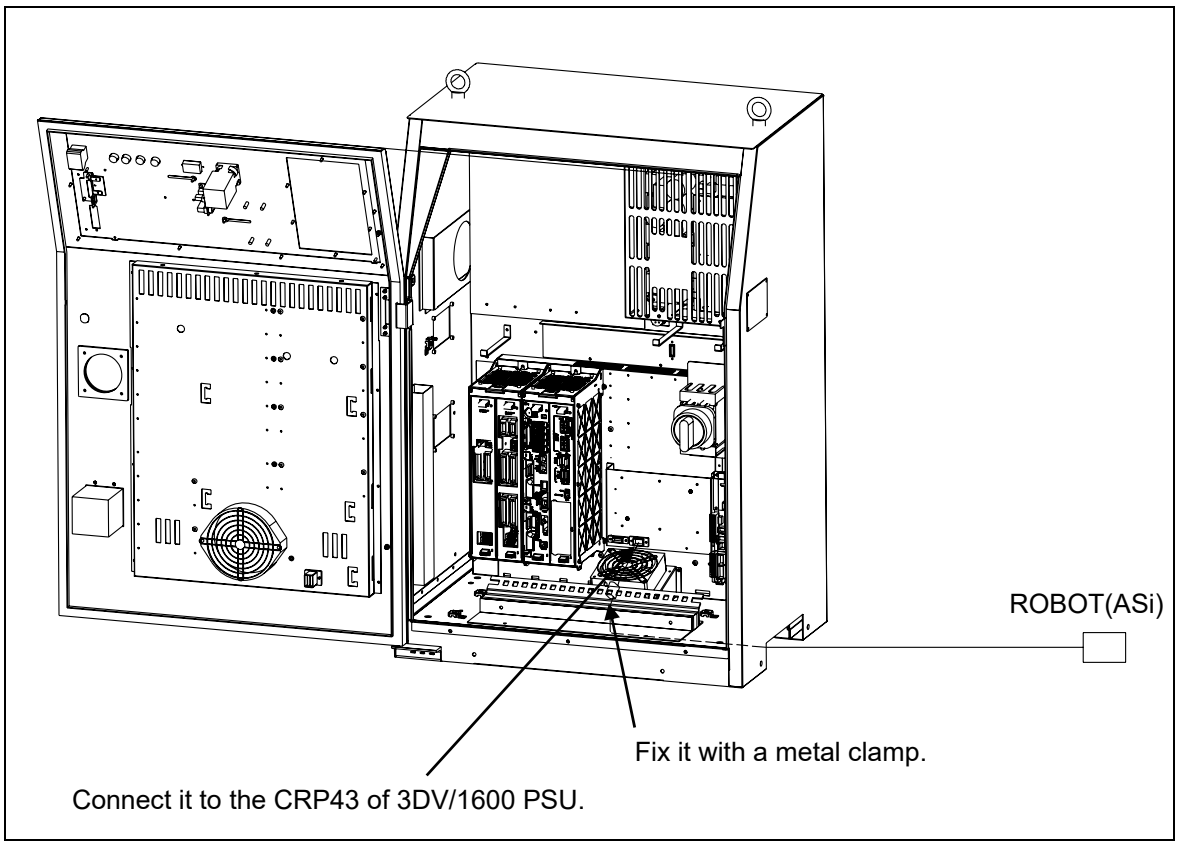


Fig. 2.8.8 (a) 3DV/1600 power cable

Order spec.	Cable spec.	Length (m)
A05B-2672-J120	A660-2008-T613#L7R003B	7
A05B-2672-J121	A660-2008-T613#L14R03B	14
A05B-2672-J122	A660-2008-T613#L20R03B	20
A05B-2672-J123	A660-2008-T613#L25R03B	25

2.8.9 Camera Connection Cable (R-30*i*B Mate Plus)

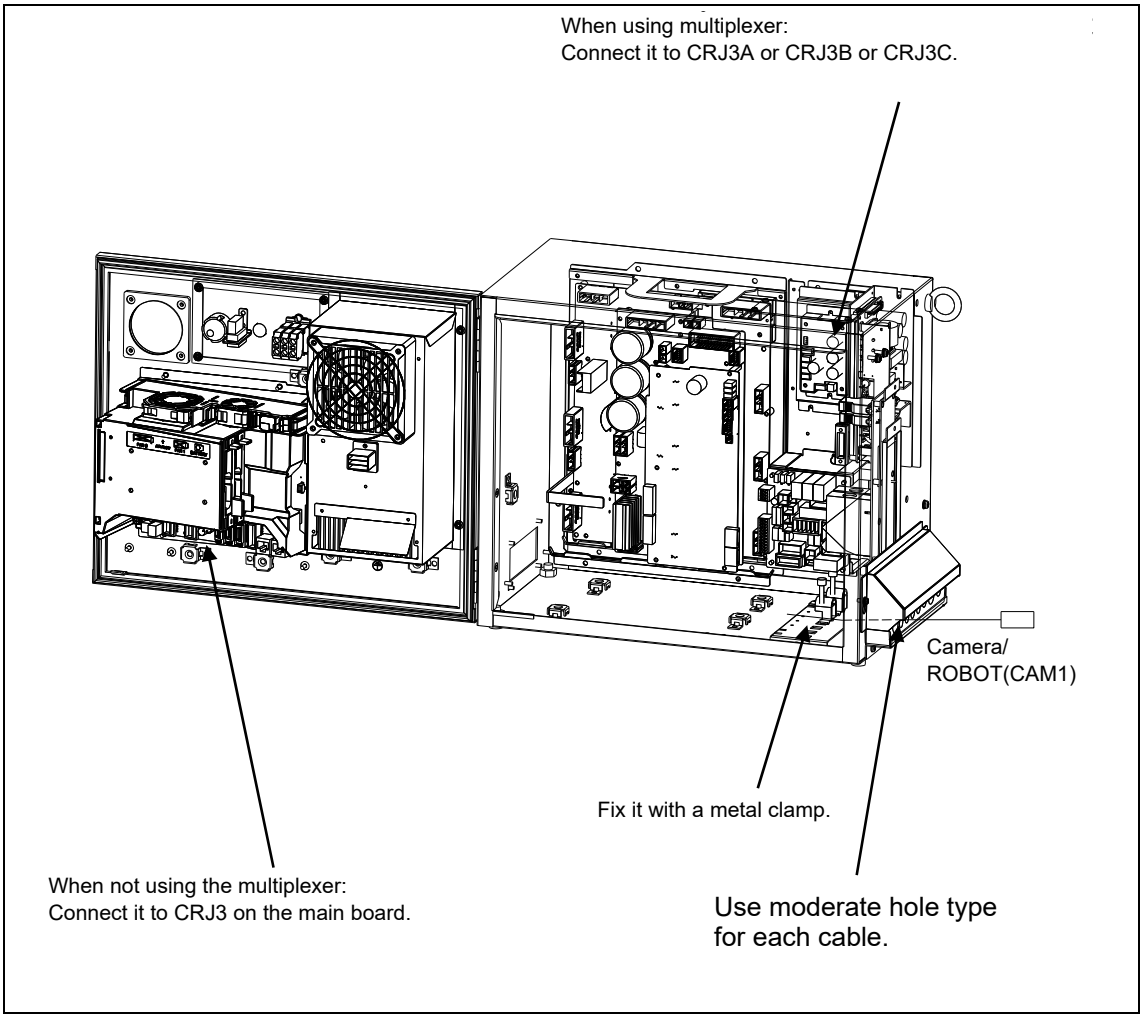


Fig. 2.8.9 (a) Camera connection cable

For fixation (in case of connected to the main board)

Order spec.	Old cable spec.	New cable spec.	Fit hole type	Length (m)
A05B-2680-J331	A660-2008-T223#L2R003D	A660-2008-T534#L2R003D	#E	2
A05B-2680-J340	A660-2008-T223#L7R003D	A660-2008-T534#L7R003D	#E	7
A05B-2680-J341	A660-2008-T223#L14R03D	A660-2008-T534#L14R03D	#E	14
A05B-2680-J342	A660-2008-T223#L20R03D	A660-2008-T534#L20R03D	#E	20
A05B-2680-J343	A660-2008-T223#L25R03D	A660-2008-T534#L25R03D	#E	25

For fixation (in case of connected to the multiplexer)

Order spec.	Old cable spec.	New cable spec.	Fit hole type	Length (m)
A05B-2680-J336	A660-2008-T223#L2R003C	A660-2008-T534#L2R003C	#E	2
A05B-2680-J345	A660-2008-T223#L7R003C	A660-2008-T534#L7R003C	#E	7
A05B-2680-J346	A660-2008-T223#L14R03C	A660-2008-T534#L14R03C	#E	14
A05B-2680-J347	A660-2008-T223#L20R03C	A660-2008-T534#L20R03C	#E	20
A05B-2680-J348	A660-2008-T223#L25R03C	A660-2008-T534#L25R03C	#E	25

For rail axis (in case of connected to the main board)

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2680-J320	A660-2008-T435#L7R003D	#C	7
A05B-2680-J321	A660-2008-T435#L14R03D	#C	14

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2680-J322	A660-2008-T435#L20R03D	#C	20
A05B-2680-J323	A660-2008-T435#L25R03D	#C	25

For rail axis (in case of connected to the multiplexer)

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2680-J325	A660-2008-T435#L7R003C	#C	7
A05B-2680-J326	A660-2008-T435#L14R03C	#C	14
A05B-2680-J327	A660-2008-T435#L20R03C	#C	20
A05B-2680-J328	A660-2008-T435#L25R03C	#C	25

2.8.10 Projector unit connection cable (R-30*i*B Mate Plus)

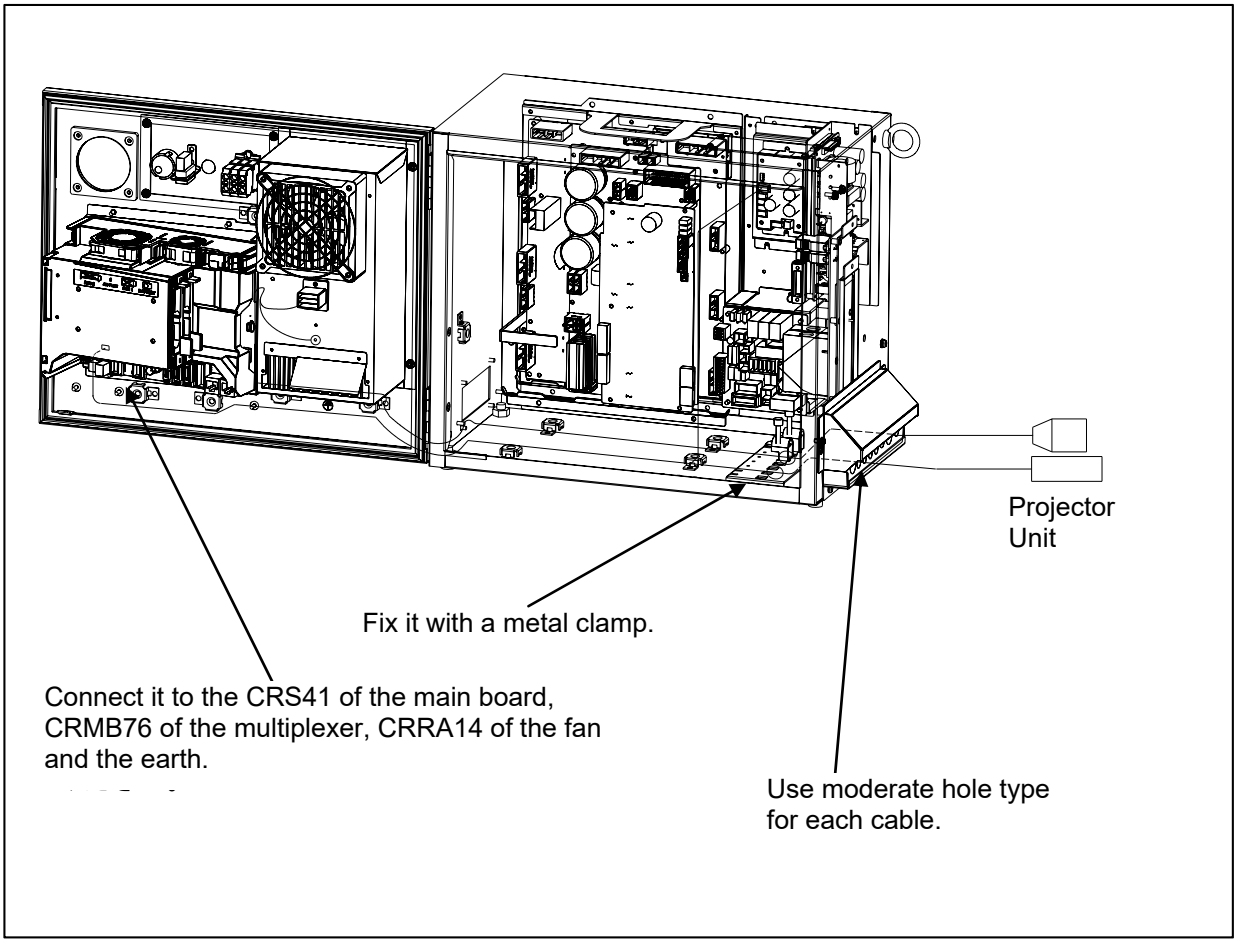


Fig. 2.8.10 (a) Projector unit connection cable

For fixation part

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2650-J390	A660-8018-T508#L7R203 A660-4005-T391#L7R203	#E #E	7
A05B-2650-J391	A660-8018-T508#L14R23 A660-4005-T391#L14R23	#E #E	14
A05B-2650-J392	A660-8018-T508#L20R23 A660-4005-T391#L20R23	#E #E	20
A05B-2650-J393	A660-8018-T508#L25R23 A660-4005-T391#L25R23	#E #E	25

For rail axis

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2650-J450	A660-8018-T508#L7R203 A660-4005-T520#L7R203	#E #E	7
A05B-2650-J451	A660-8018-T508#L14R23 A660-4005-T520#L14R23	#E #E	14
A05B-2650-J452	A660-8018-T508#L20R23 A660-4005-T520#L20R23	#E #E	20
A05B-2650-J453	A660-8018-T508#L25R23 A660-4005-T520#L25R23	#E #E	25

2.8.11 Force sensor connection cable (R-30*i*B Mate Plus)

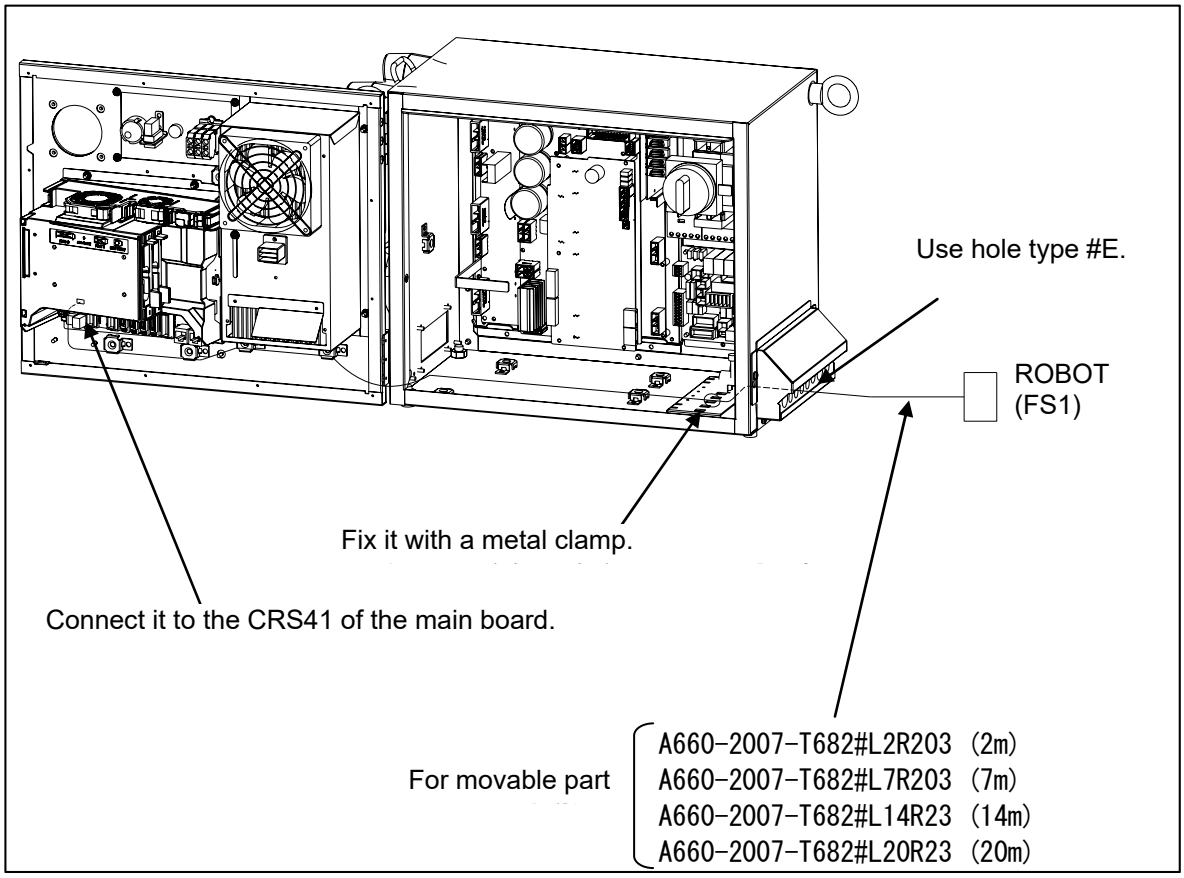


Fig. 2.8.11 (a) Force sensor connection cable

2.8.12 3DV/1600 power cable (R-30*i*B Mate Plus)

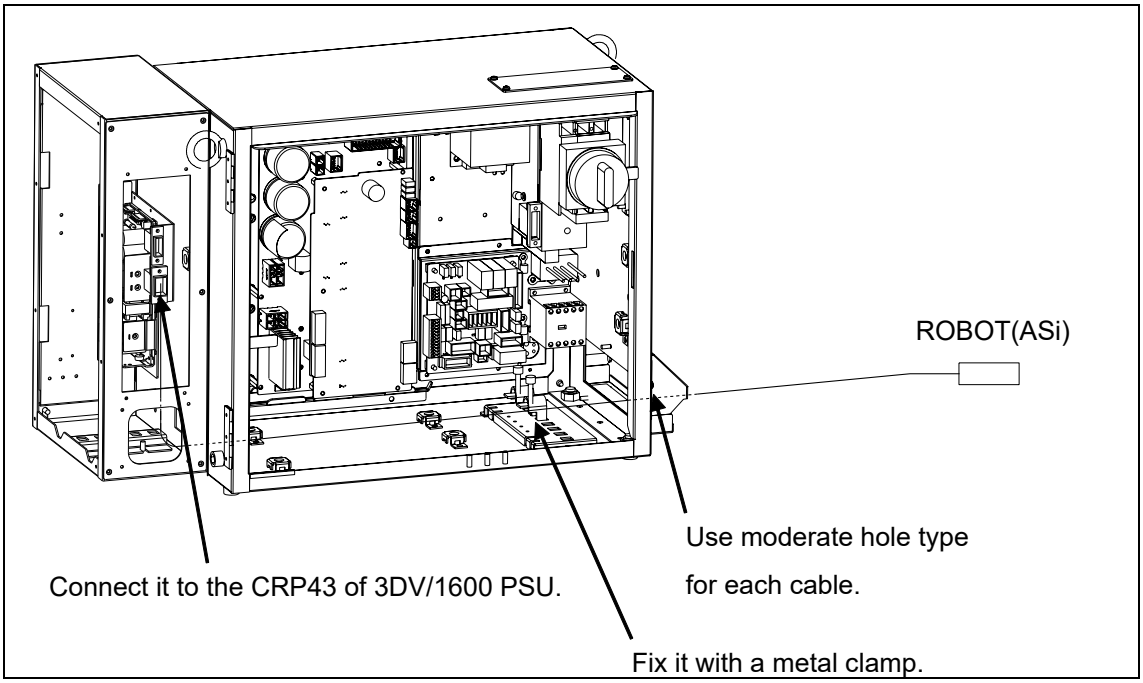


Fig. 2.8.12 (a) 3DV/1600 power cable

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2680-J450	A660-2008-T613#L7R003C	#C	7
A05B-2680-J451	A660-2008-T613#L14R03C	#C	14
A05B-2680-J452	A660-2008-T613#L20R03C	#C	20
A05B-2680-J453	A660-2008-T613#L25R03C	#C	25

Cable entrance of the R-30*i*B Mate Plus

When inserting a cable into the R-30*i*B Mate Plus, use moderate hole type. Refer to Controller maintenance manual (B-83525EN) for details.

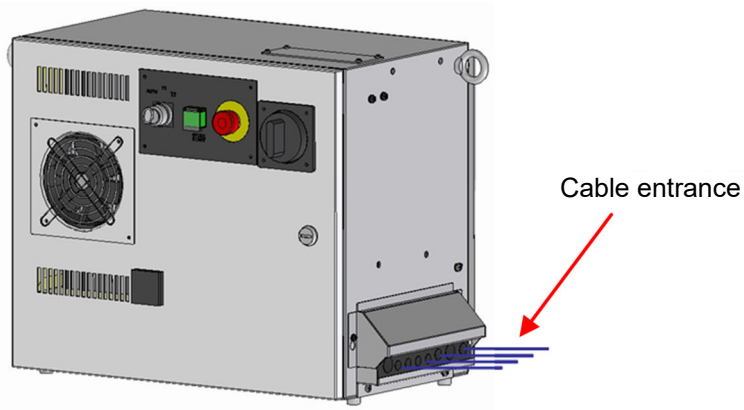


Fig. 2.8.12 (b) Cable entrance of the R-30*i*B Mate Plus

2.8.13 Camera connection cable (R-30*i*B Mate Plus open air type)

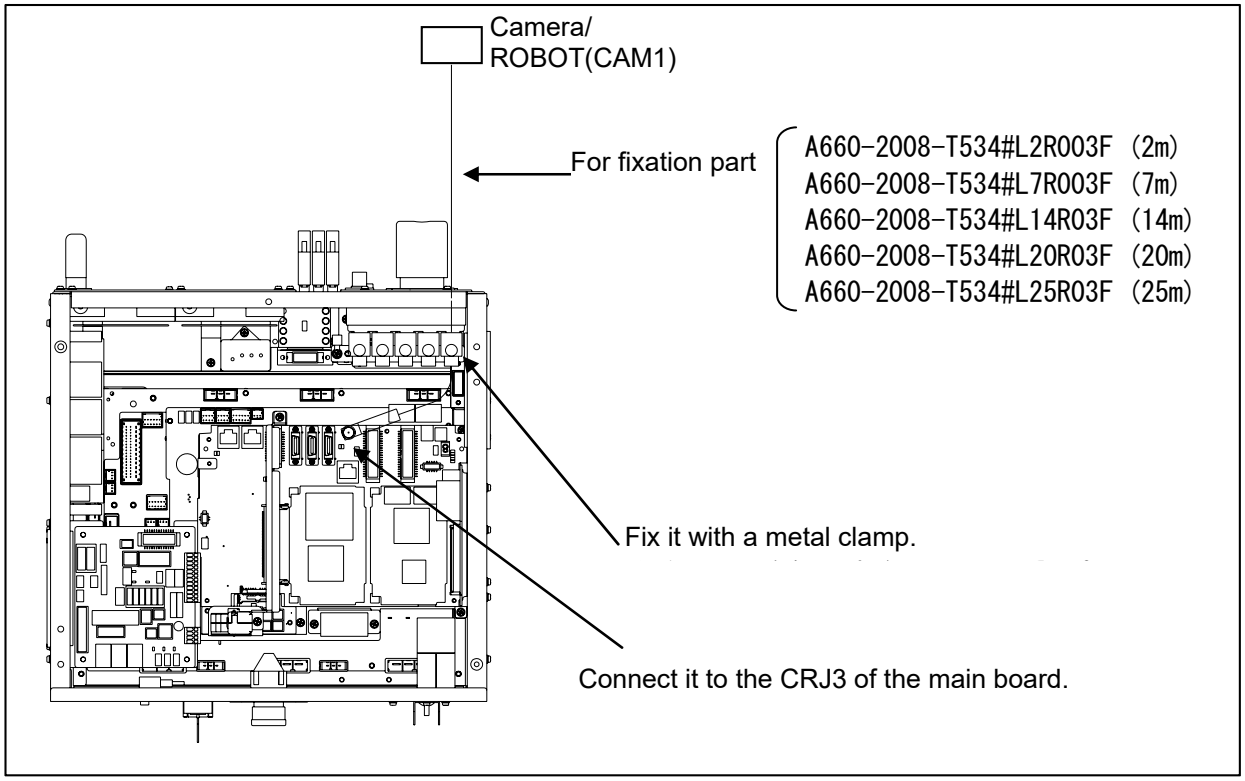


Fig. 2.8.13 (a) Camera connection cable

2.8.14 Force sensor connection cable (R-30*i*B Mate Plus open air type)

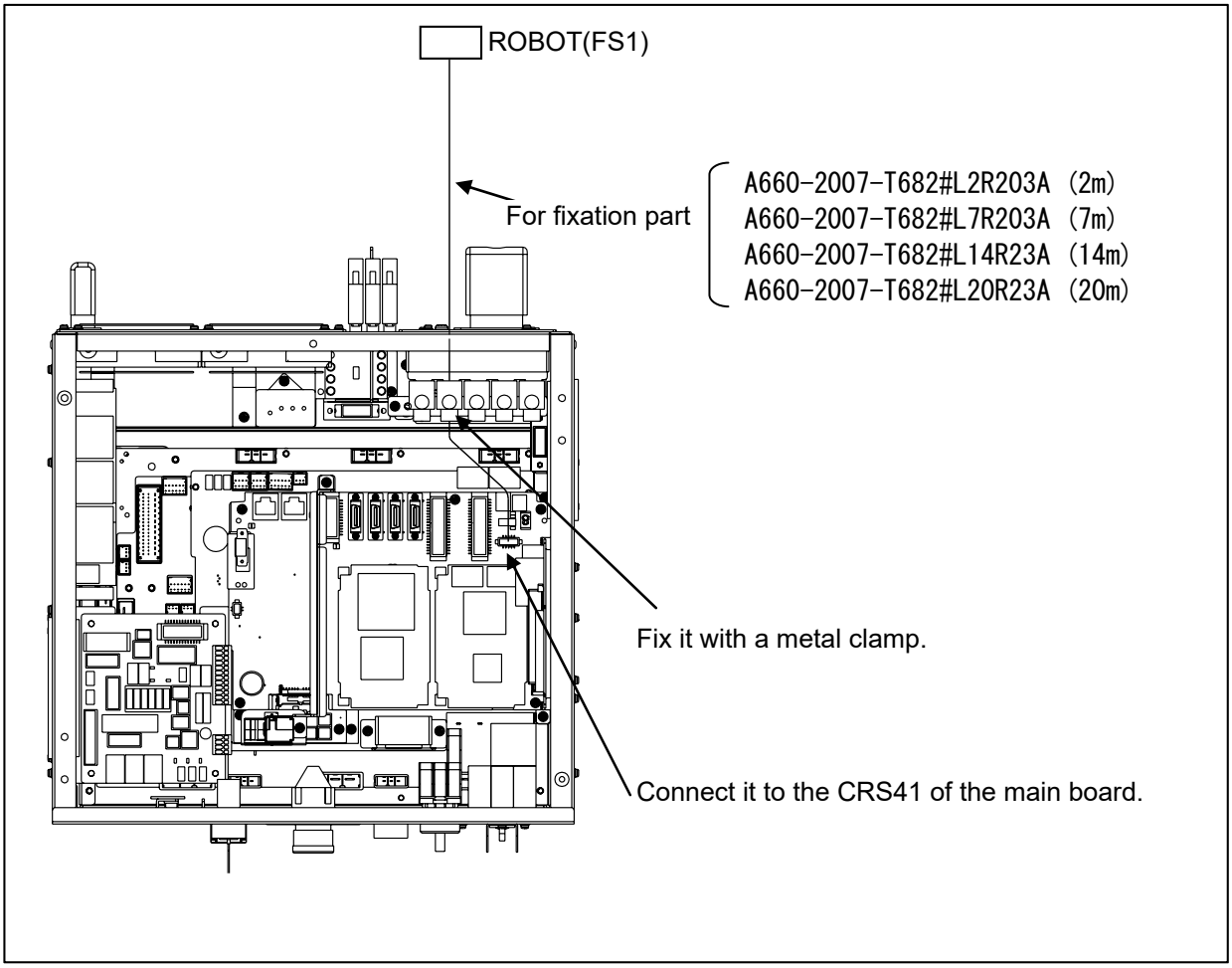


Fig. 2.8.14 (a) Force sensor connection cable

2.8.15 Camera connection cable (R-30*i*B Compact Plus)

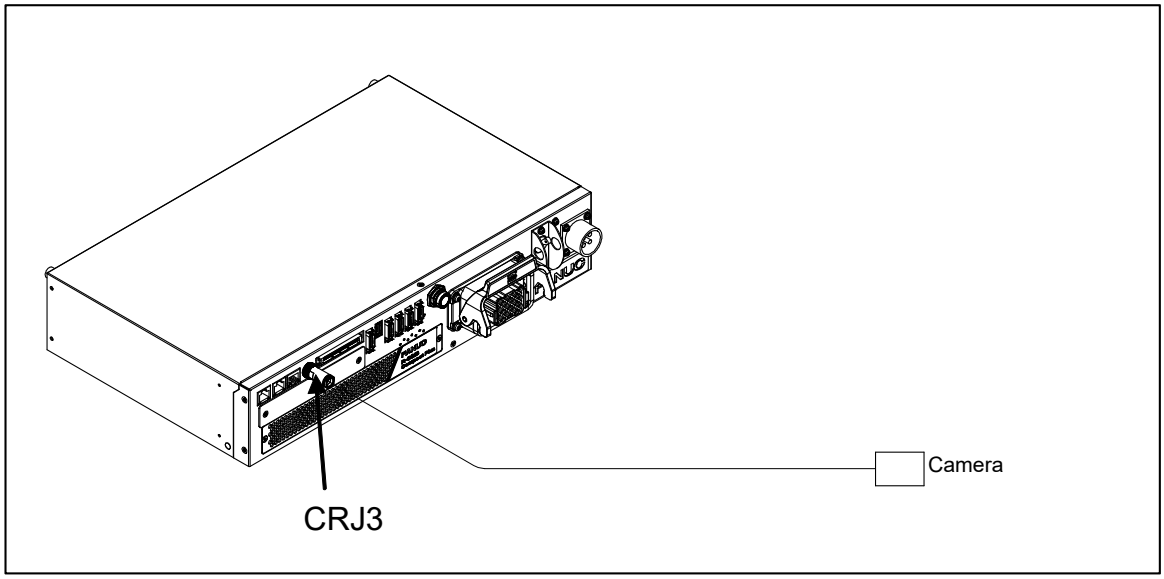


Fig. 2.8.15 (a) Camera connection cable

For fixation part

Order spec.	Old cable spec.	New cable spec.	Length (m)
A05B-2690-J340	A660-2008-T223#L7R003E	A660-2008-T534#L7R003E	7
A05B-2690-J341	A660-2008-T223#L14R03E	A660-2008-T534#L14R03E	14
A05B-2690-J342	A660-2008-T223#L20R03E	A660-2008-T534#L20R03E	20
A05B-2690-J343	A660-2008-T223#L25R03E	A660-2008-T534#L25R03E	25

For rail axis

Order spec.	Cable spec.	Length (m)
A05B-2690-J320	A660-2008-T435#L7R003E	7
A05B-2690-J321	A660-2008-T435#L14R03E	14
A05B-2690-J322	A660-2008-T435#L20R03E	20
A05B-2690-J323	A660-2008-T435#L25R03E	25

2.8.16 Camera connection cable (R-30*i*B Mini Plus)

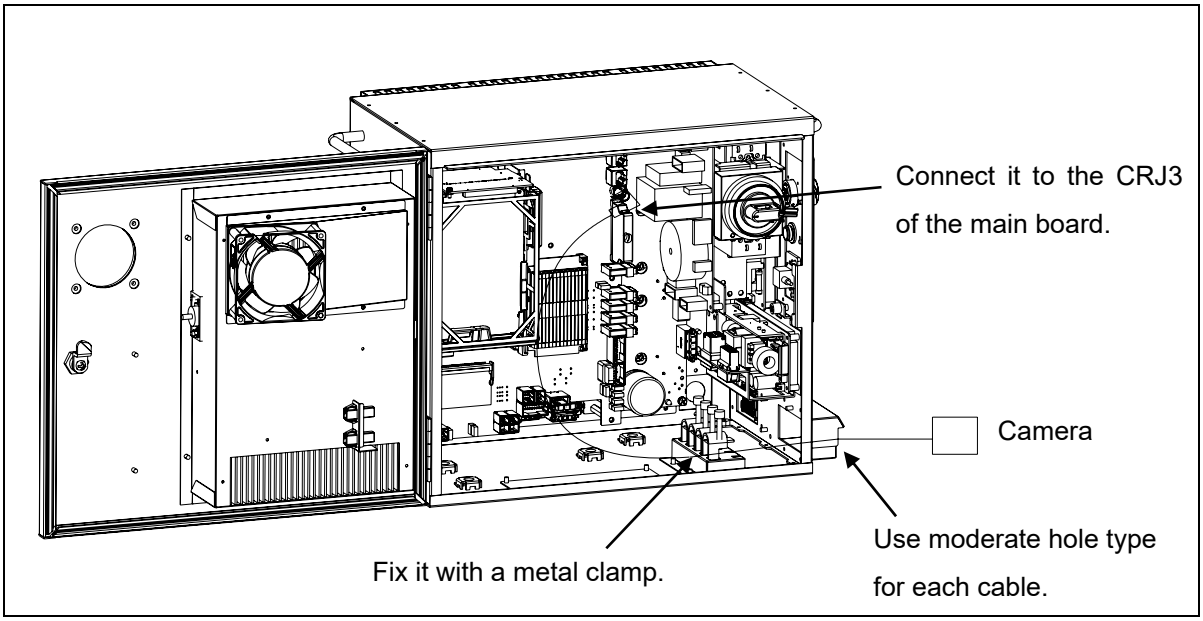


Fig. 2.8.16 (a) Camera connection cable

For fixation part

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2696-J340	A660-2008-T534#L1R503G	#E	1.5
A05B-2696-J341	A660-2008-T534#L2R503G	#E	2.5
A05B-2696-J342	A660-2008-T534#L5R503G	#E	5.5
A05B-2696-J343	A660-2008-T534#L8R503G	#E	8.5
A05B-2696-J344	A660-2008-T534#L15R53G	#E	15.5

For rail axis

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2696-J323	A660-2008-T435#L8R503H	#C	8.5
A05B-2680-J324	A660-2008-T435#L15R53H	#C	15.5
A05B-2680-J325	A660-2008-T435#L21R53H	#C	21.5
A05B-2680-J326	A660-2008-T435#L25R03H	#C	25

2.8.17 Force sensor connection cable (R-30*i*B Mini Plus)

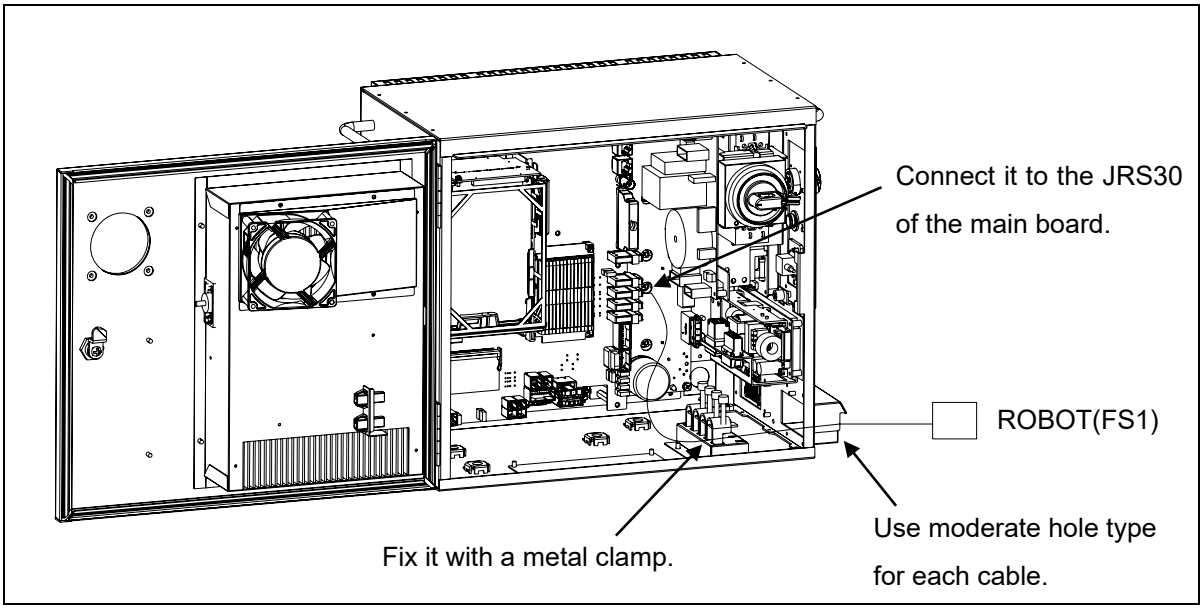


Fig. 2.8.17 (a) Force sensor connection cable

Order spec.	Cable spec.	Fit hole type	Length (m)
A05B-2696-J350	A660-2008-T785#L1R503	#E	1.5
A05B-2696-J351	A660-2008-T785#L2R503	#E	2.5
A05B-2696-J352	A660-2008-T785#L5R503	#E	5.5
A05B-2696-J353	A660-2008-T785#L8R503	#E	8.5
A05B-2696-J354	A660-2008-T785#L15R53	#E	15.5

3 MOTION RANGE AND EXTERNAL DIMENSIONS

3.1 MOTION RANGE

Refer to the Mechanical Unit Manual for explanations of the motion range of each robot.
The motion range may be restricted by software to protect the sensor.

3.2 SENSOR EXTERNAL DIMENSIONS

3.2.1 Force Sensor

Fig. 3.2.1 (a) to (j) show the external dimensions of the force sensor head.
Also, see the descriptions of the mounting face dimensions for the end effector in the next chapter.

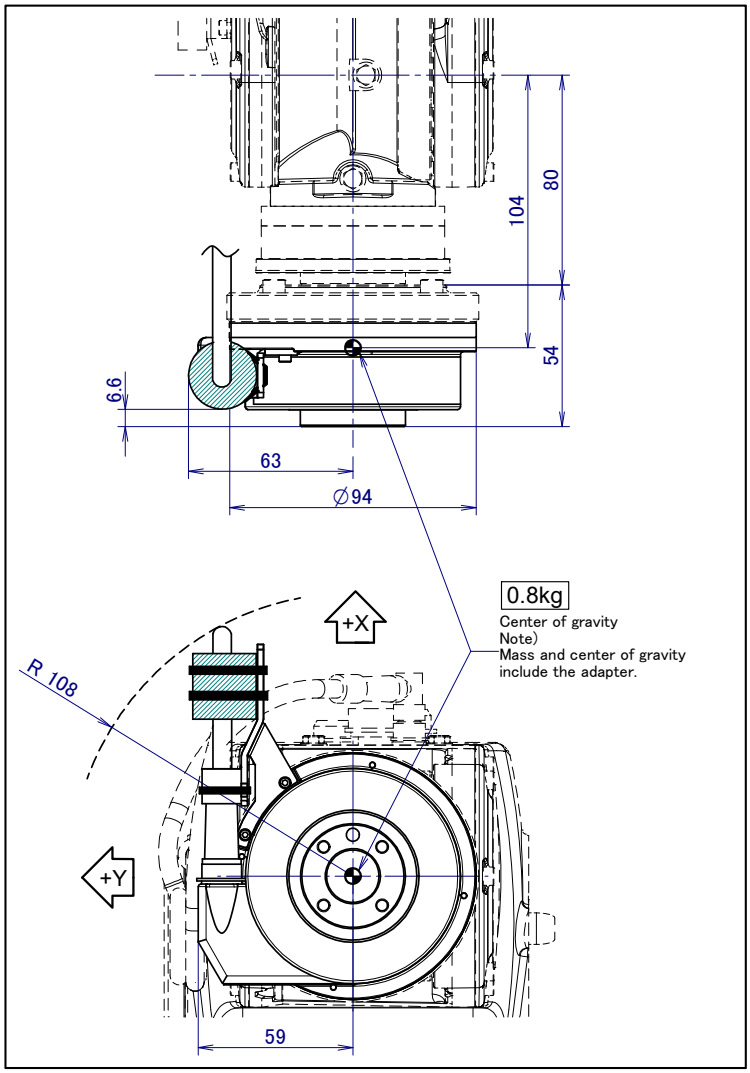


Fig. 3.2.1 (a) External dimensions of the force sensor head (Example of LR Mate 200*i*D + FS-15*i*A)

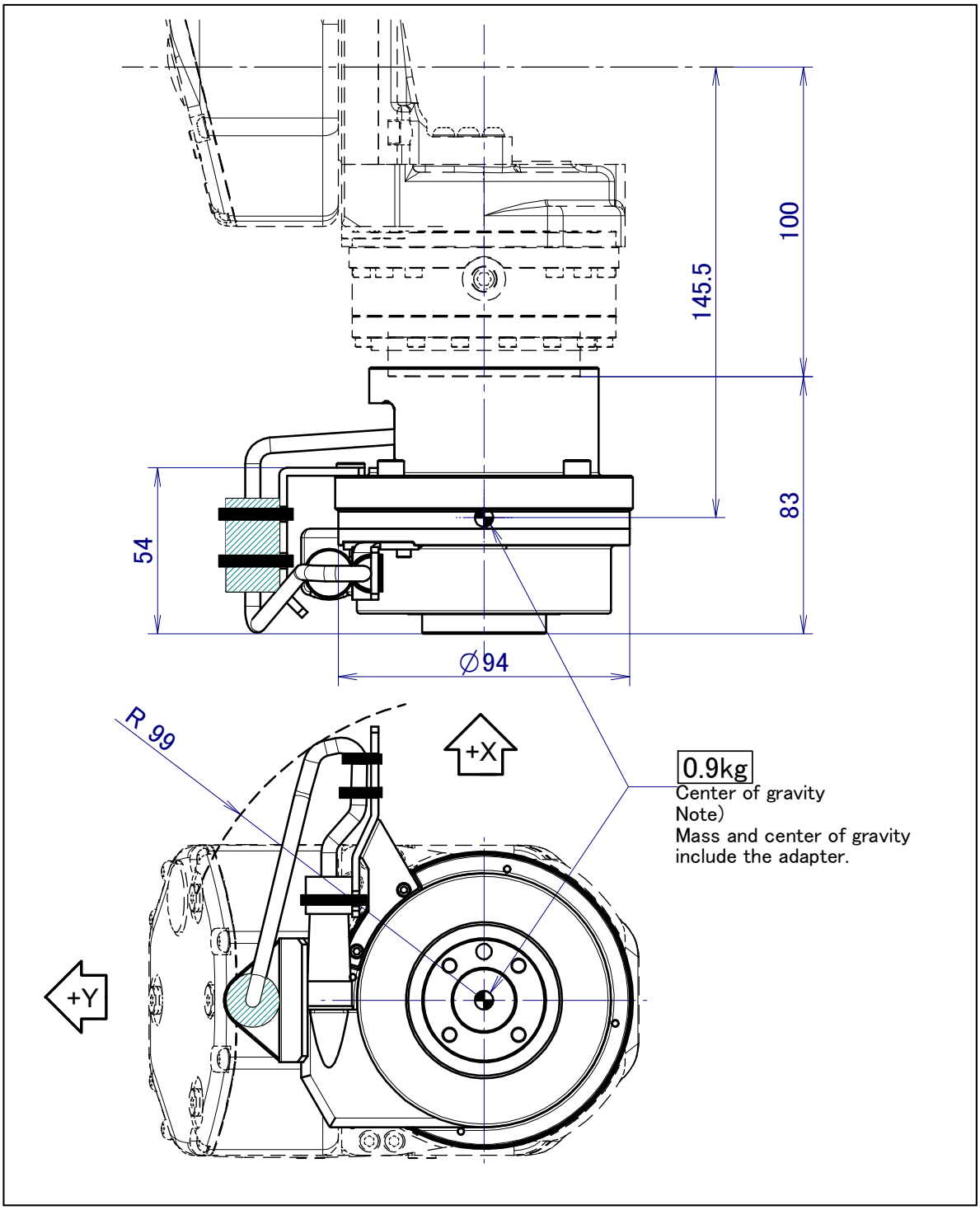


Fig. 3.2.1 (b) External dimensions of the force sensor head
(Example of M-10*i*A + FS-15*i*A)

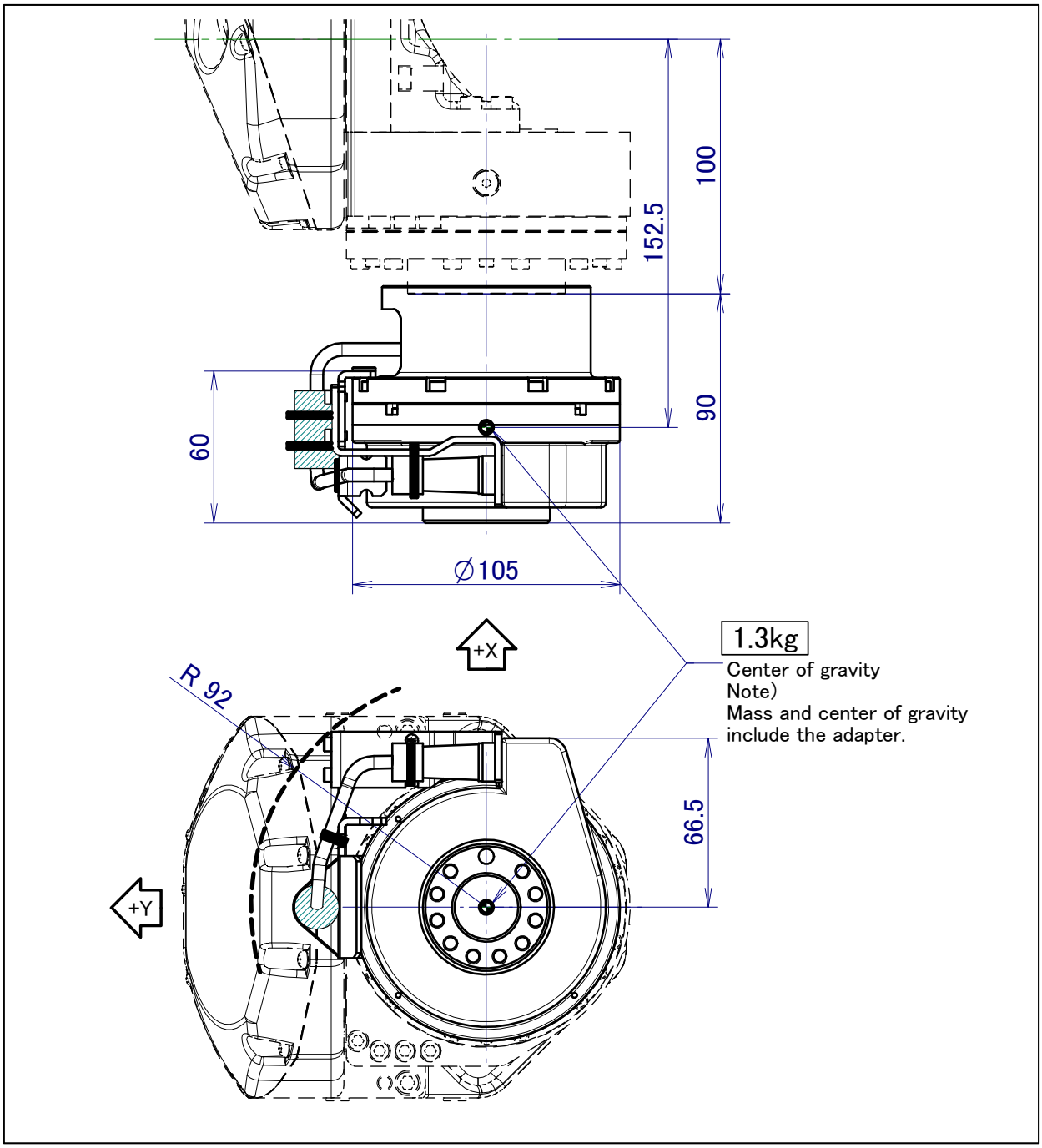


Fig. 3.2.1 (c) External dimensions of the force sensor head
(Example of M-20*i*A + FS-40*i*A)

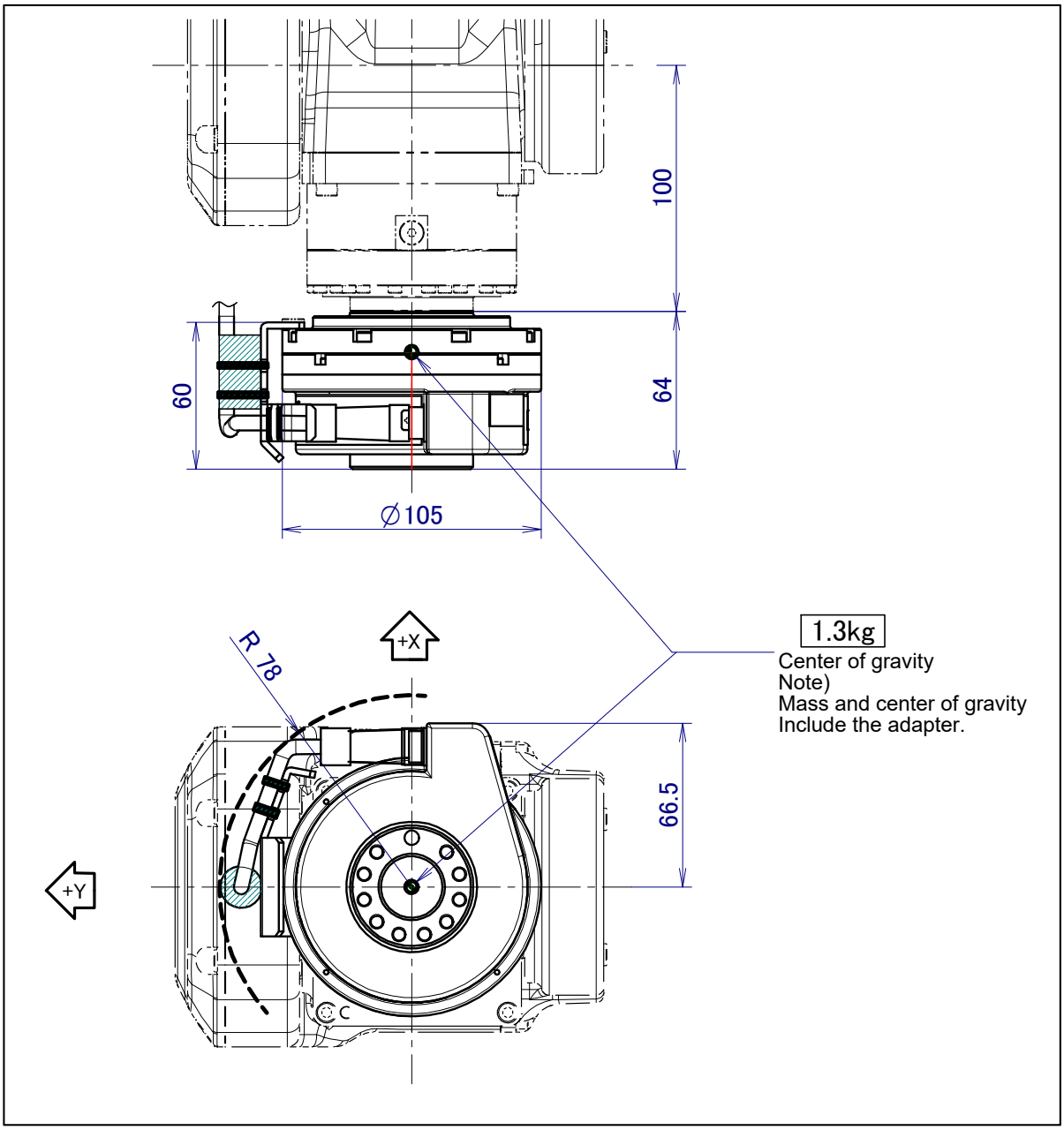


Fig. 3.2.1 (d) External dimensions of the force sensor head
(Example of M-20*i*A/20M/35M + FS-40*i*A)

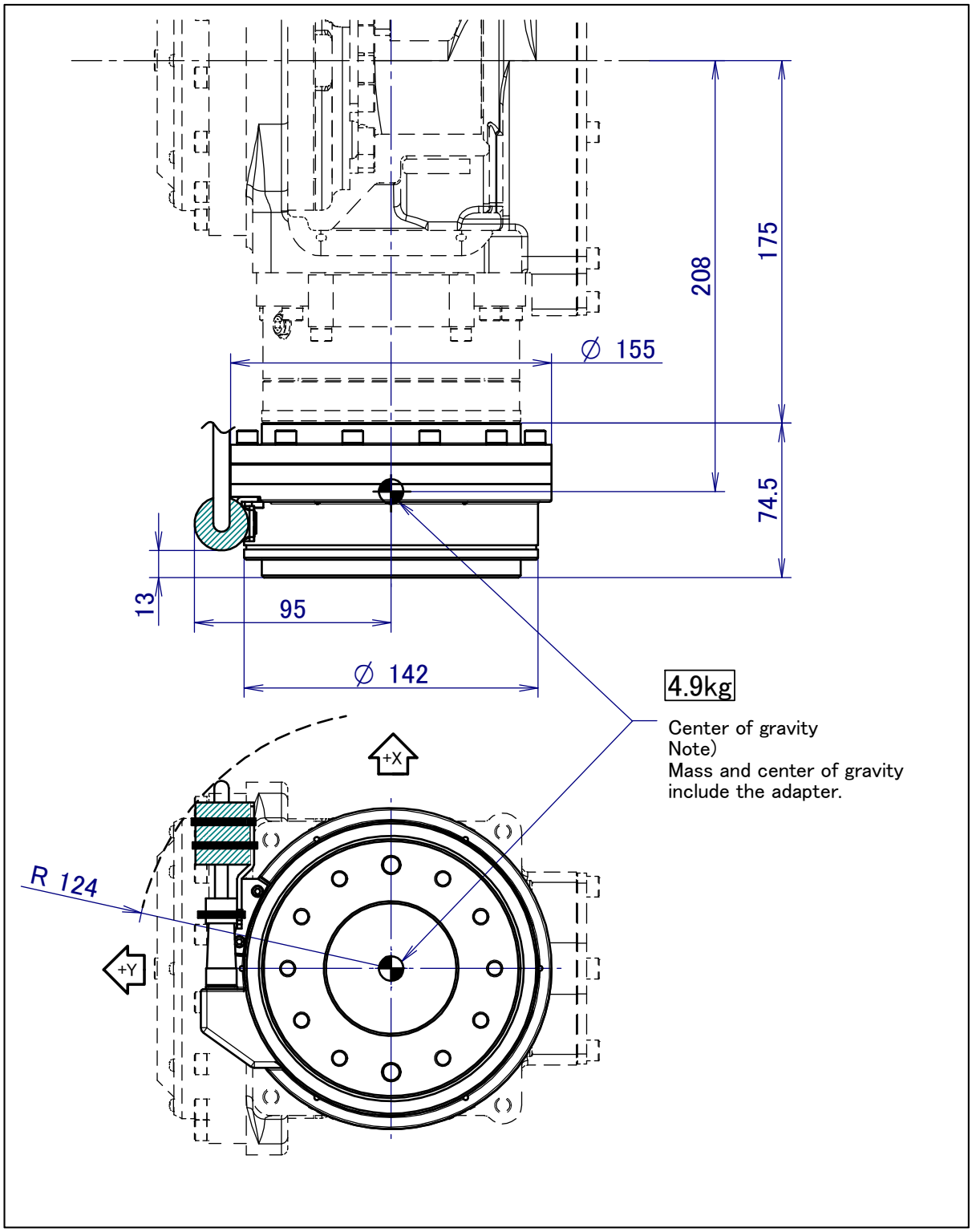


Fig. 3.2.1 (e) External dimensions of the force sensor head
(Example of M-710*i*C + FS-100*i*A)

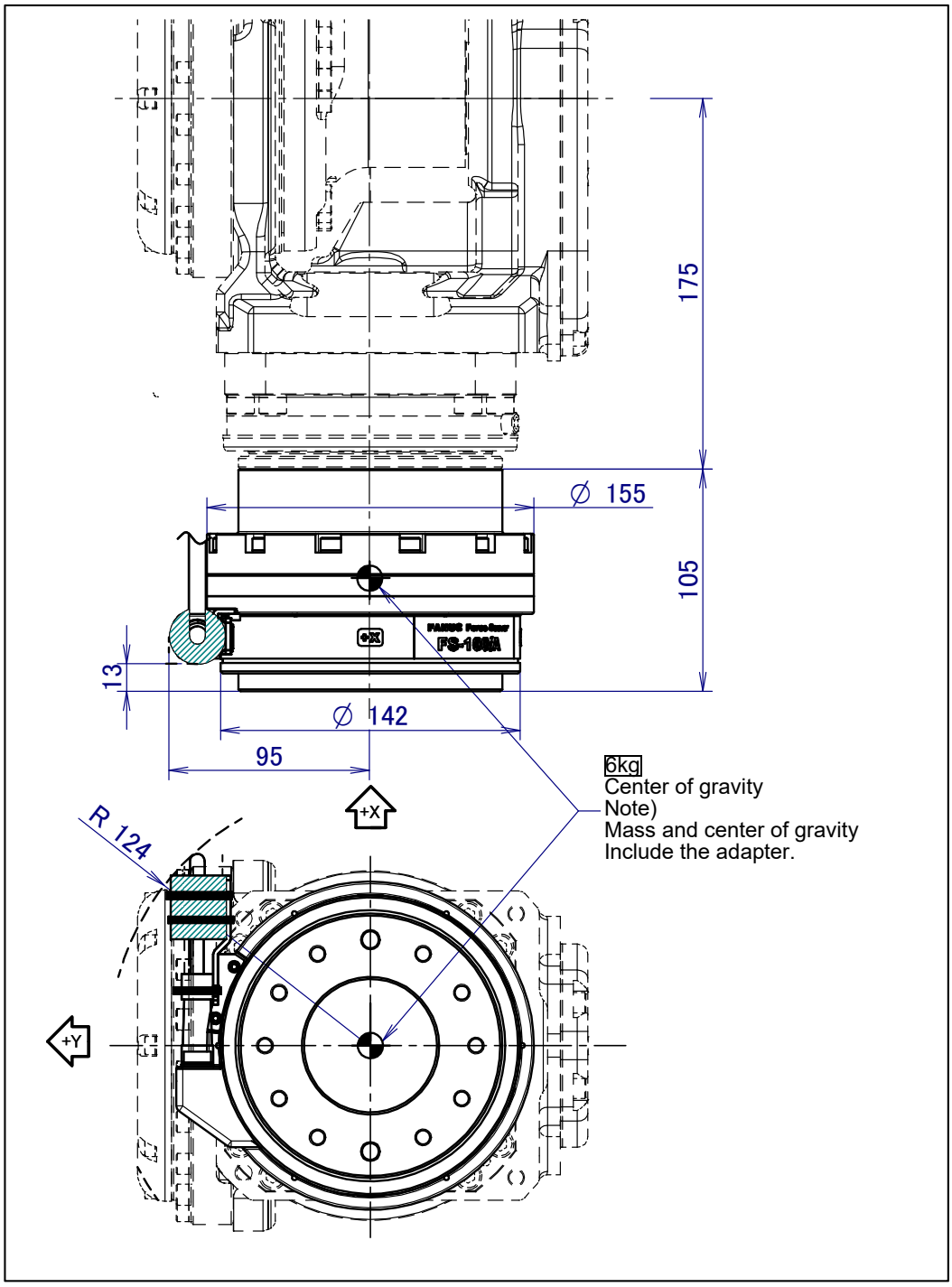


Fig. 3.2.1 (f) External dimensions of the force sensor head
(Example of R-1000*i*A + FS-100*i*A)

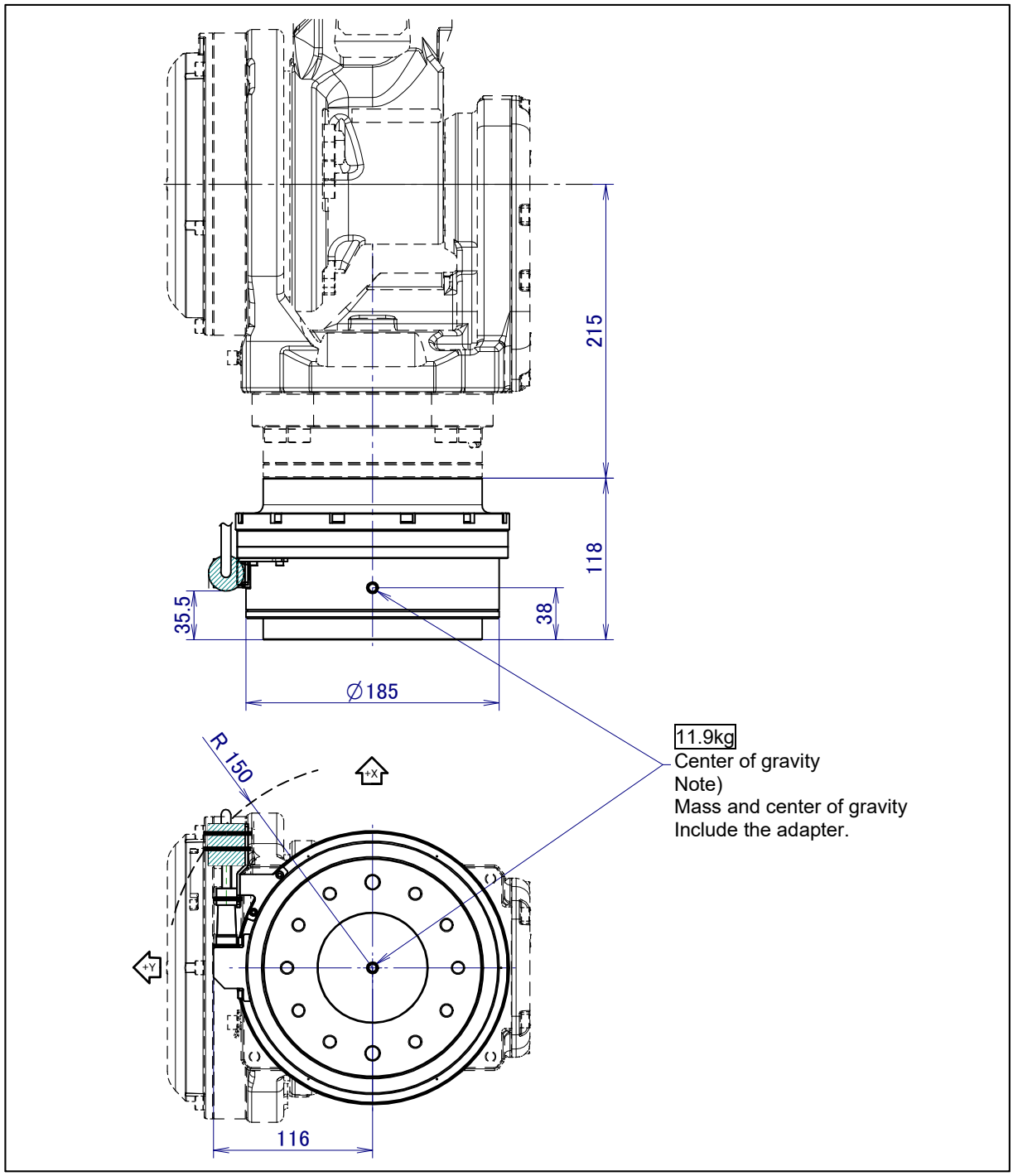


Fig. 3.2.1 (g) External dimensions of the force sensor head (Example of R-2000*i*C + FS-250*i*A with standard adapter)

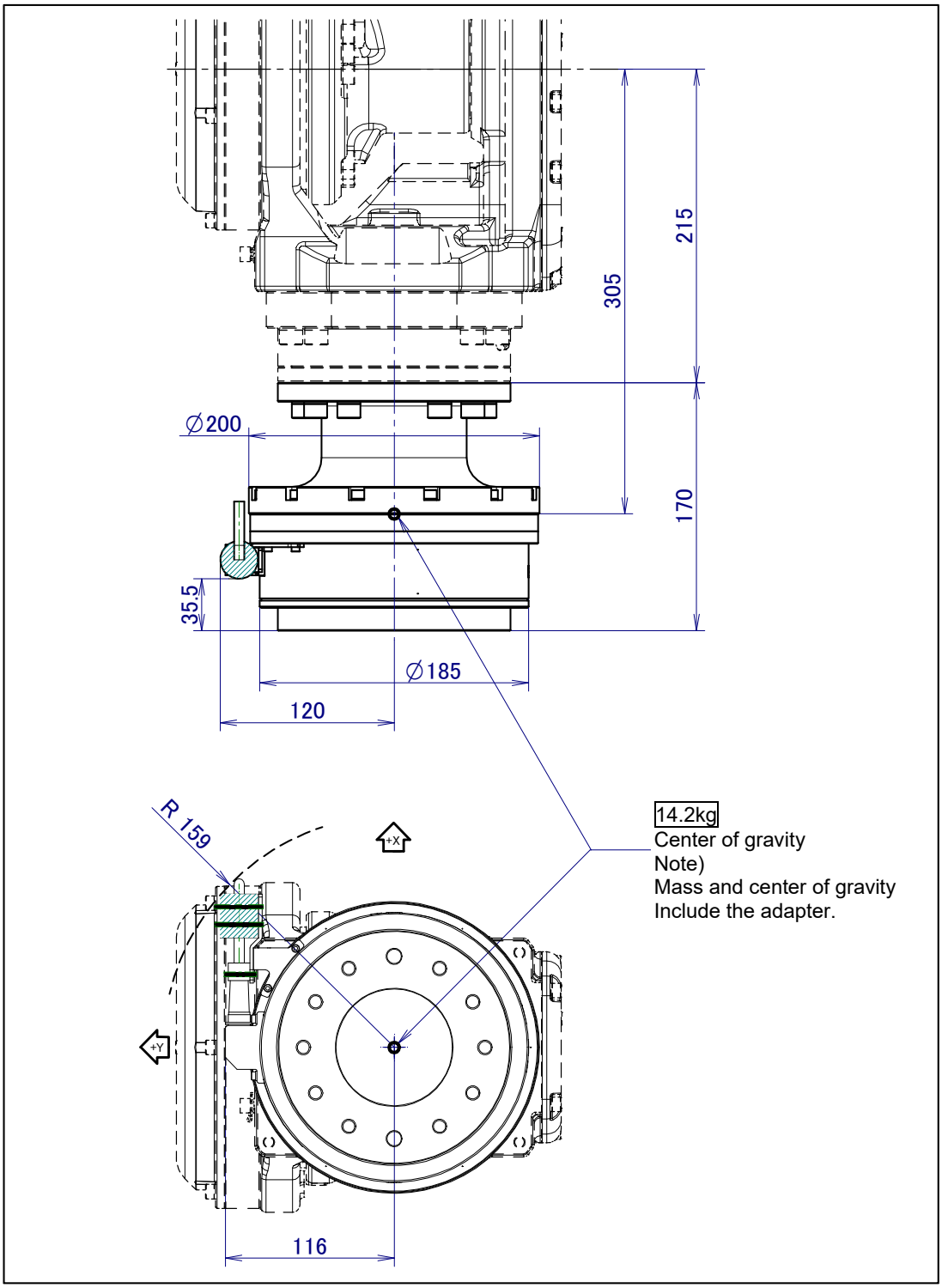


Fig. 3.2.1 (h) External dimensions of the force sensor head
(Example of R-2000*i*C + FS-250*i*A with adapter which does not need torque wrench)

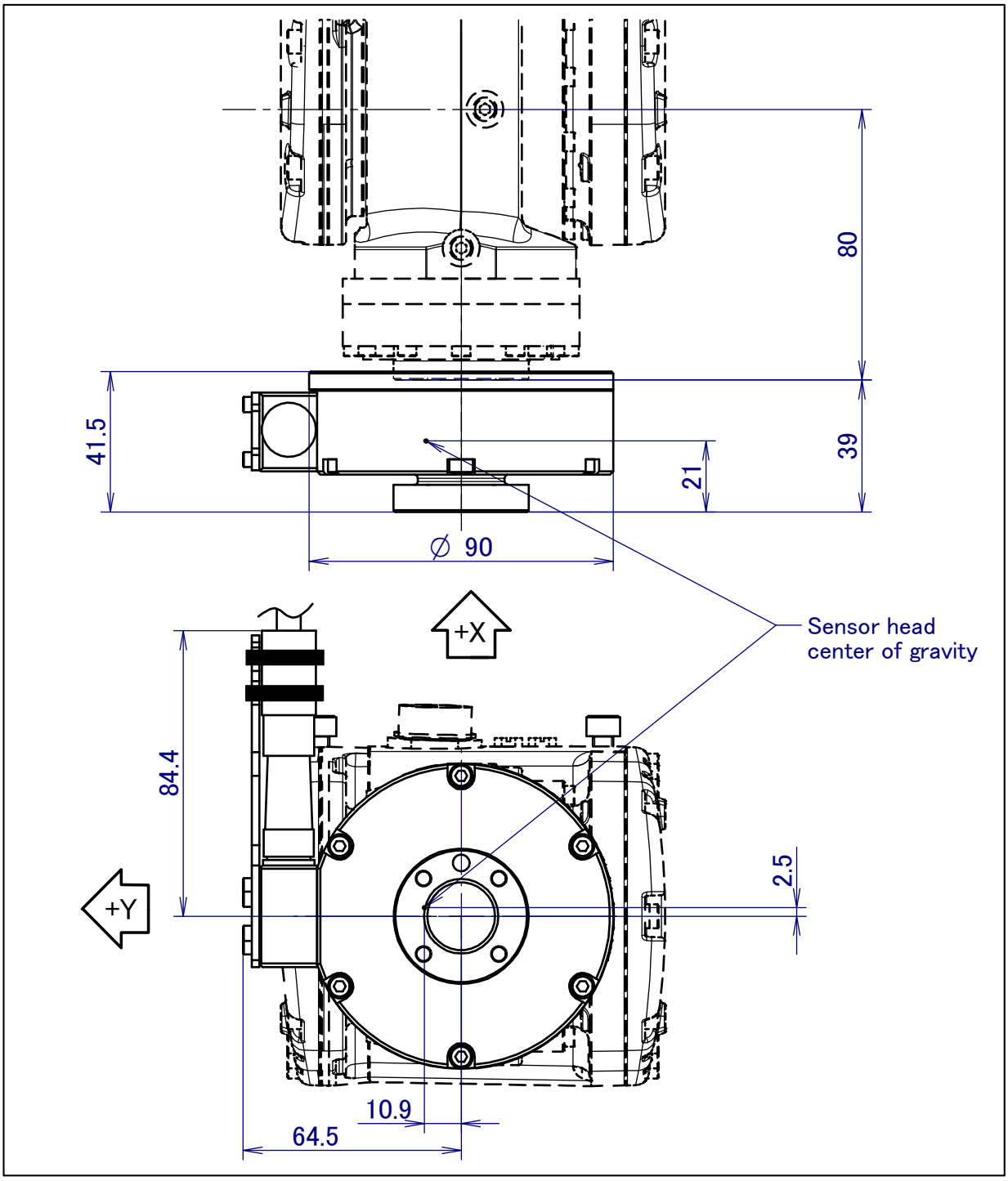


Fig. 3.2.1 (i) External dimensions of the force sensor head (Example of LR Mate 200*i*D + FS-15*i*Ae)

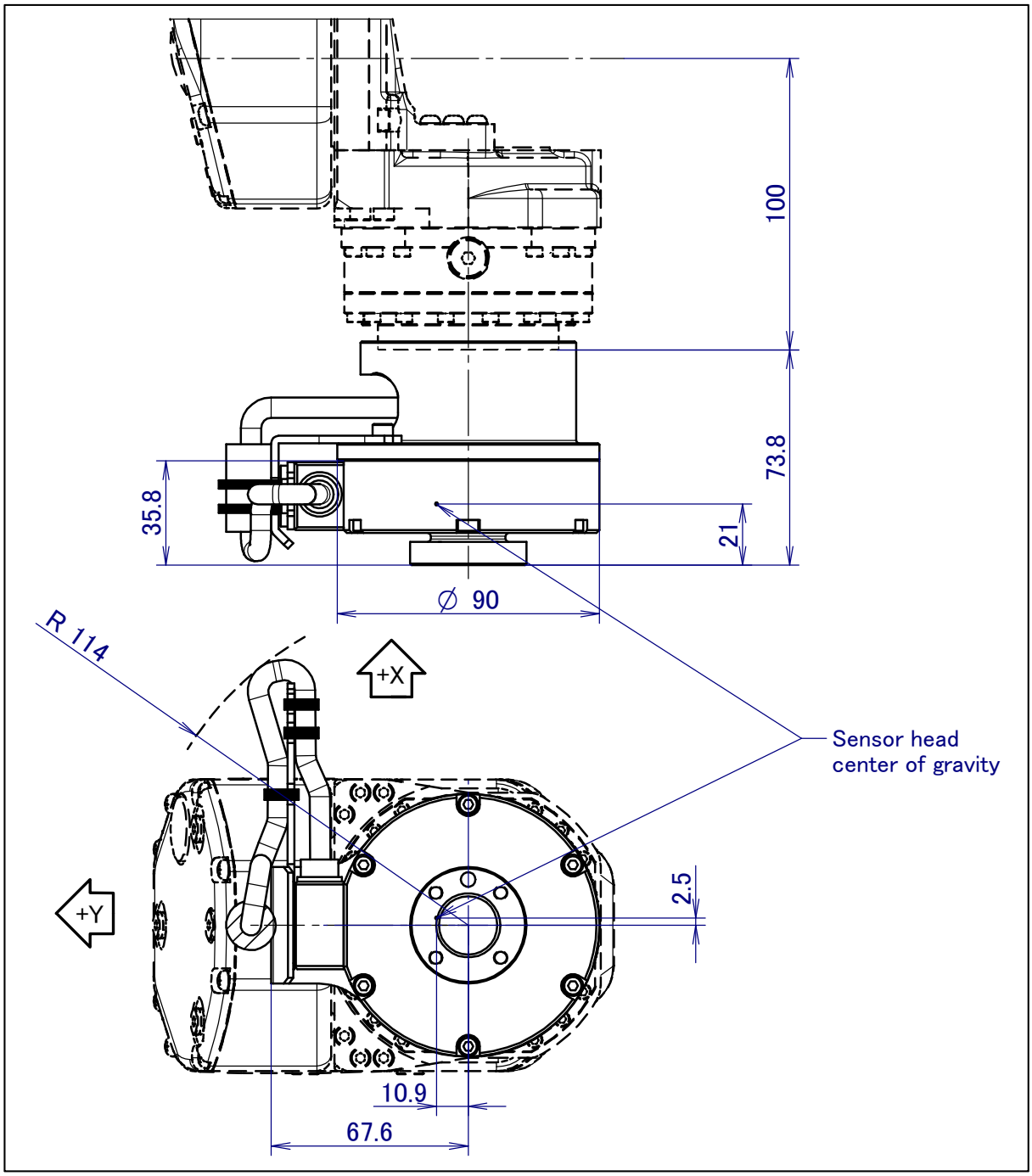


Fig. 3.2.1 (j) External dimensions of the force sensor head (Example of M-10*i*A + FS-15*i*Ae)

3.2.2 Camera

Fig. 3.2.2 (a) show the external dimensions of the camera mounting interface.
Fix the camera to the trestle with bolts and pins. By using dowel pins, the position of the camera can repeatably be maintained when replaced.

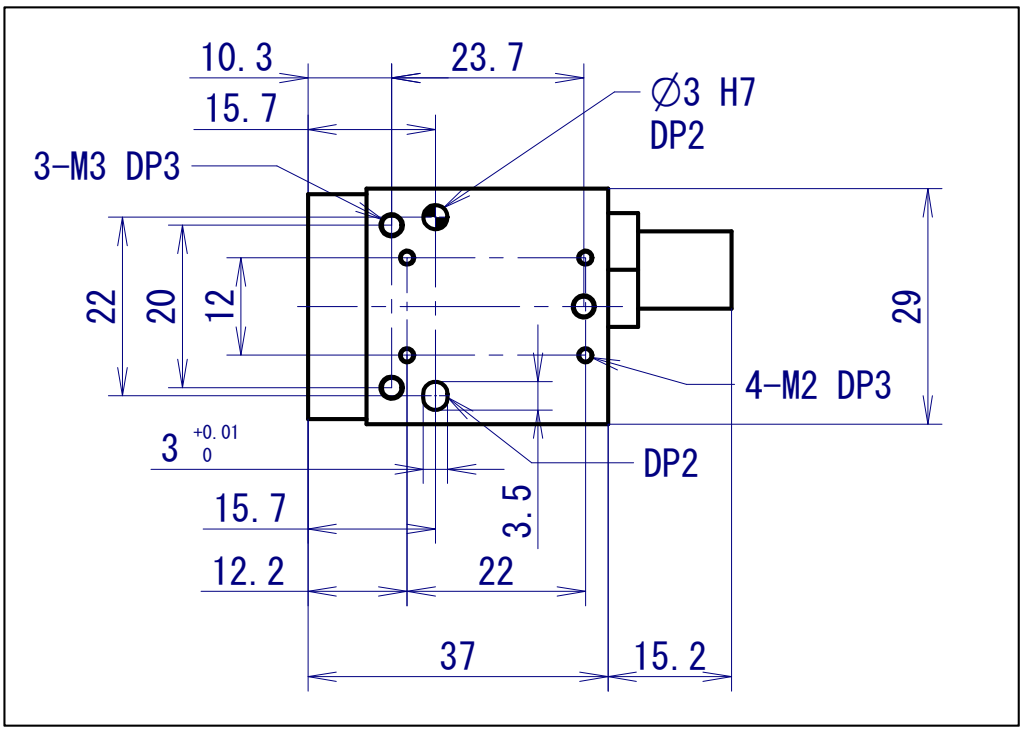


Fig. 3.2.2 (a) External dimensions of the camera mounting interface

3.2.3 Camera package

3.2.3.1 Sensor head

Fig. 3.2.3.1 (a) and (b) show the external dimension and vision range of the Camera package.
The vision range in figure is an example of focal distance of 8mm.
See the table below for the other case.

Table 3.2.3.1 (a) angle of view of camera package

Focal distance of lens	horizontal × vertical
8mm	33.1°x25.0°
12mm	22.4°x16.6°
16mm	16.9°x12.7°
25mm	11.0°x8.2°

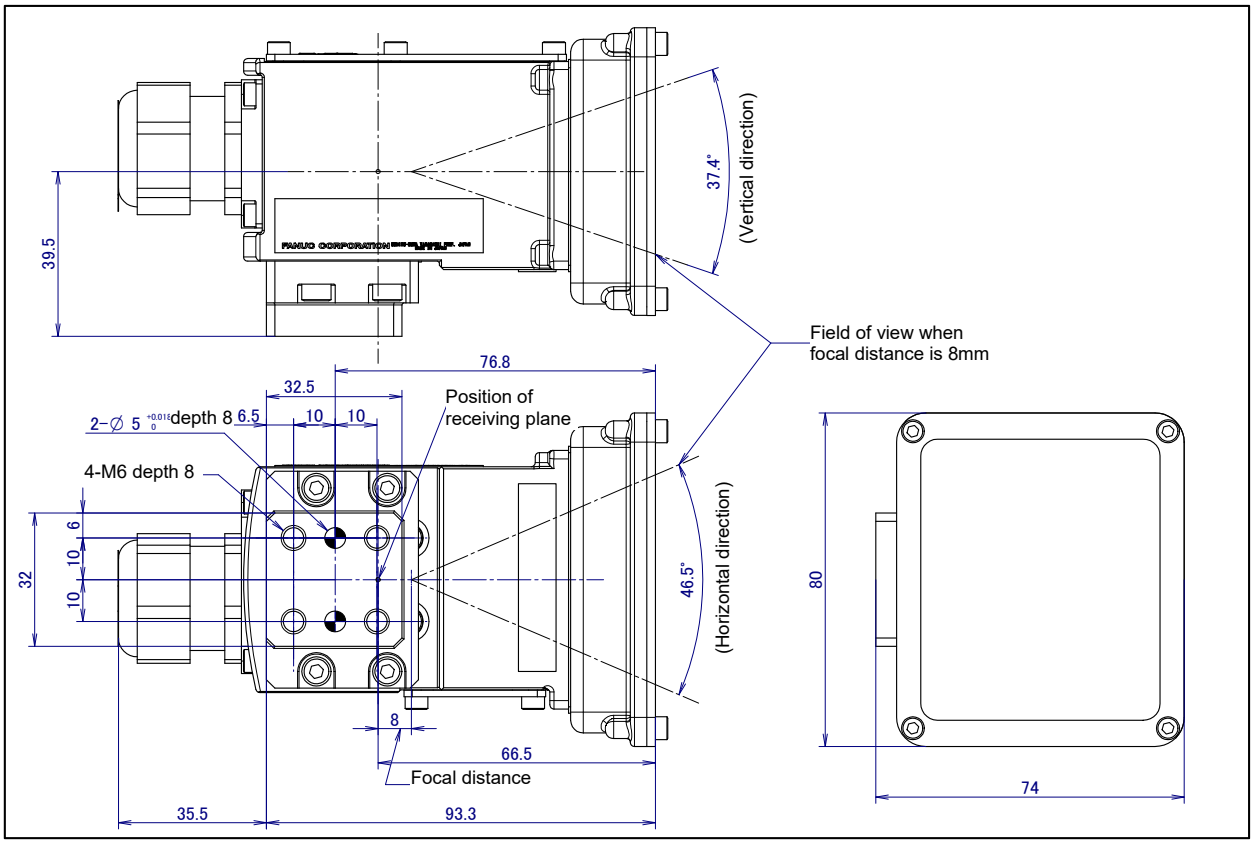


Fig. 3.2.3.1 (a) External dimensions and vision range of sensor head of camera package (with LED light)

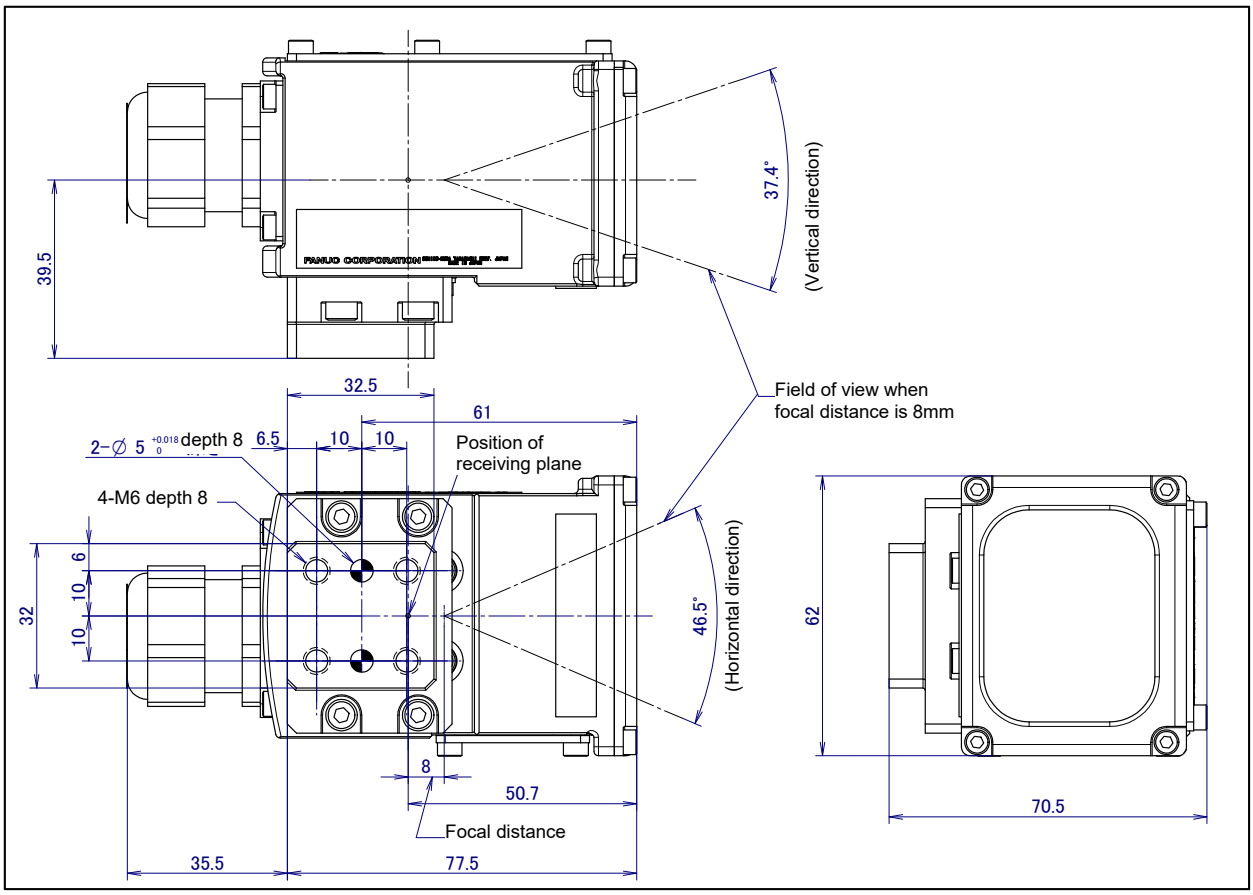


Fig. 3.2.3.1 (b) External dimensions and vision range of sensor head of camera package (without LED light)

3.2.4 3D Laser Vision Sensor

3.2.4.1 Sensor head

Fig. 3.2.4.1 (a) to (f) show the external dimensions and vision range of the 3D Laser Vision Sensor head.

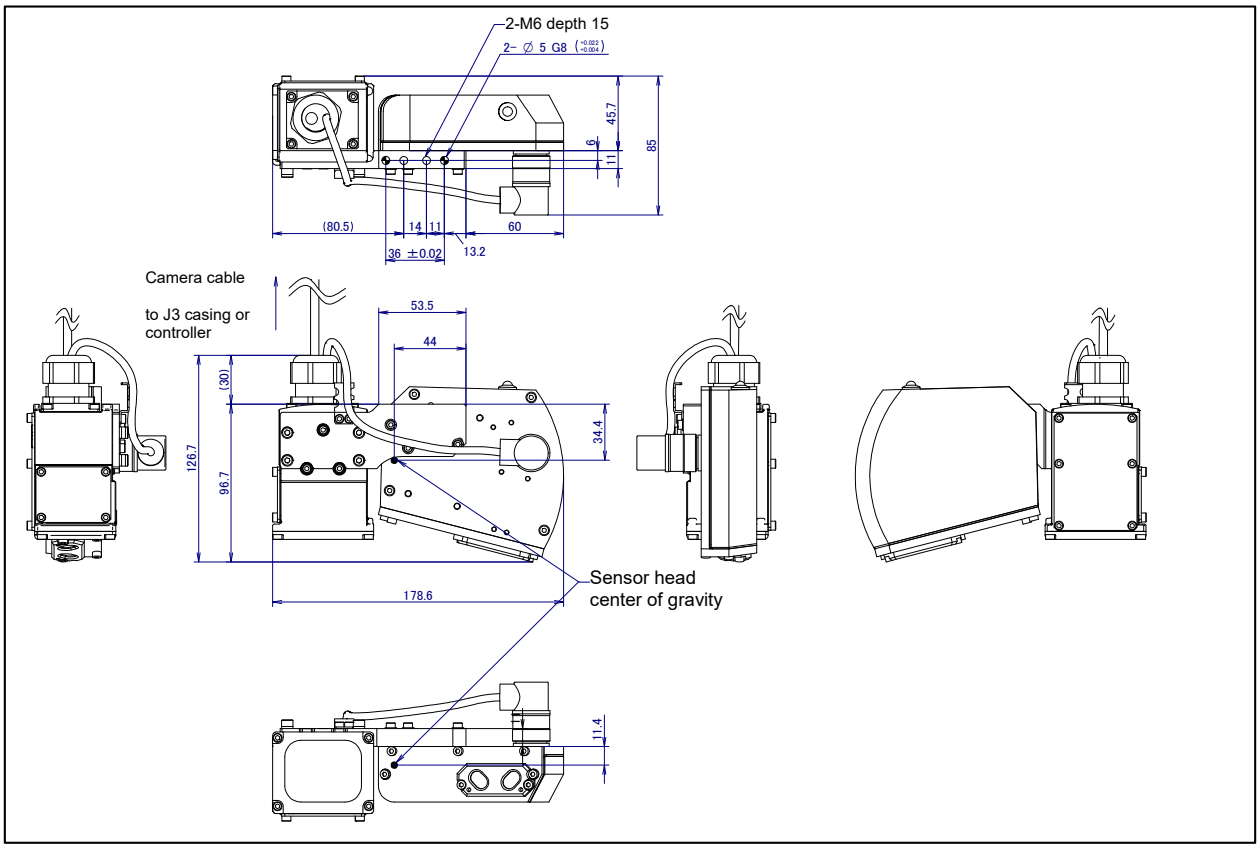


Fig. 3.2.4.1 (a) External dimensions of the 3D Laser Vision Sensor Head (stand off 400mm)

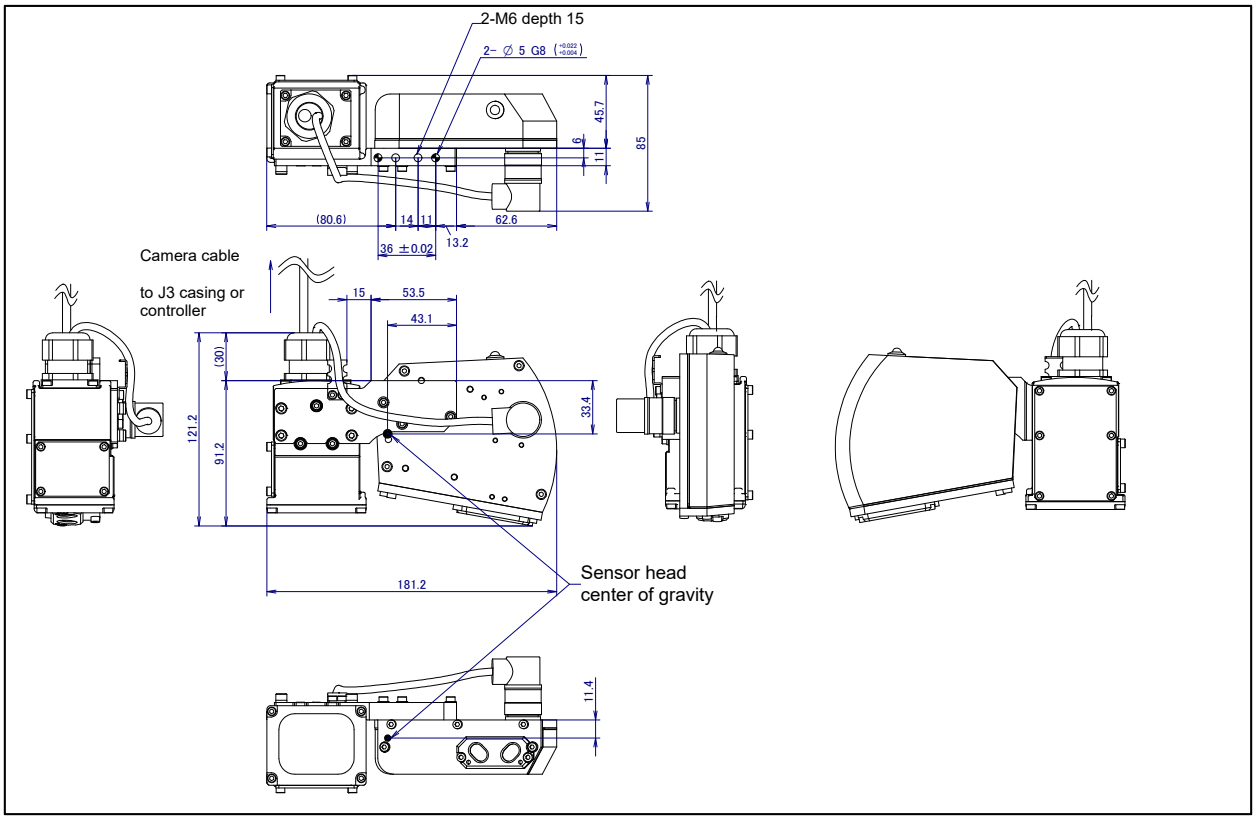


Fig. 3.2.4.1 (b) External dimensions of the 3D Laser Vision Sensor Head (stand off 600mm)

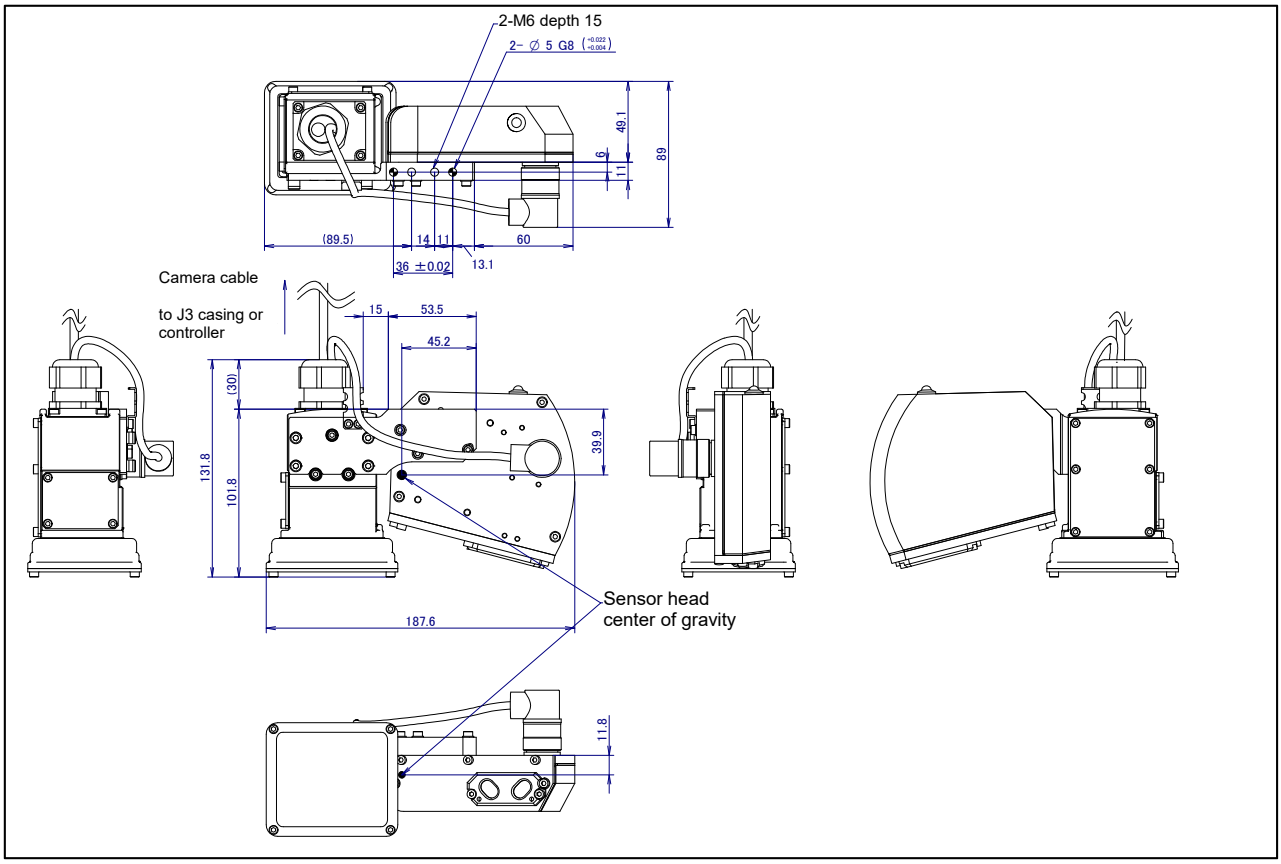


Fig. 3.2.4.1 (c) External dimensions of the 3D Laser Vision Sensor Head with LED (stand off 400mm)

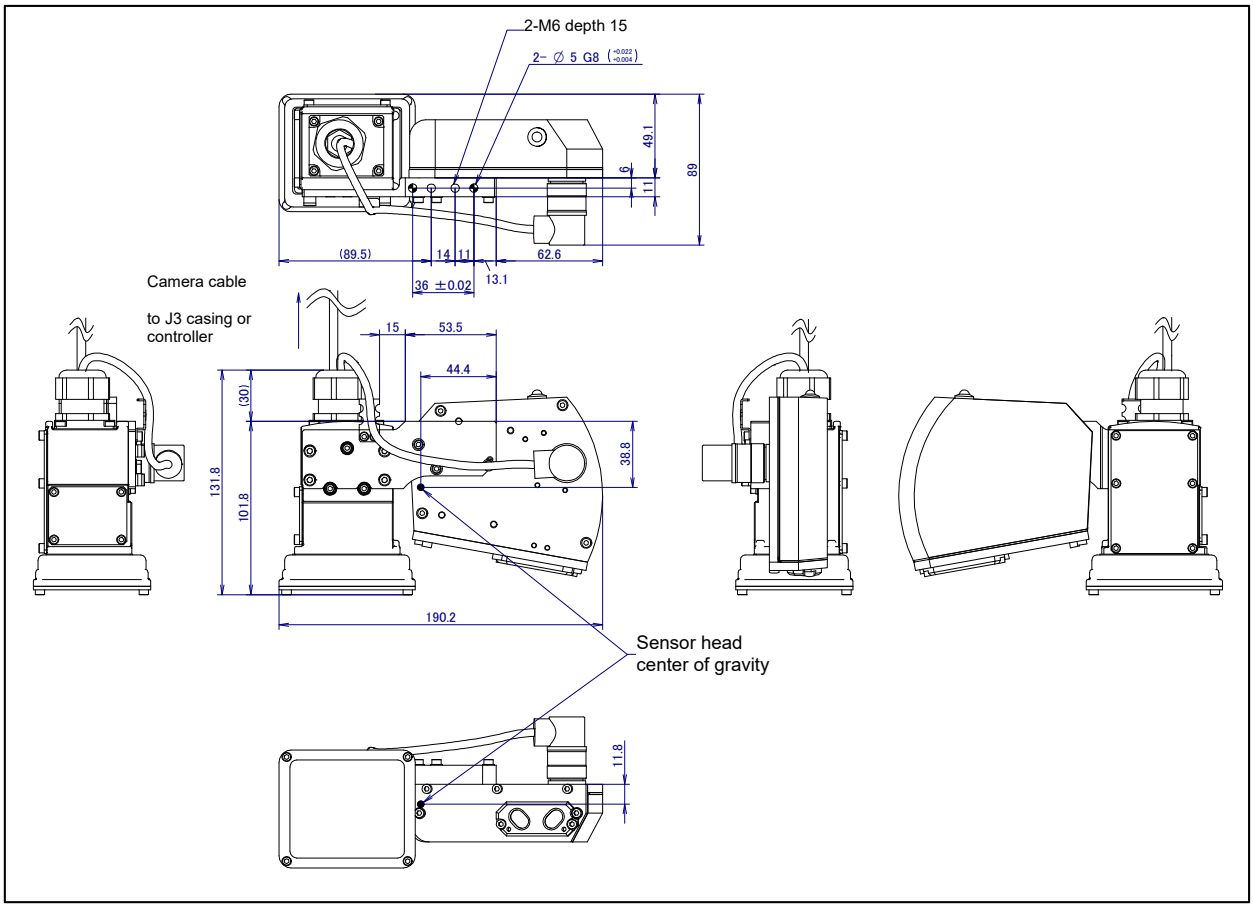


Fig. 3.2.4.1 (d) External dimensions of the 3D Laser Vision Sensor Head with LED (stand off 600mm)

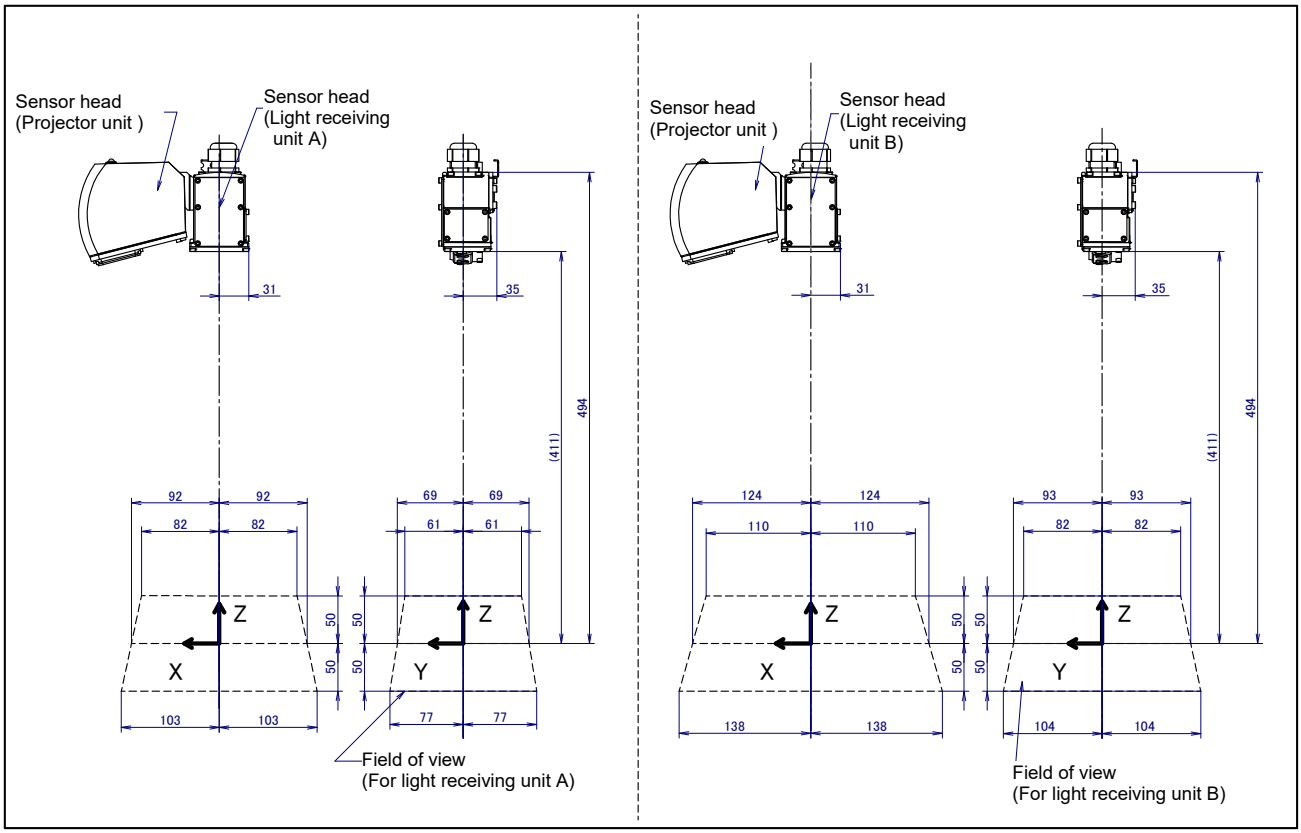


Fig. 3.2.4.1 (e) Vison range of the 3D laser vision sensor (stand off 400mm)

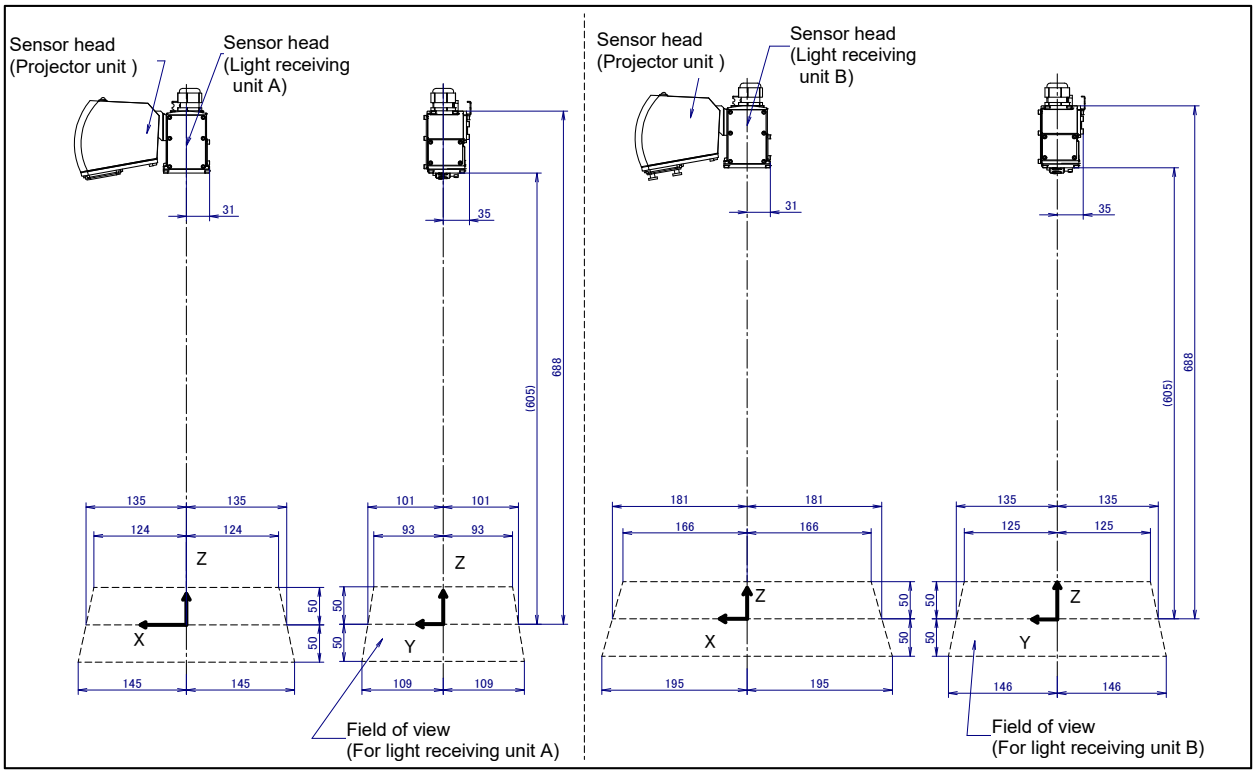


Fig. 3.2.4.1 (f) Vison range of the 3D laser vision sensor (stand off 600mm)

3.2.5 3D Area Sensor

Fig.3.2.5 (a) shows external dimensions of 3D Area Sensor 3DA/1300 standard placement.
Fig.3.2.5 (b) shows projection area of 3D Area Sensor 3DA/1300 projector unit.
Fig.3.2.5 (c) shows external dimensions of 3D Area Sensor 3DA/400 standard placement.

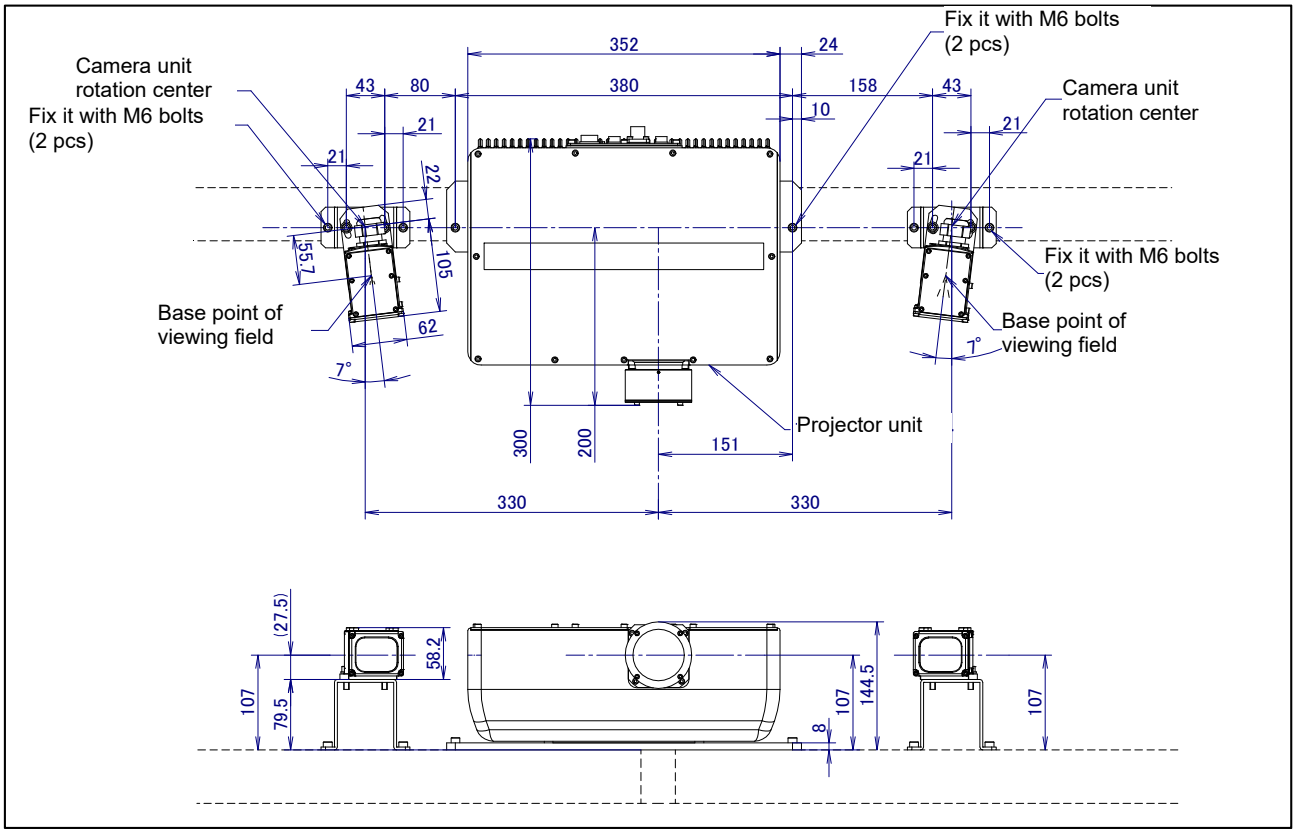


Fig.3.2.5 (a) External dimensions of 3D Area Sensor (3DA/1300)

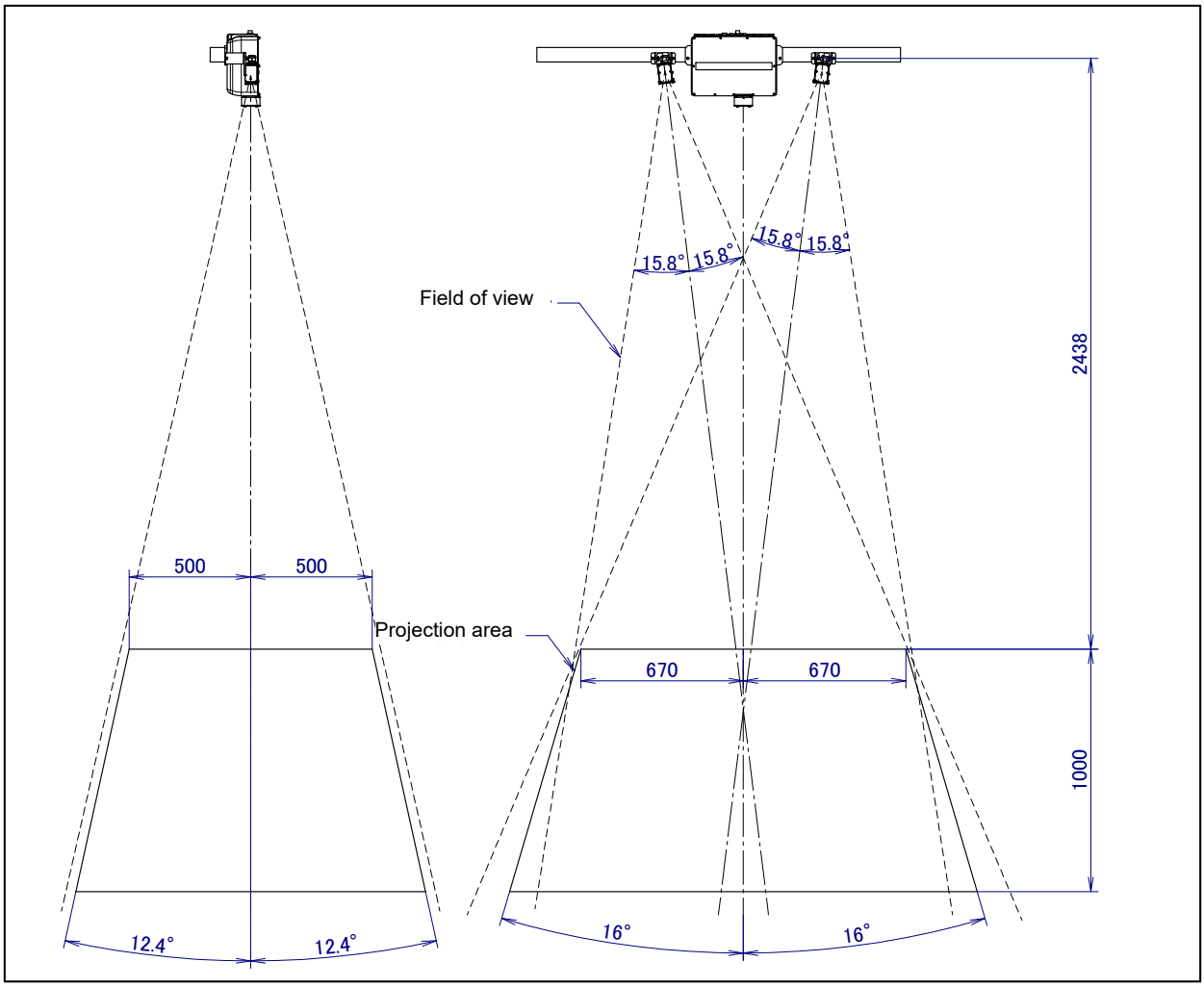


Fig.3.2.5 (b) Projection area of 3D Area Sensor (3DA/1300) projector unit

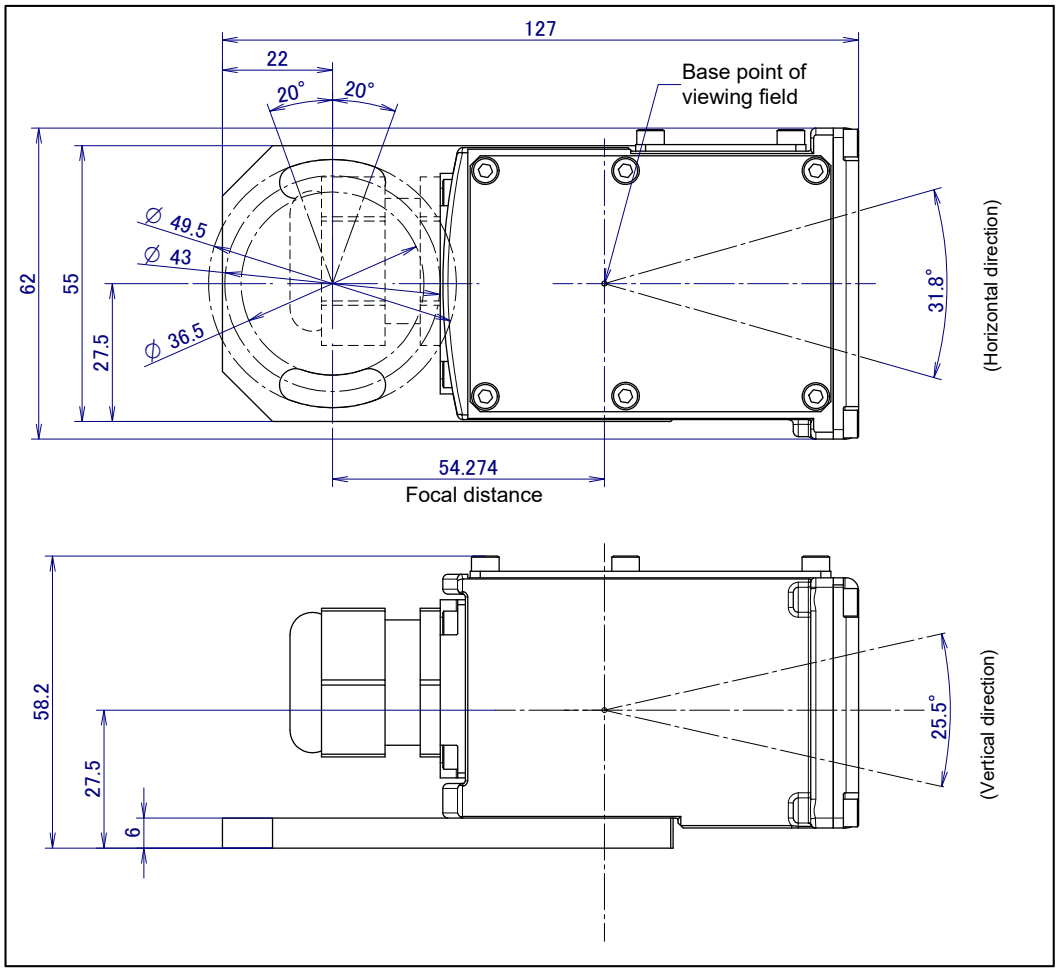


Fig.3.2.5 (c) External dimensions and field of view of 3D Area Sensor camera unit

3.2.6 3D Vision Sensor

Fig. 3.2.6 (a) shows external dimensions of the 3DV/70, 3DV/200, 3DV/400 with LED and 3DV/600.

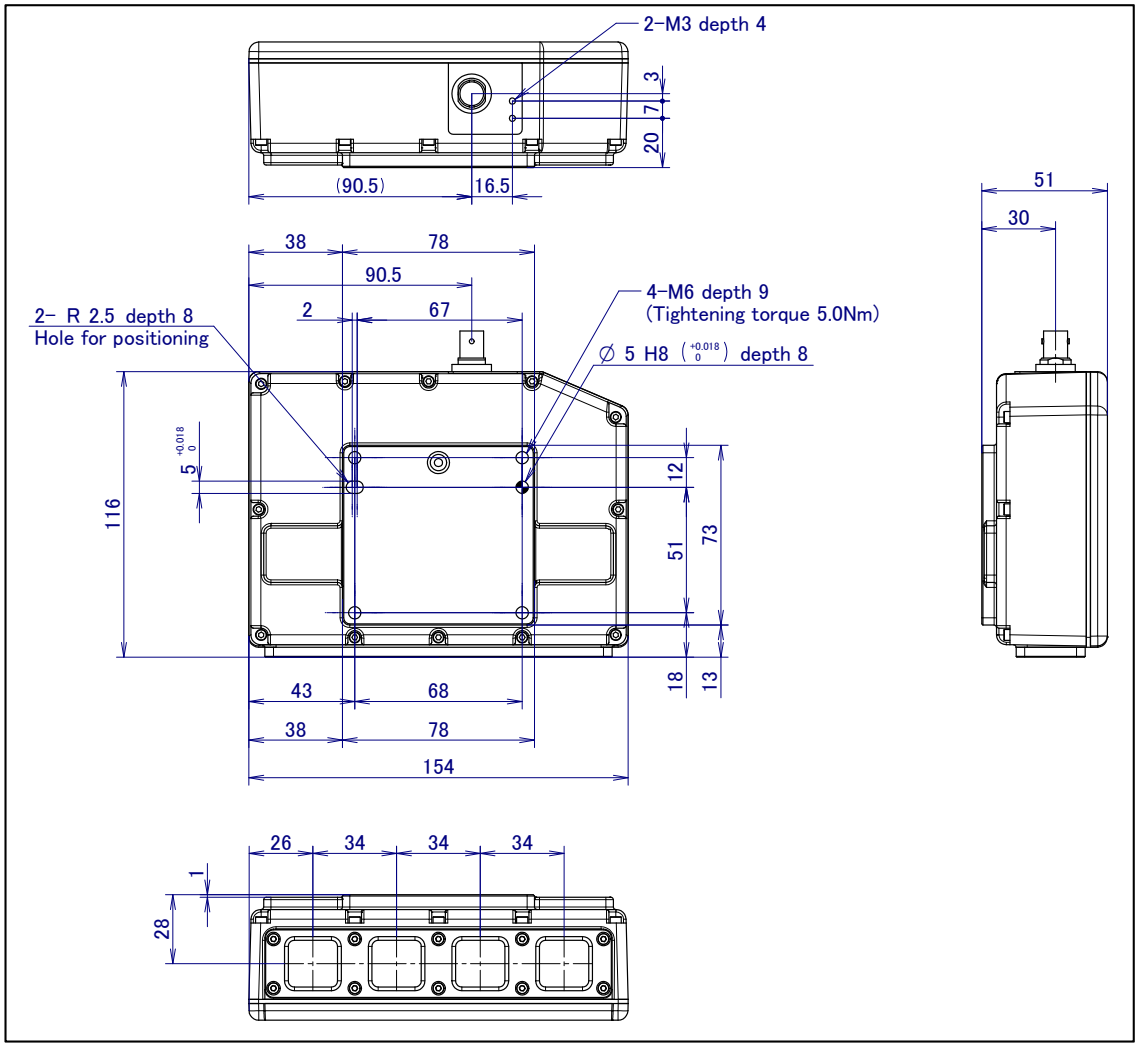


Fig. 3.2.6 (a) External dimensions of the 3D Vision Sensor (3DV/70, 3DV/200, 3DV/400 with LED and 3DV/600)

Fig. 3.2.6 (b) shows external dimensions of the 3DV/400 without LED.

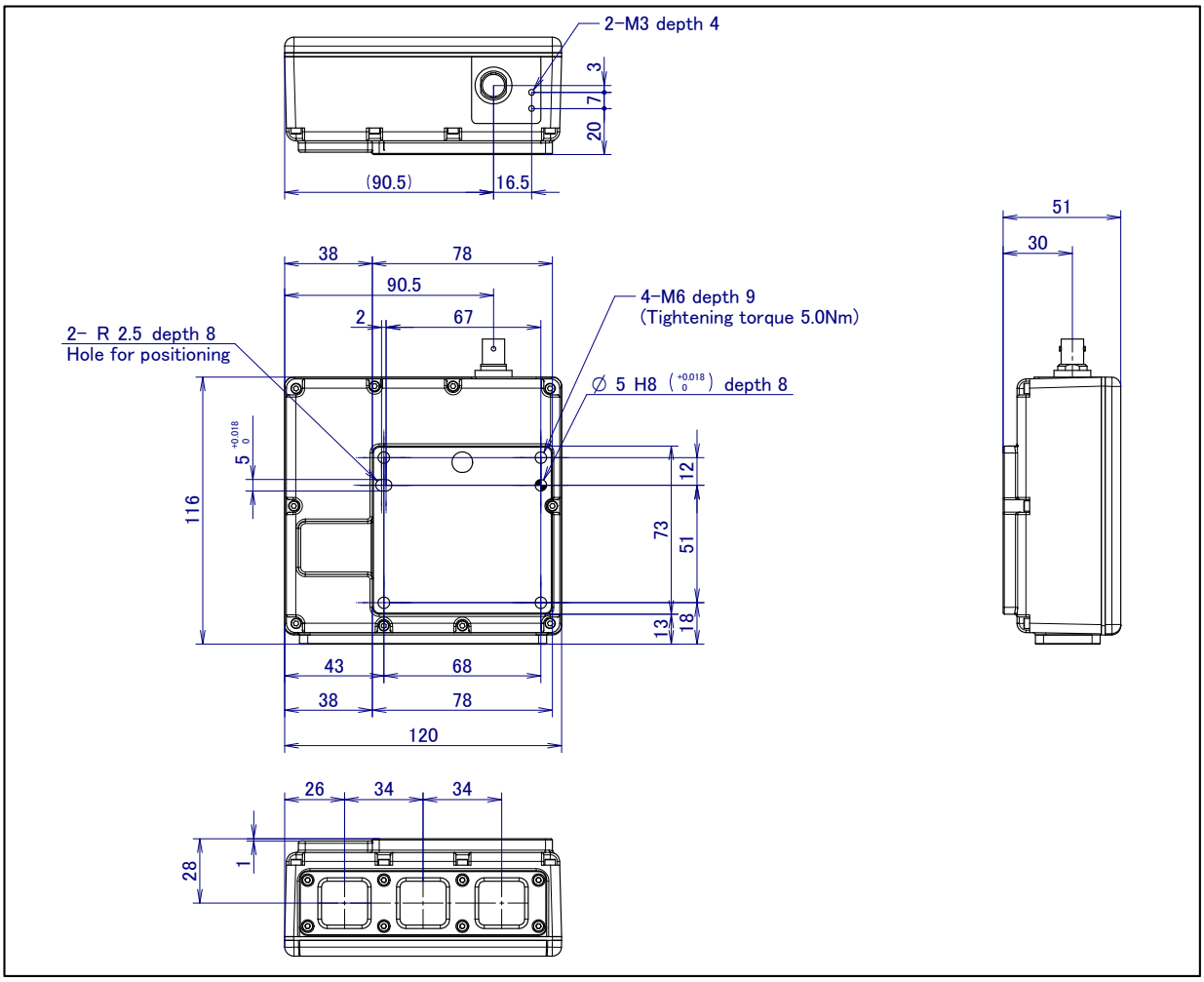


Fig. 3.2.6 (b) External dimensions of the 3D Vision Sensor (3DV/400 without LED)

Fig. 3.2.6 (c) show external dimensions of 3DV/1600 with LED.

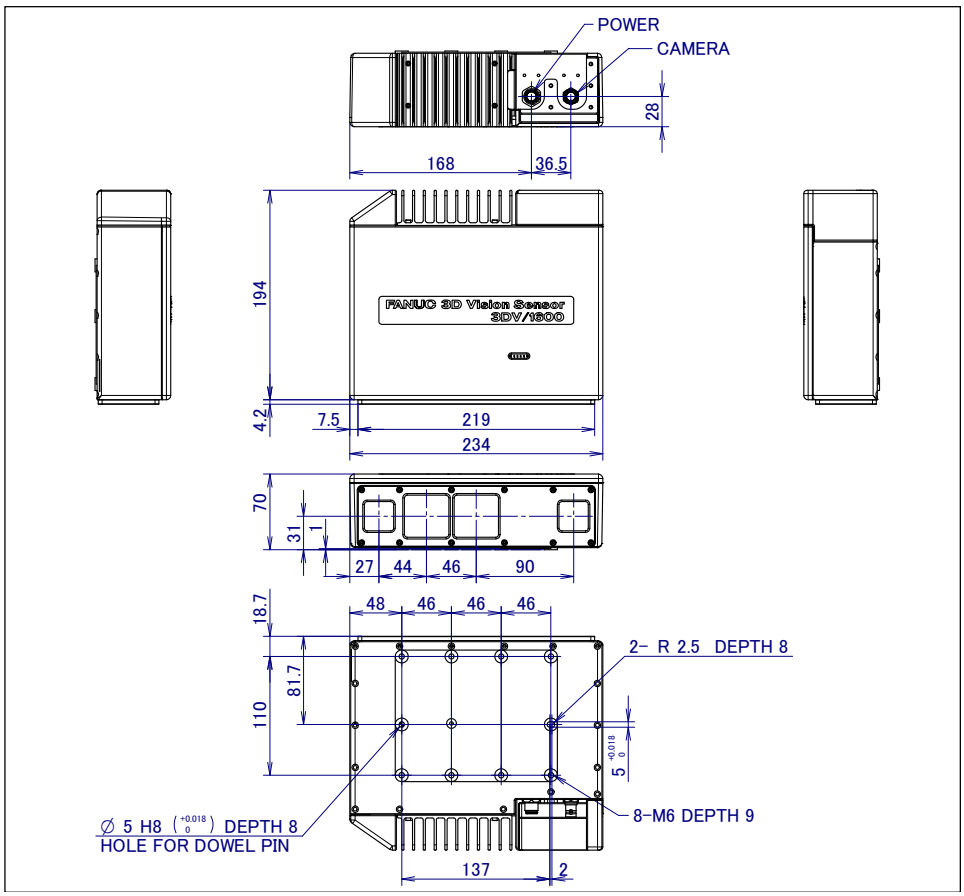


Fig. 3.2.6 (c) External dimensions of 3D Vision Sensor (3DV/1600)

The member to which the 3DV sensor is attached should satisfy the flatness and surface roughness as shown in Fig. 3.2.6 (d).
If the condition of the mounting surface is worse than the recommended value, the sensor performance may not be exhibited.

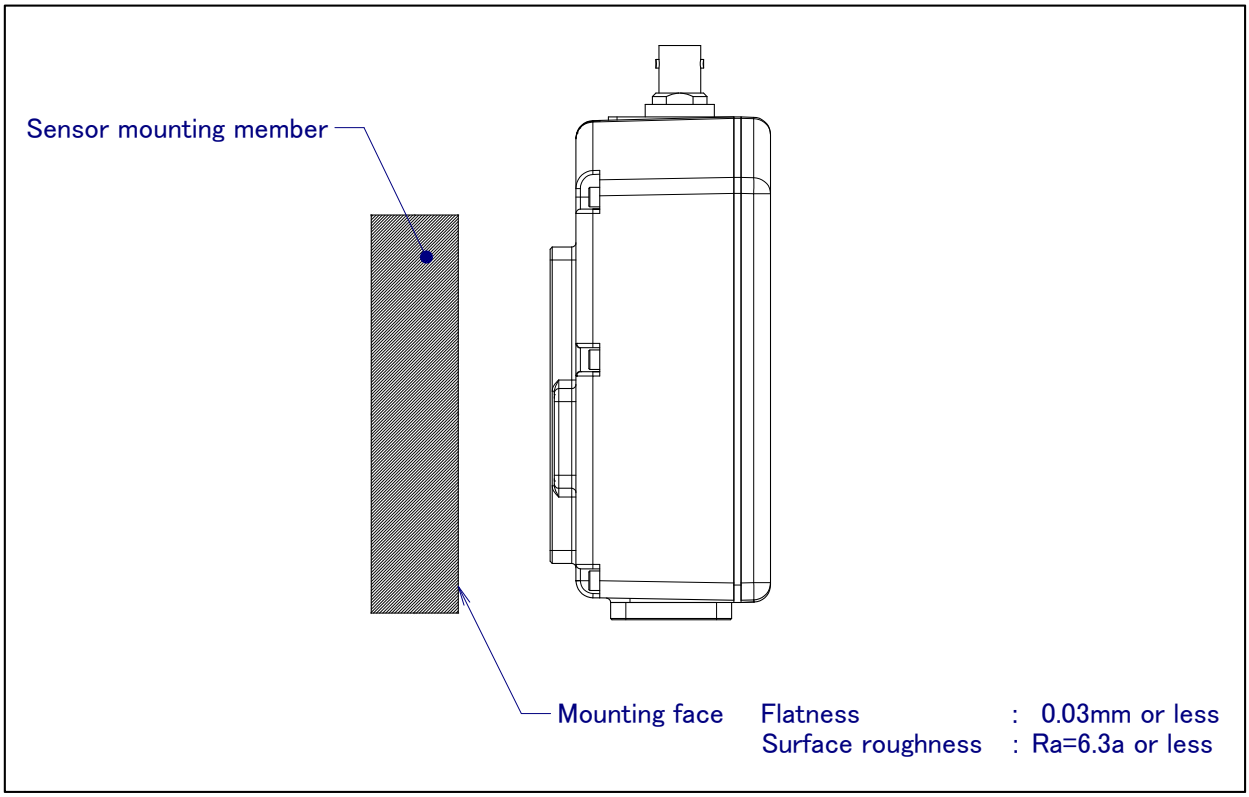


Fig. 3.2.6 (d) About the mounting surface of the 3D Vision Sensor

Fig. 3.2.6 (e) shows measured area of 3DV/70.

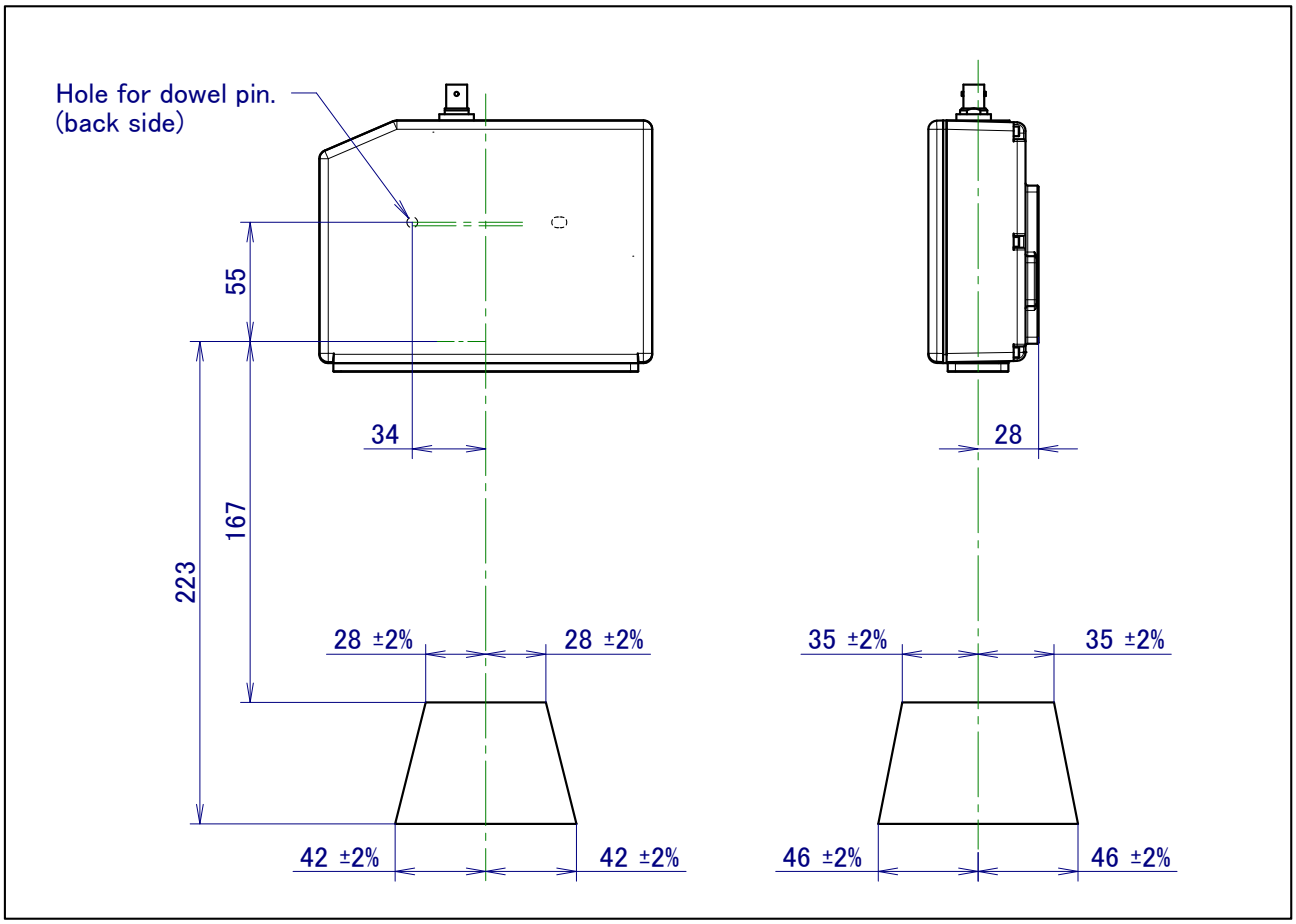


Fig. 3.2.6 (e) Measured area of the 3D Vision Sensor (3DV/70)

Fig. 3.2.6 (f) shows measured area of 3DV/200.

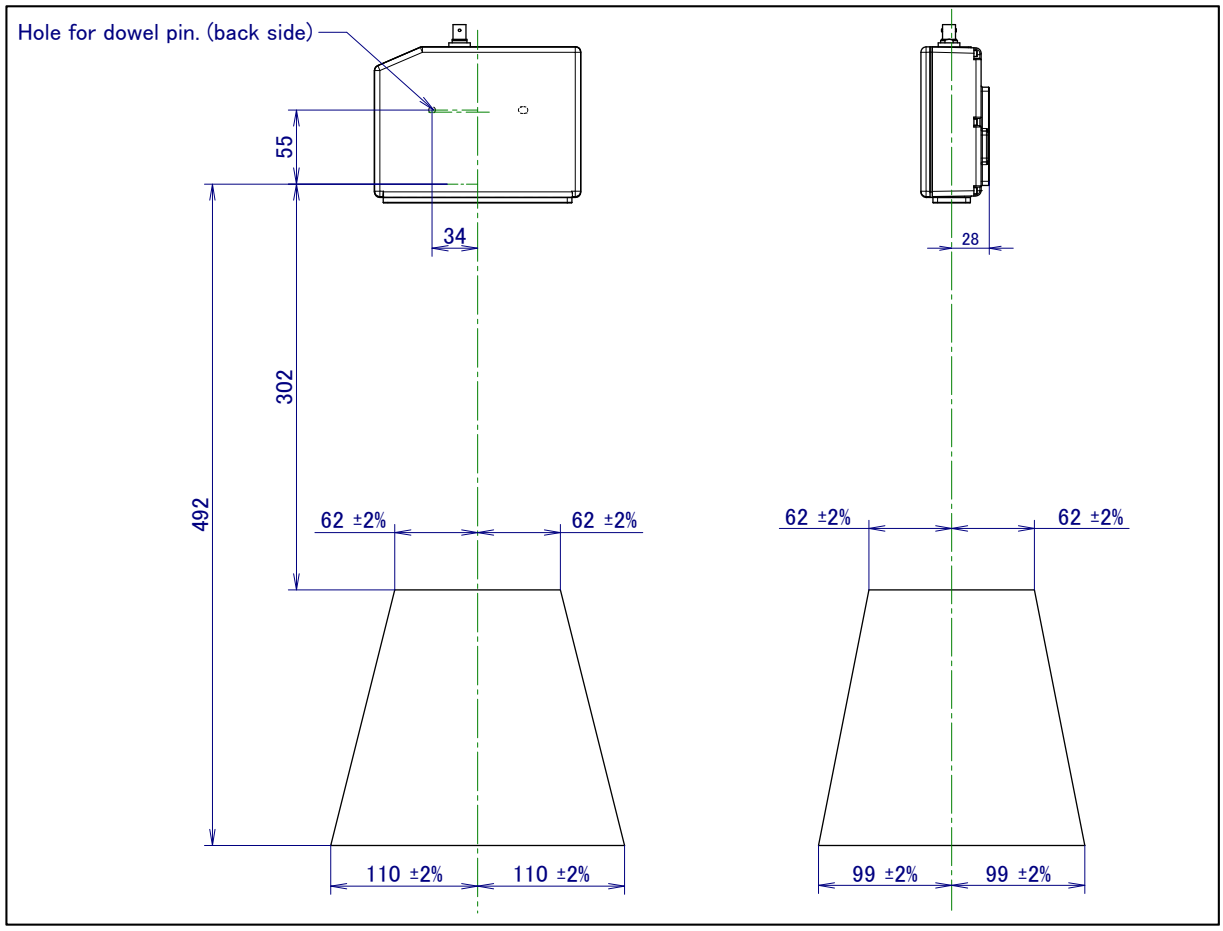


Fig. 3.2.6 (f) Measured area of the 3D Vision Sensor (3DV/200)

Fig. 3.2.6 (g) shows measured area of 3DV/400 without LED.

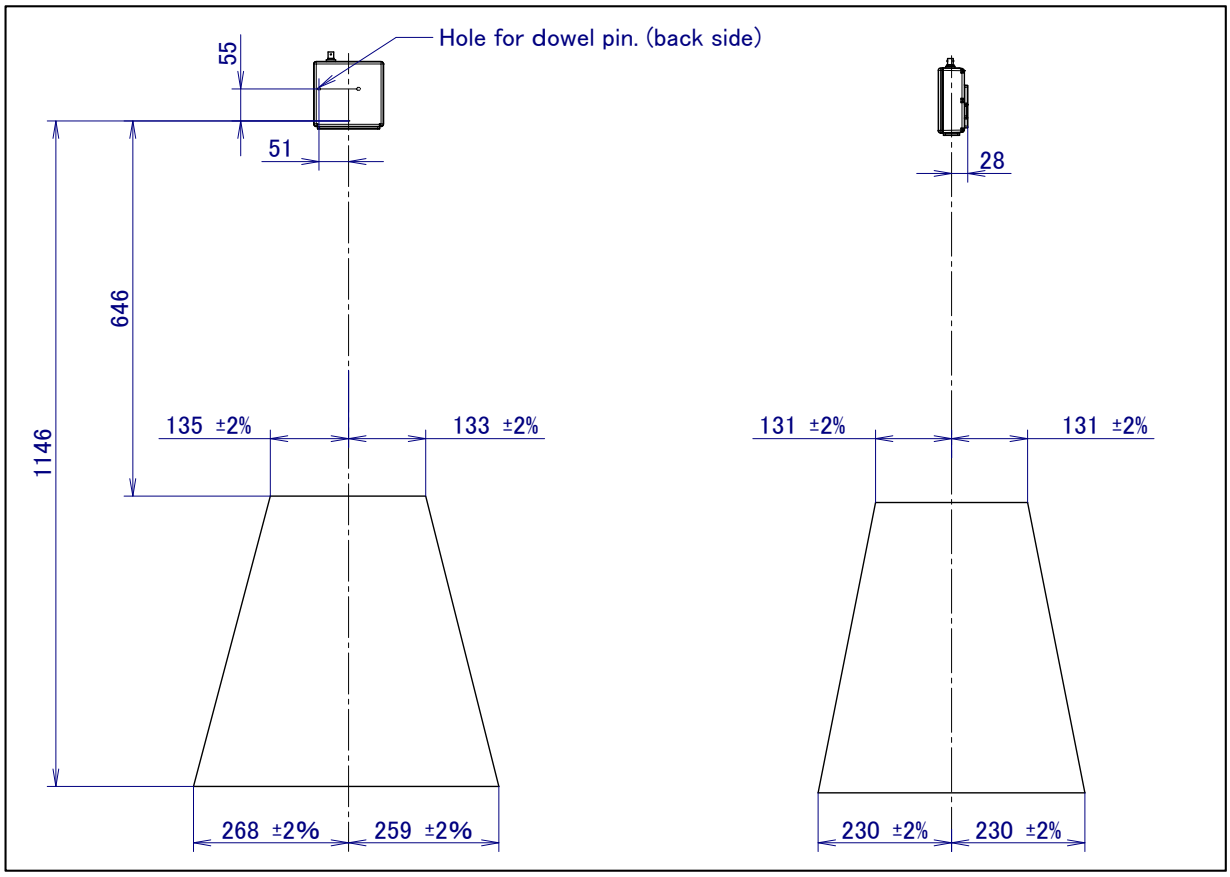


Fig. 3.2.6 (g) Measured area of the 3D Vision Sensor (3DV/400, without LED light)

Fig. 3.2.6 (h) shows measured area of 3DV/400 with LED.

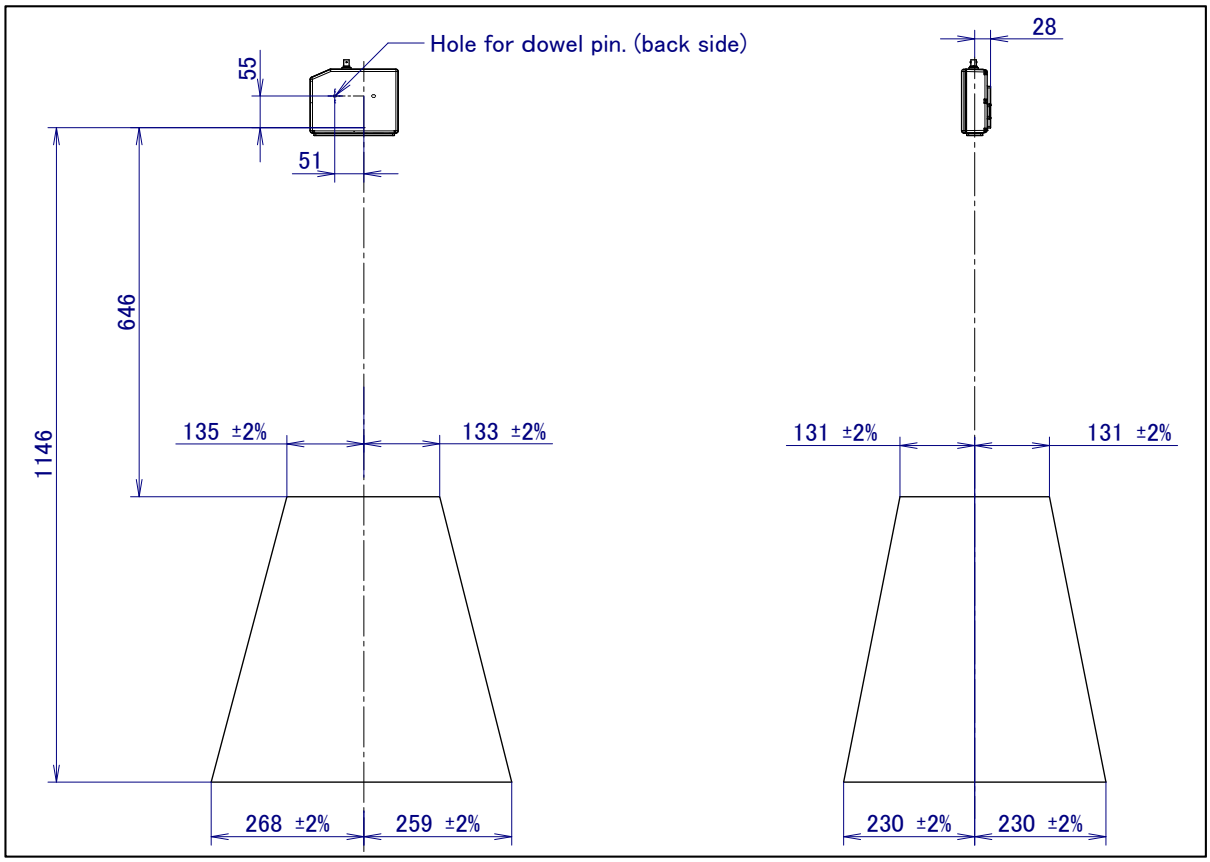


Fig. 3.2.6 (h) Measured area of 3D Vison Sensor (3DV/400 with LED)

Fig. 3.2.6 (i) shows measured area of 3DV/600.

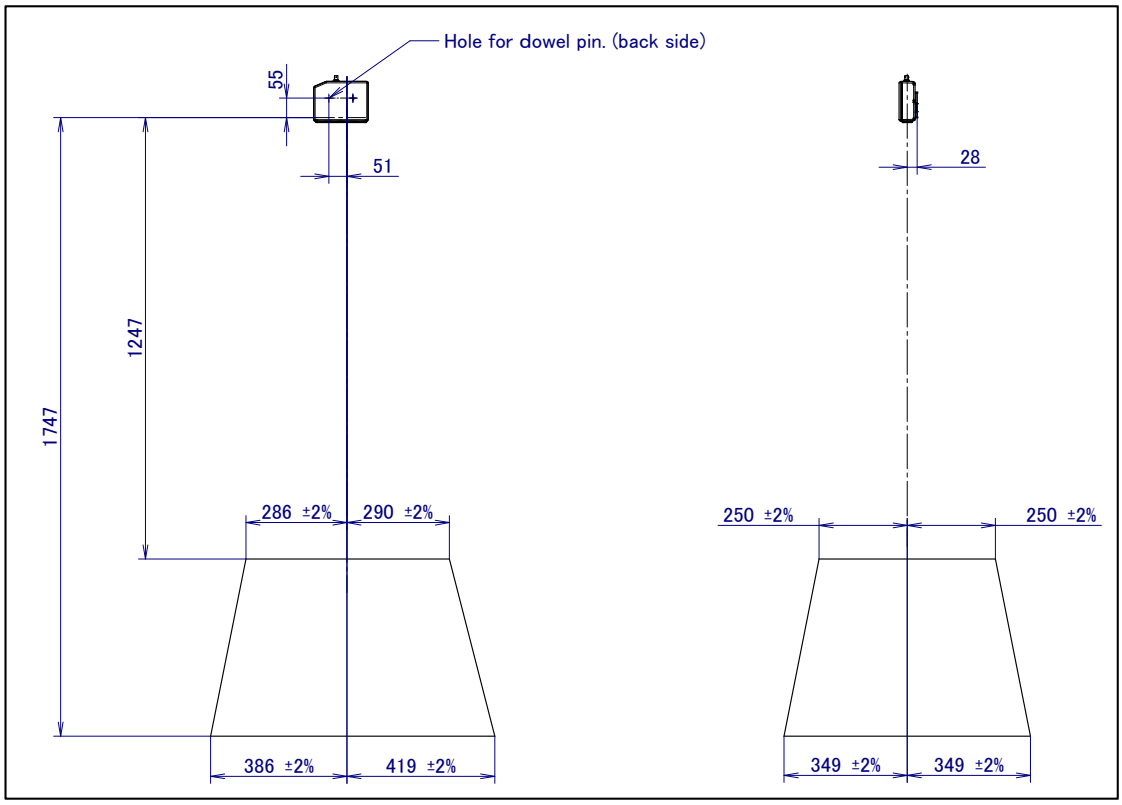


Fig. 3.2.6 (i) Measured area of 3D Vision Sensor (3DV/600)

Fig. 3.2.6 (j) shows measured area of 3DV/1600.

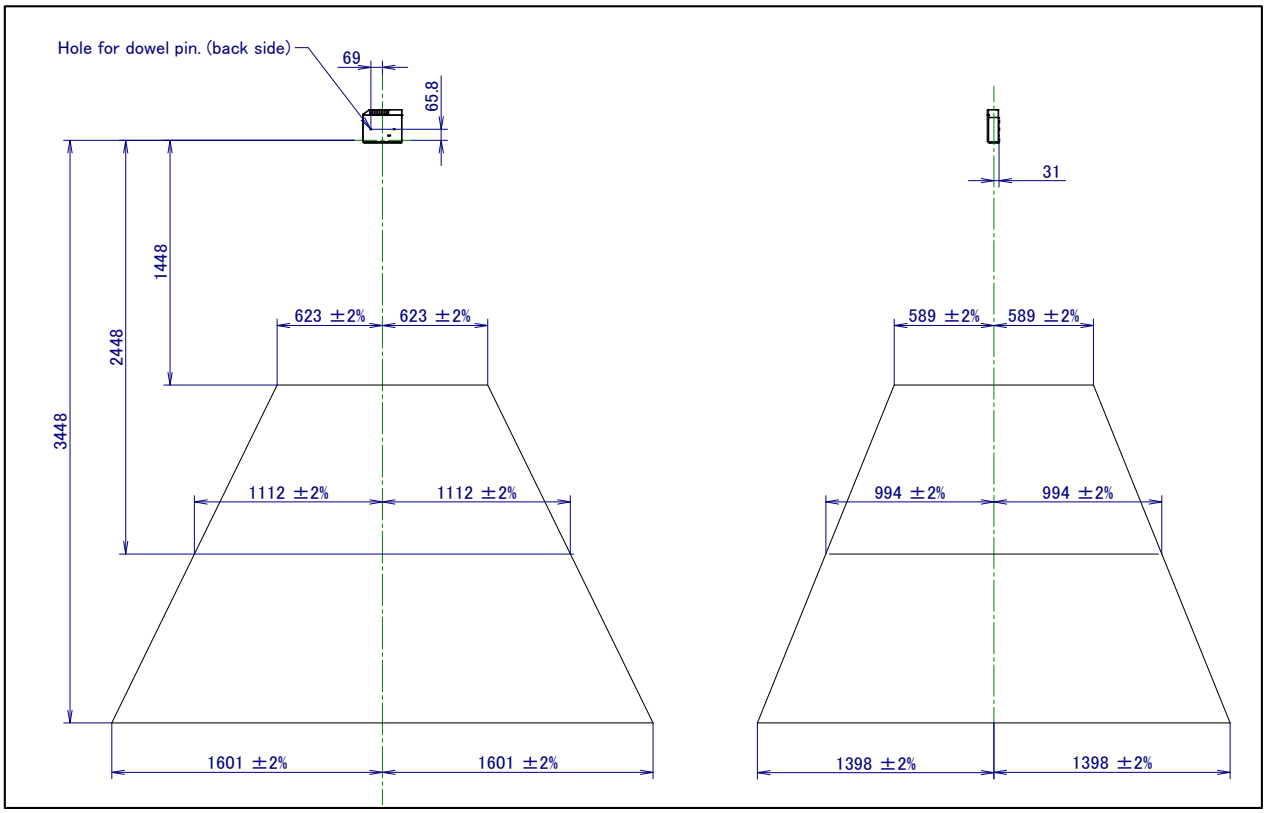


Fig. 3.2.6 (j) Measured area of 3D Vison Sensor (3DV/1600)

4 EQUIPMENT INSTALLATION

4.1 WRIST SECTION END EFFECTOR MOUNTING SURFACE

4.1.1 With a Force Sensor

Figs. 4.1.1 (a) to (f) show the mounting face for the wrist section end effector when a force sensor is used. The end effector should be designed in such a way that it satisfies the load requirements for the wrist section. Use caution to avoid interference with the robot main body.

⚠ CAUTION
When inserting a parallel pin to the pin hole on the end effector mounting face, be careful not to apply excessive force. It might break the sensor.

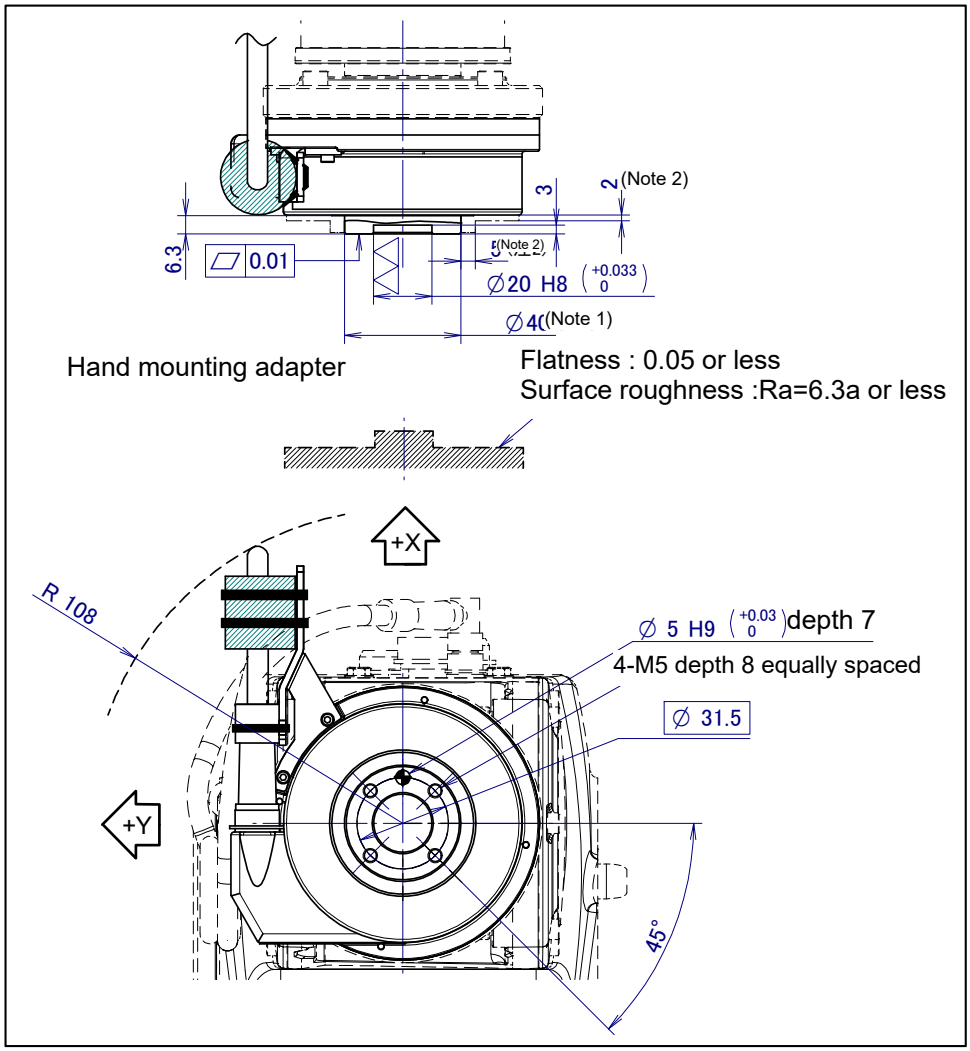


Fig. 4.1.1 (a) Wrist section end effector mounting surface (FS-15*i*A)

NOTE
1 Do not use Φ40 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

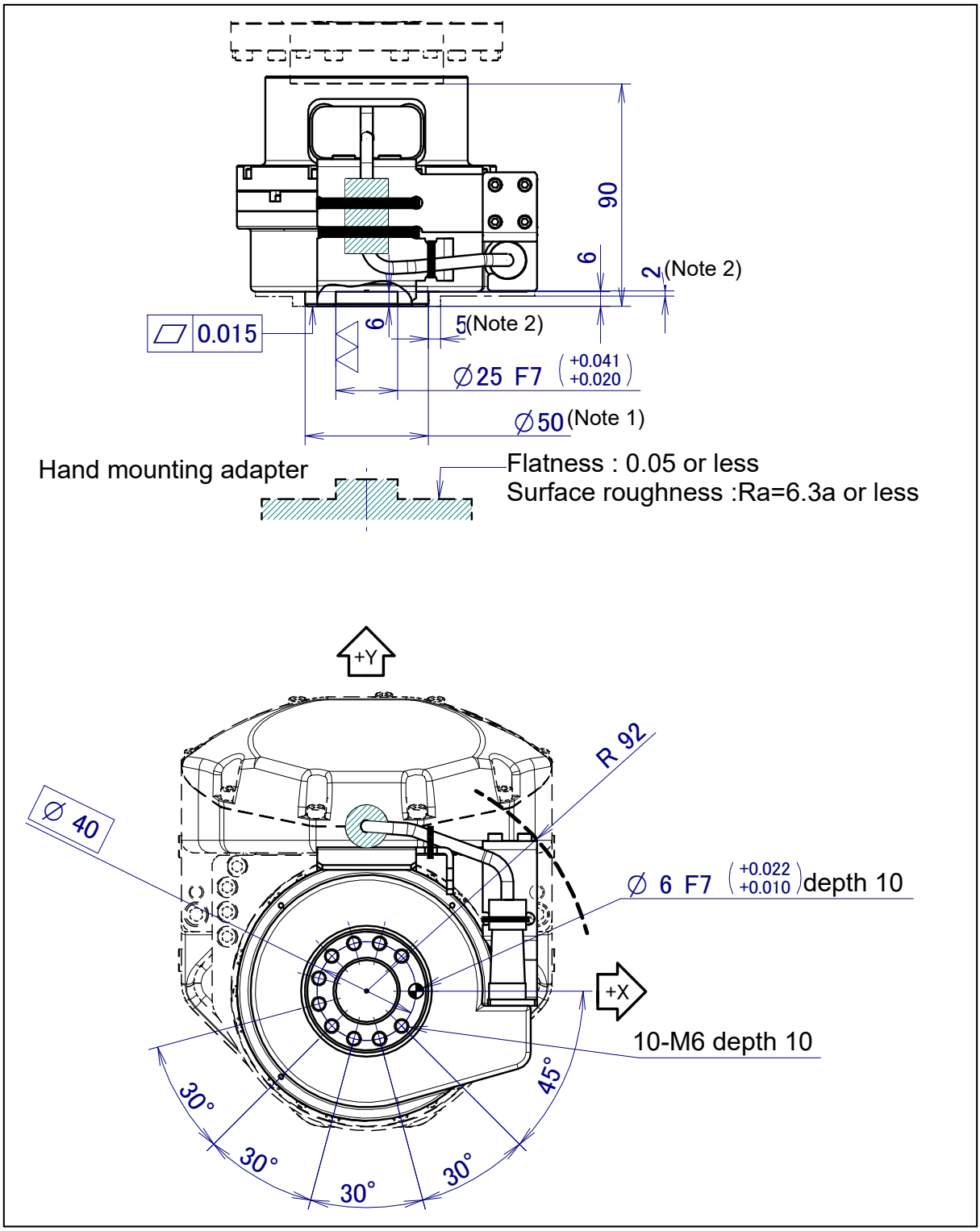


Fig. 4.1.1 (b) Wrist section end effector mounting surface (FS-40*i*A)

NOTE
1 Do not use Φ50 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

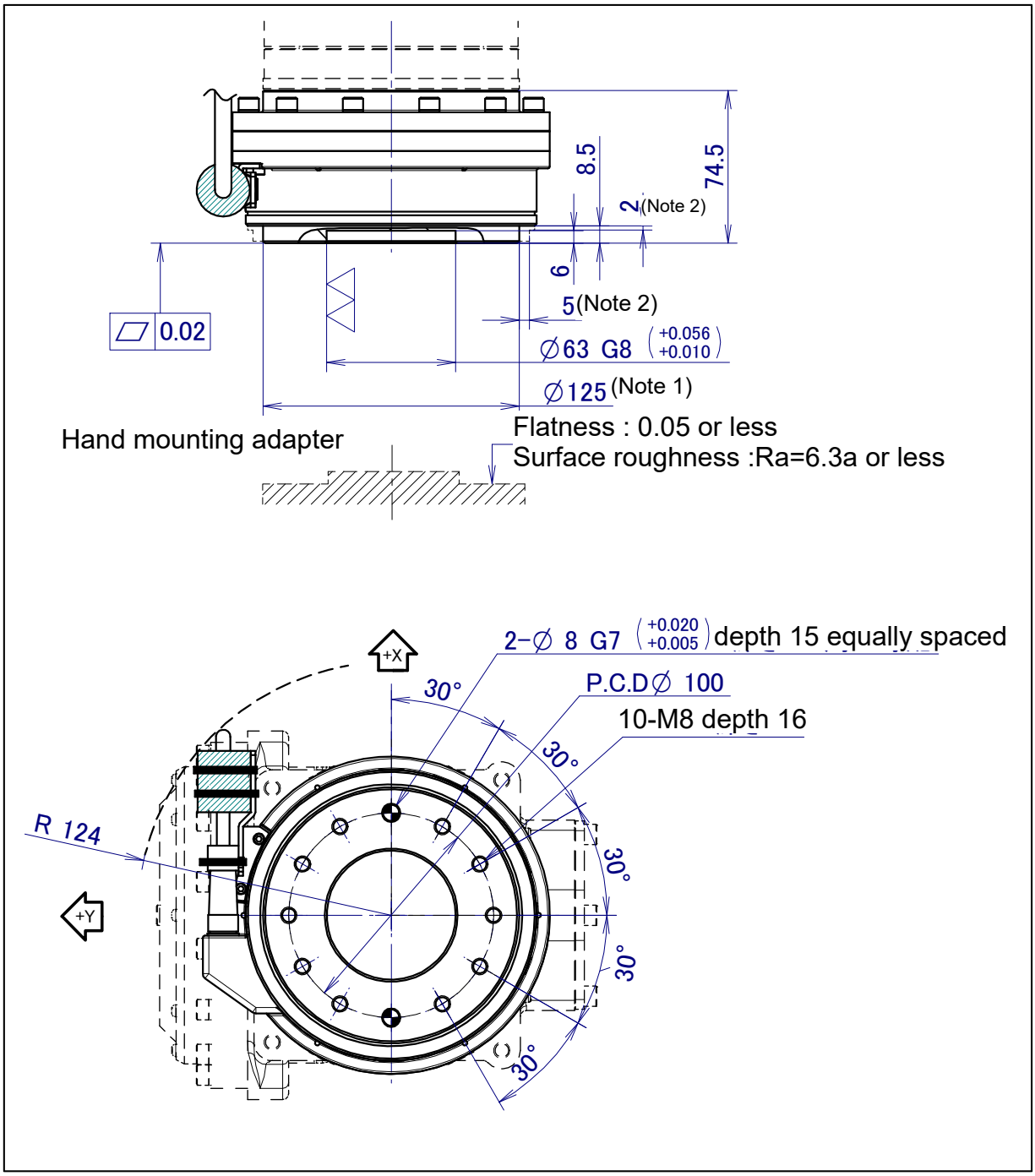


Fig. 4.1.1 (c) Wrist section end effector mounting surface (FS-100*i*A)

NOTE
1 Do not use Φ125 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

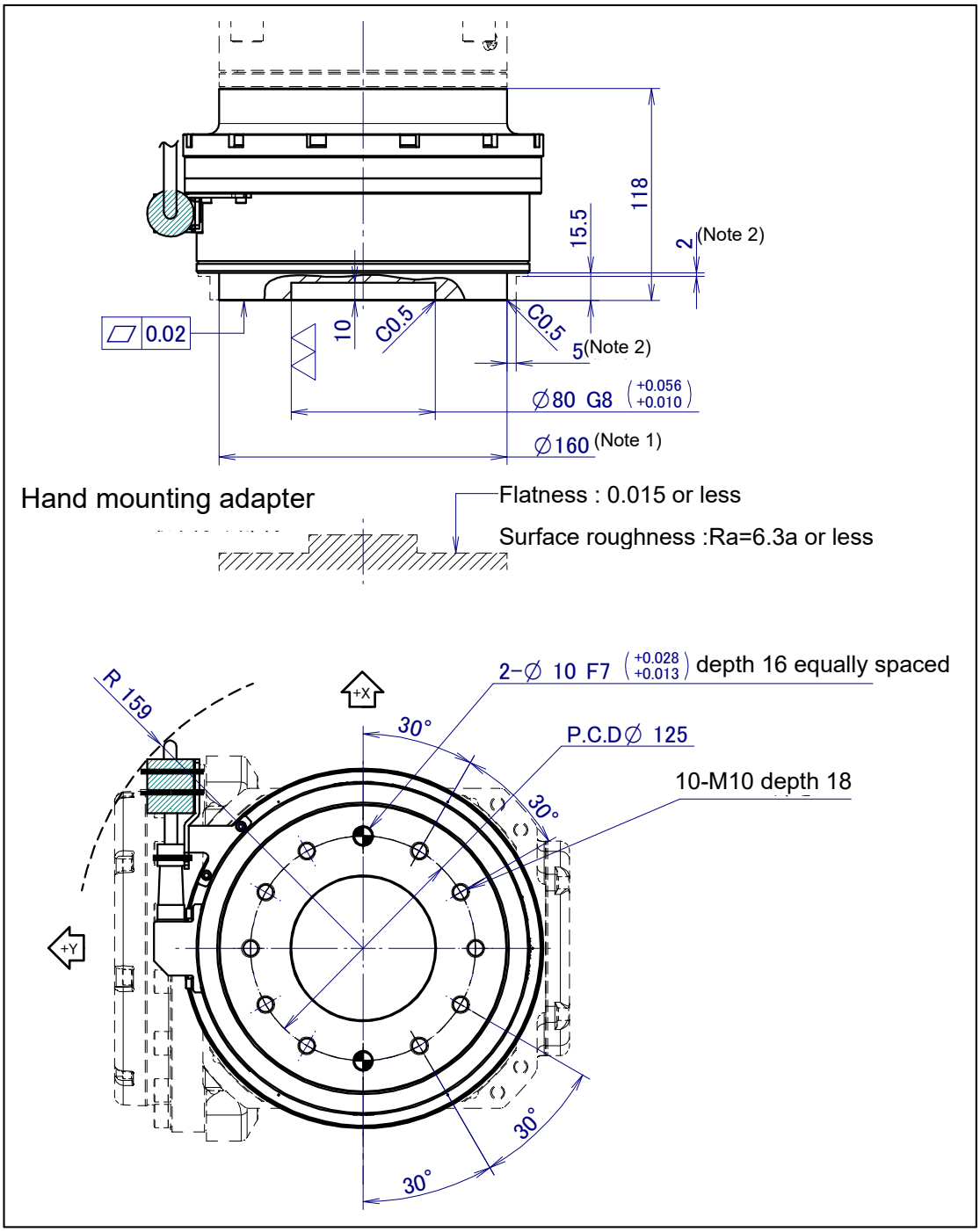


Fig. 4.1.1 (d) Wrist section end effector mounting surface (FS-250*i*A standard adapter)

NOTE
1 Do not use Φ160 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

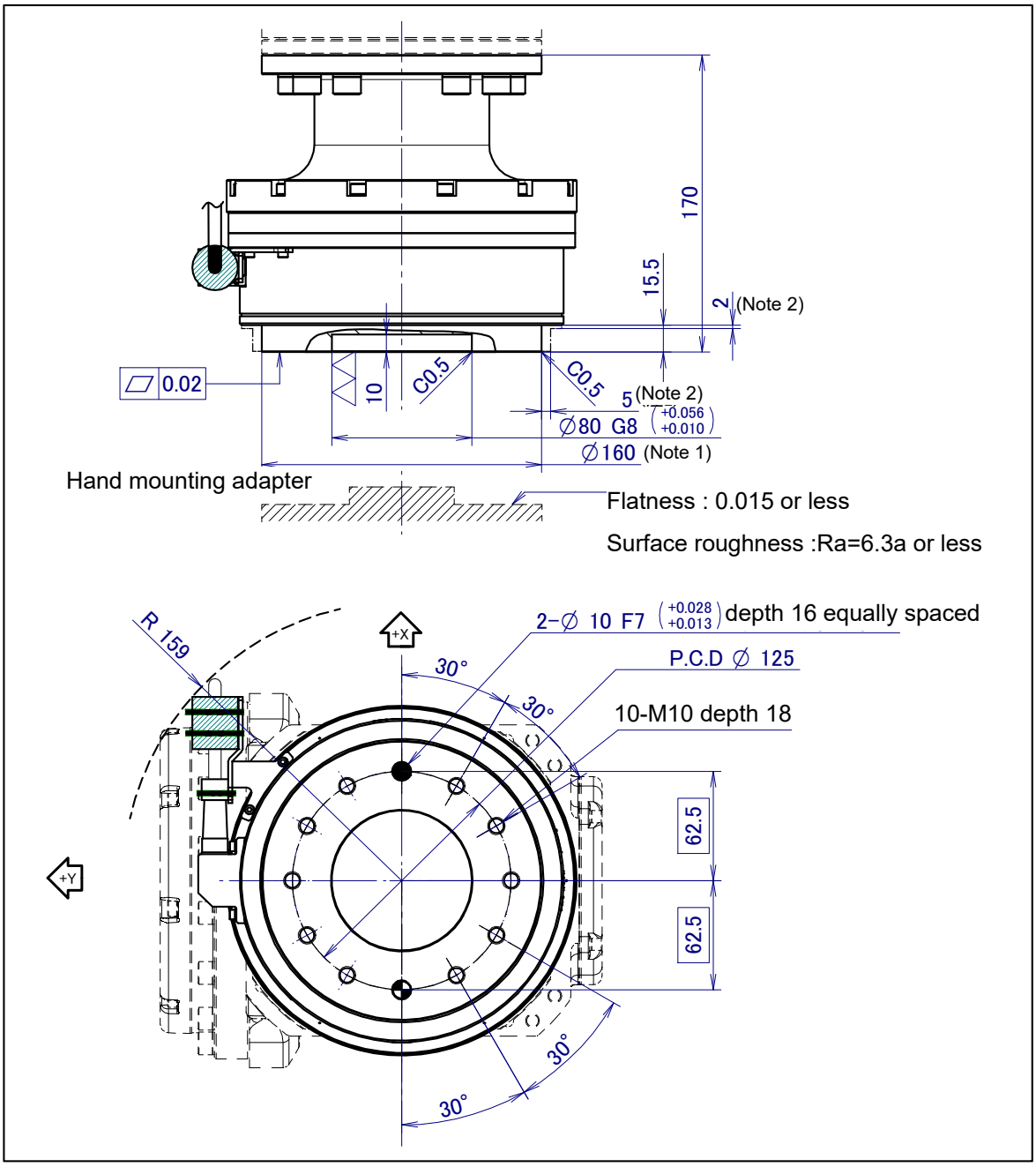


Fig. 4.1.1 (e) Wrist section end effector mounting surface (FS-250*i*A adapter which does not need torque wrench)

NOTE
1 Do not use Φ160 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

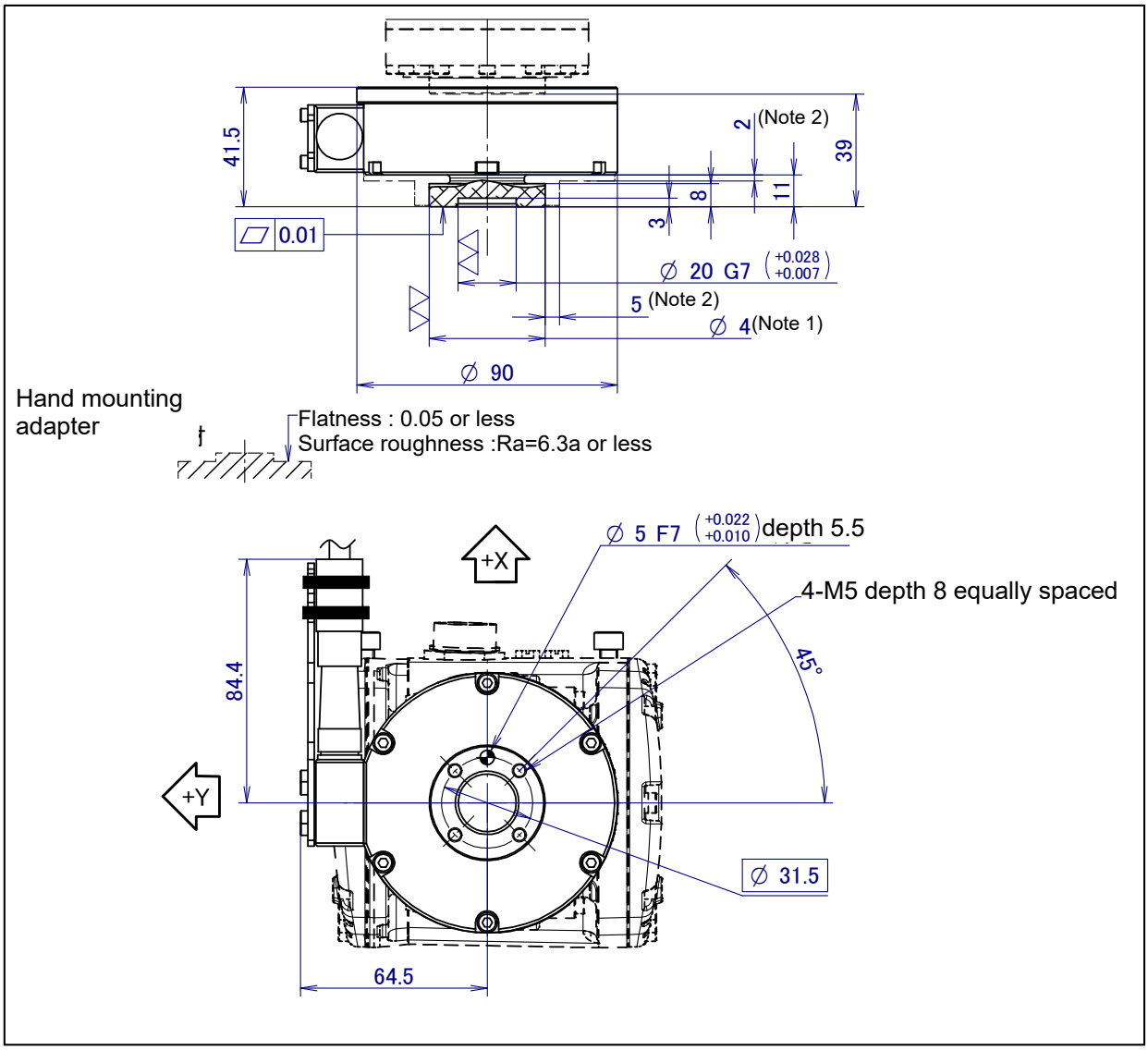


Fig. 4.1.1 (f) Wrist section end effector mounting surface (FS-15*i*Ae)

NOTE
1 Do not use Φ40 for mating when installing the hand.
2 Make this dimension clearance between the hand and the force sensor.

4.1.2 Example of Designing the Hand Mounting Adapter

When designing a member (hereafter called a hand mounting adapter) used to mount an end effector such as a hand on the force sensor, observe the following:

(1) The surface that meets the force sensor shall satisfy:
Flatness: 0.05 or less (In case of FS-250*i*A : 0.015 or less)
Surface roughness: Ra = 6.3a or less
(See Fig. 4.1.2 (a) to (d).)
(2) The flatness of the mounting face on the hand side must also satisfy the above requirements.
(3) A parallel pin shall be used as a positioning pin for the hand mounting adapter. Do not use a spring pin.

⚠ CAUTION
1 If the hand mounting adapter used does not satisfy the specified flatness and surface roughness requirements, the force sensor might be deformed, resulting in a heavy load being detected even when there is no load.
If this is the case, it is impossible to provide a sufficient measurement range.
2 If the force sensor is subject to a sudden temperature change (for example caused by direct contact with a hot, or a cold work piece), some time is necessary in order to stabilize its output. For these cases, please consider applying an external countermeasure (such as adding a material which low thermal conductivity, between hand adapter and hand).

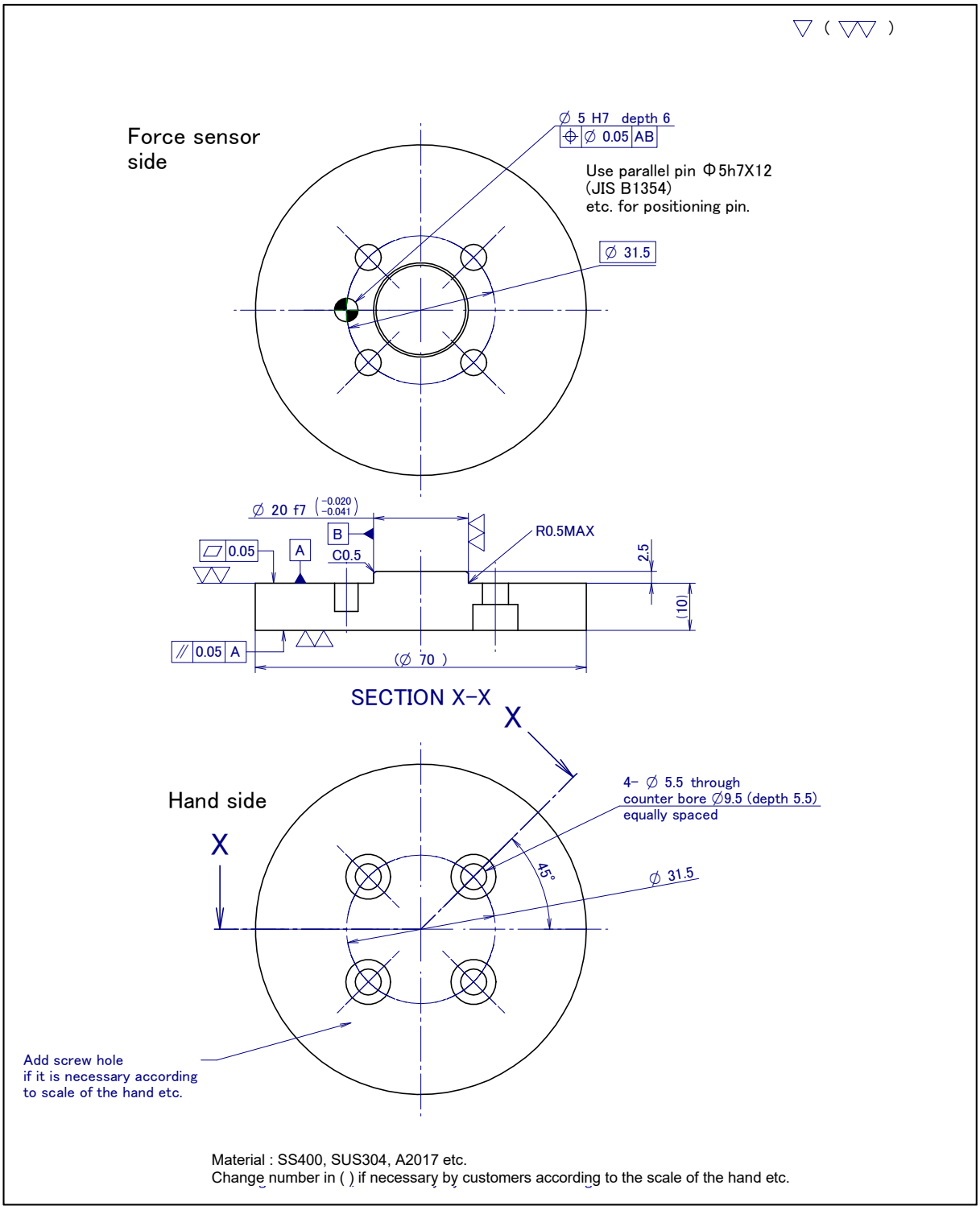


Fig. 4.1.2 (a) Example of designing the hand mounting adapter (FS-15*i*A, FS-15*i*Ae)

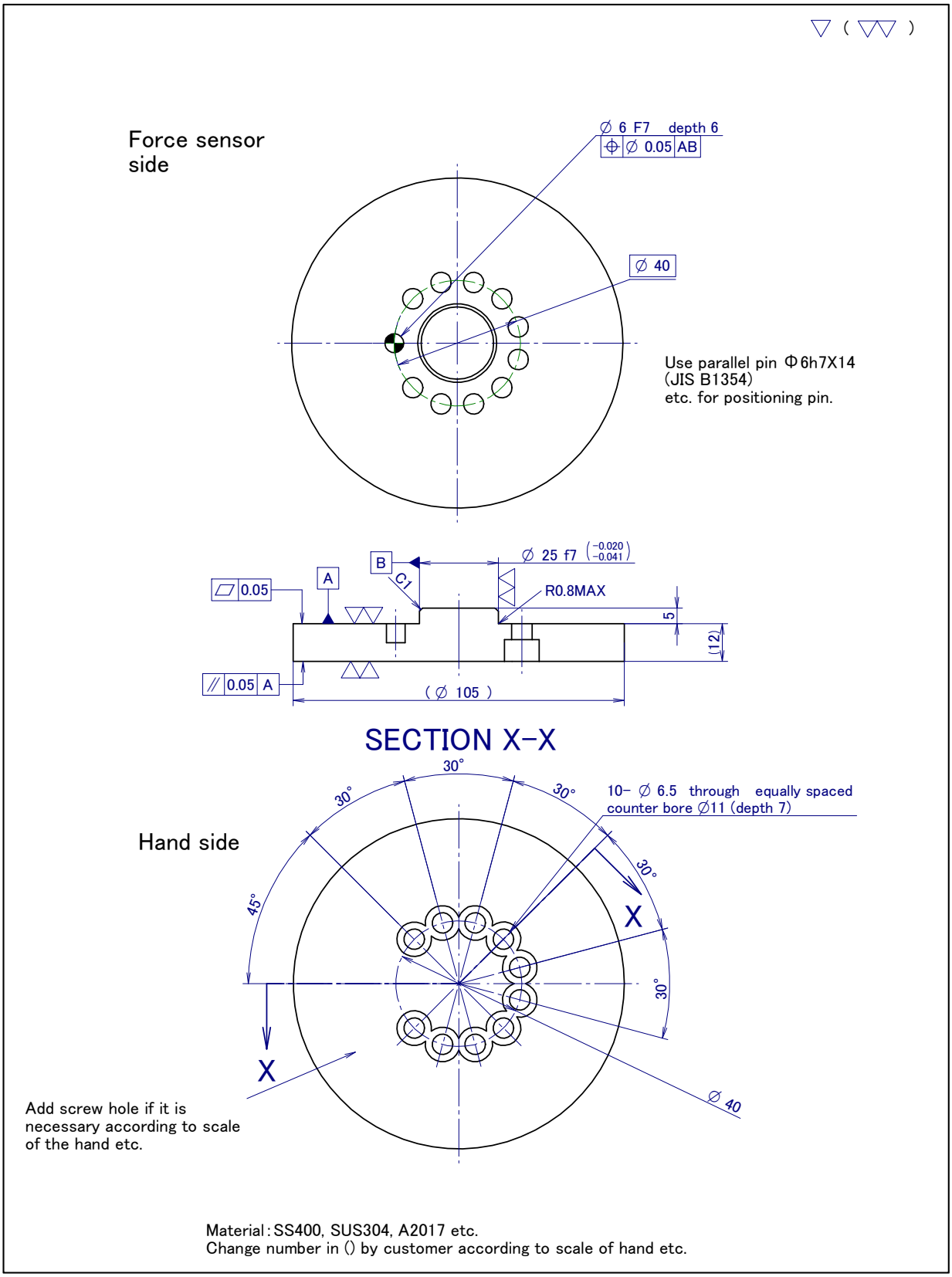


Fig. 4.1.2 (b) Example of designing the hand mounting adapter (FS-40*i*A)

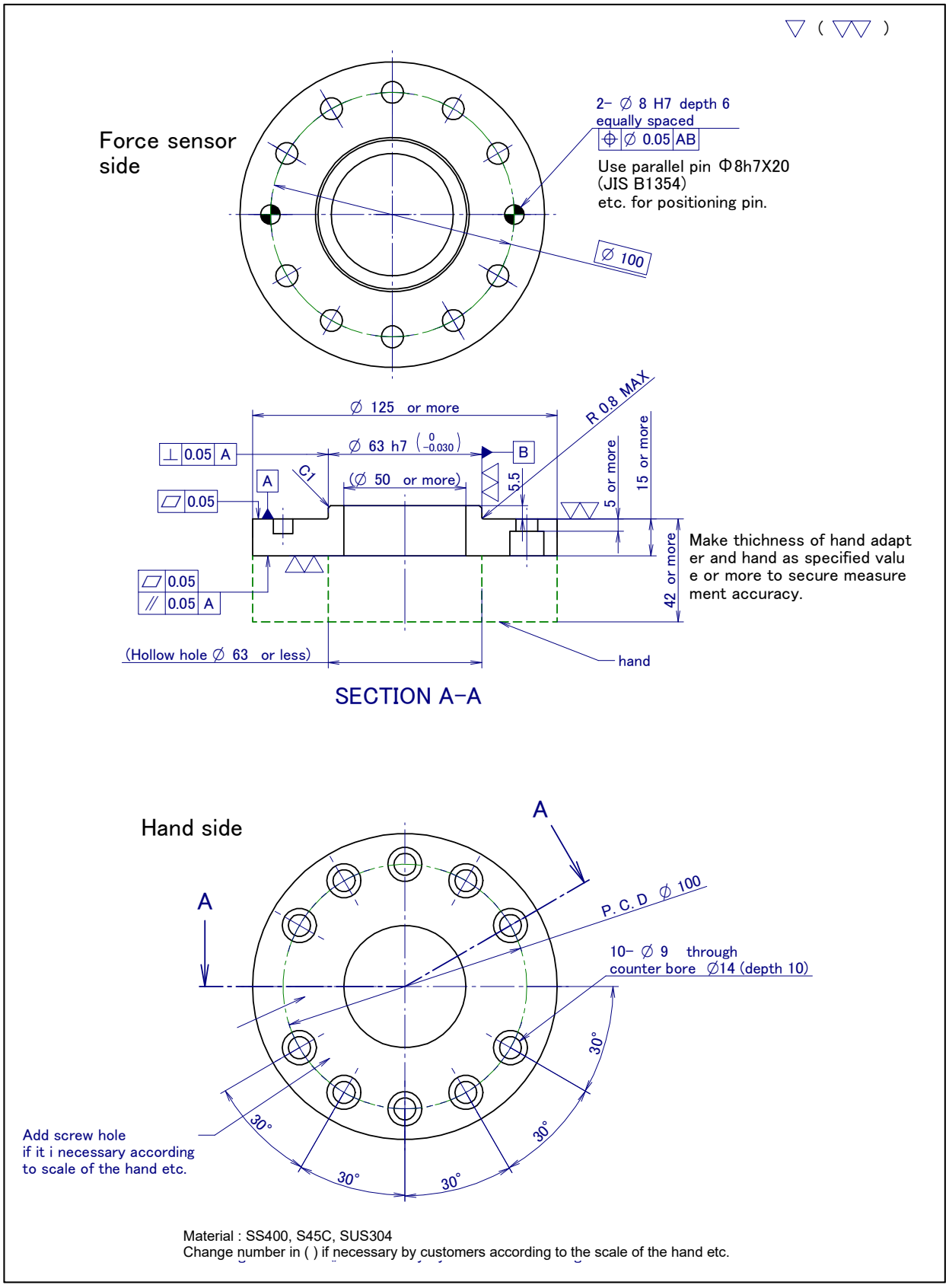


Fig. 4.1.2 (c) Example of designing the hand mounting adapter (FS-100*i*A)

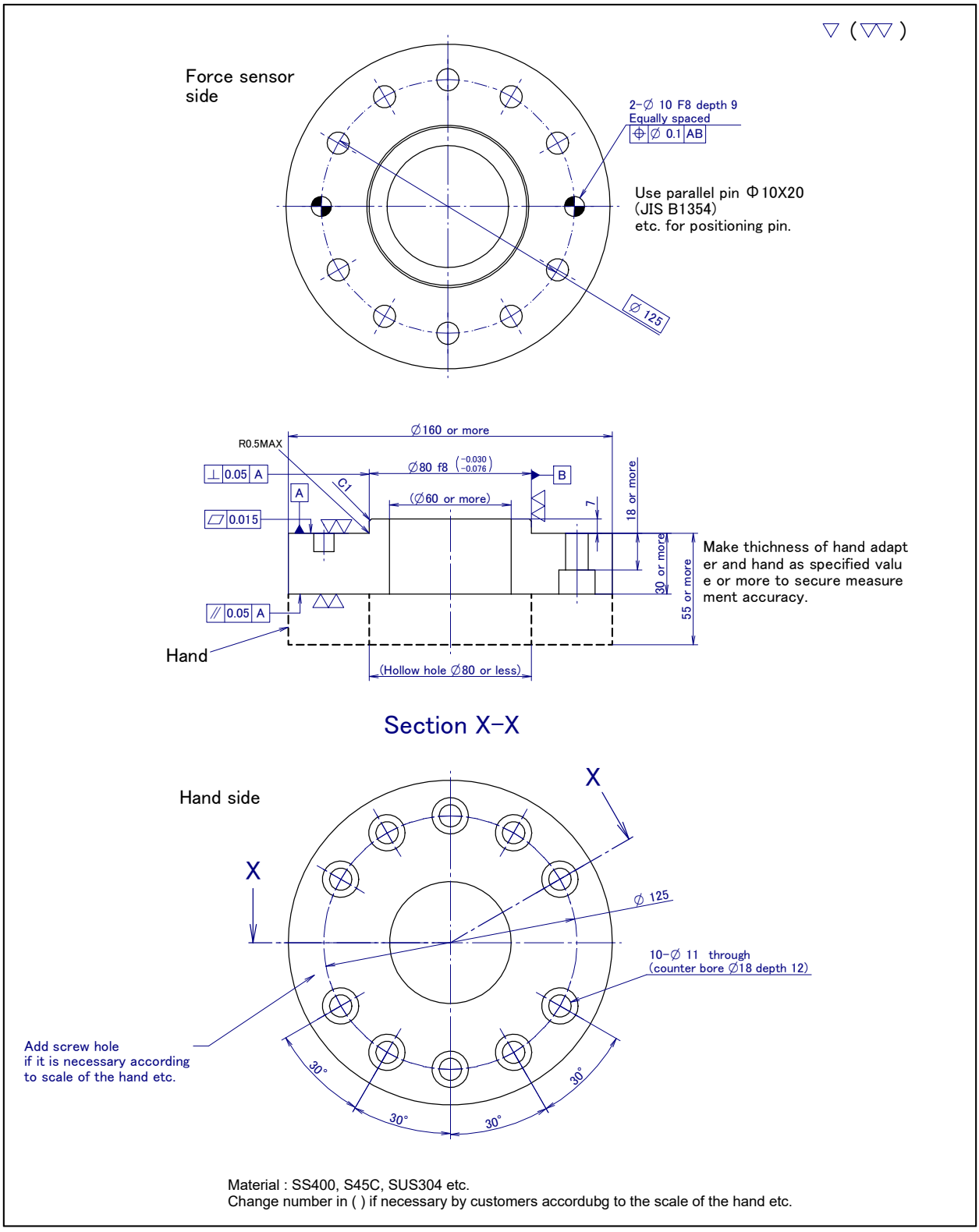


Fig. 4.1.2 (d) Example of designing the hand mounting adapter (FS-250*i*A)

4.2 3D LASER VISION SENSOR INTERFERENCE AREAS

Fig. 4.2 (a) to (d) show the interference areas of the 3D Laser Vision Sensor.

When the 3D Laser Vision Sensor is to be used, design an end effector in consideration of a vision interference area, a laser light interference area.

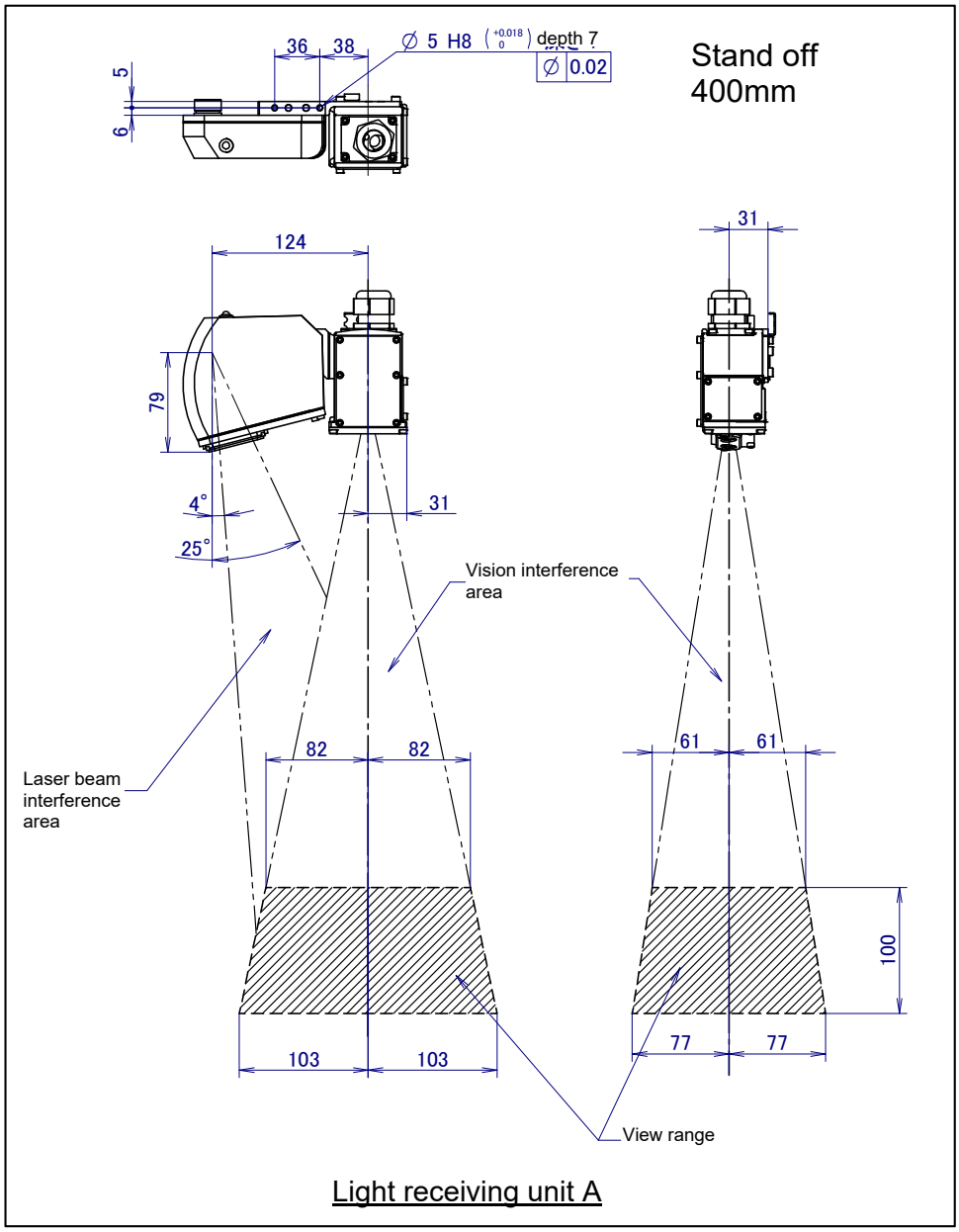


Fig. 4.2 (a) 3D Laser Vision Sensor interference area (Light receiving unit A)

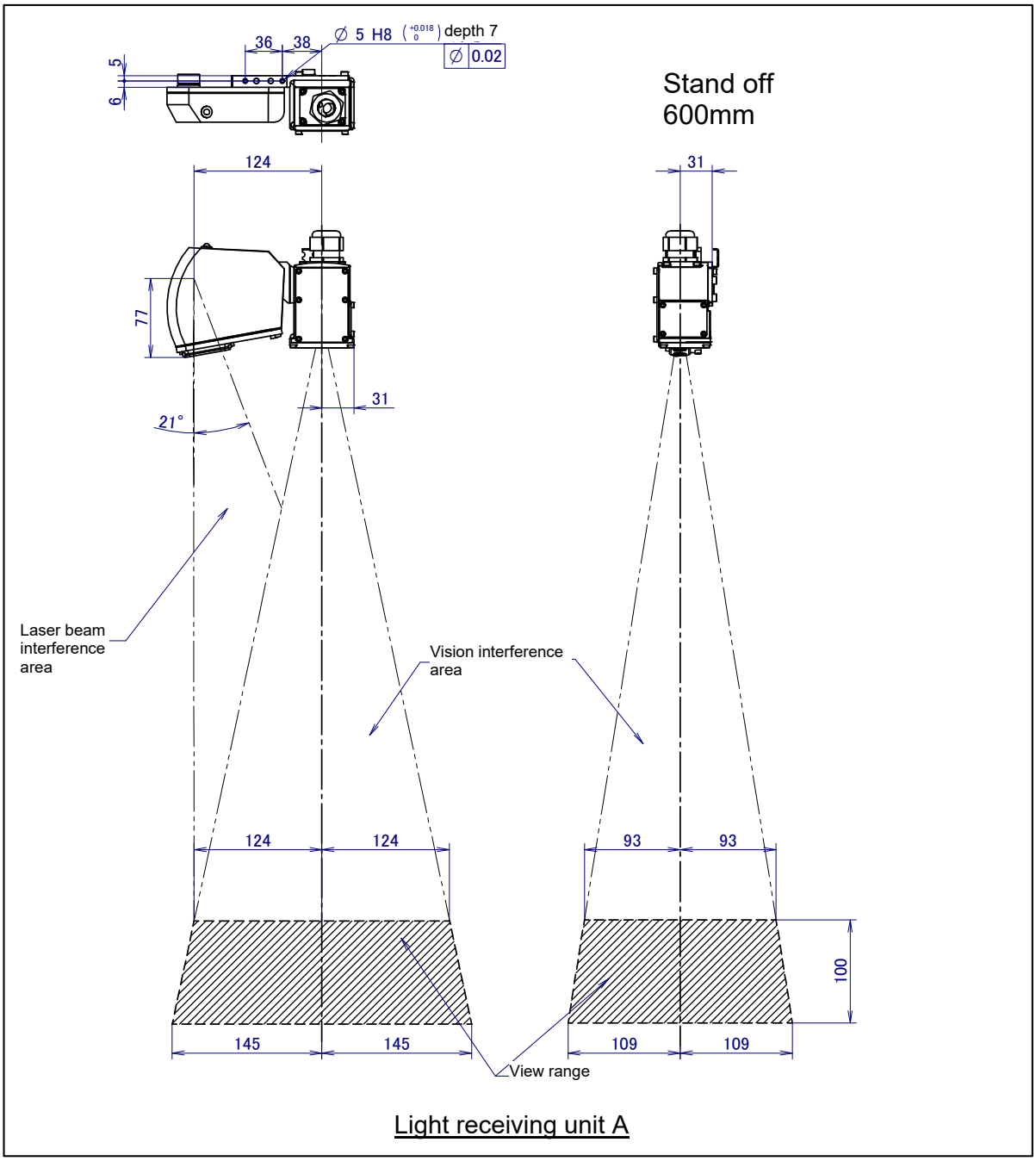


Fig. 4.2 (b) 3D Laser Vision Sensor interference area (Light receiving unit A)

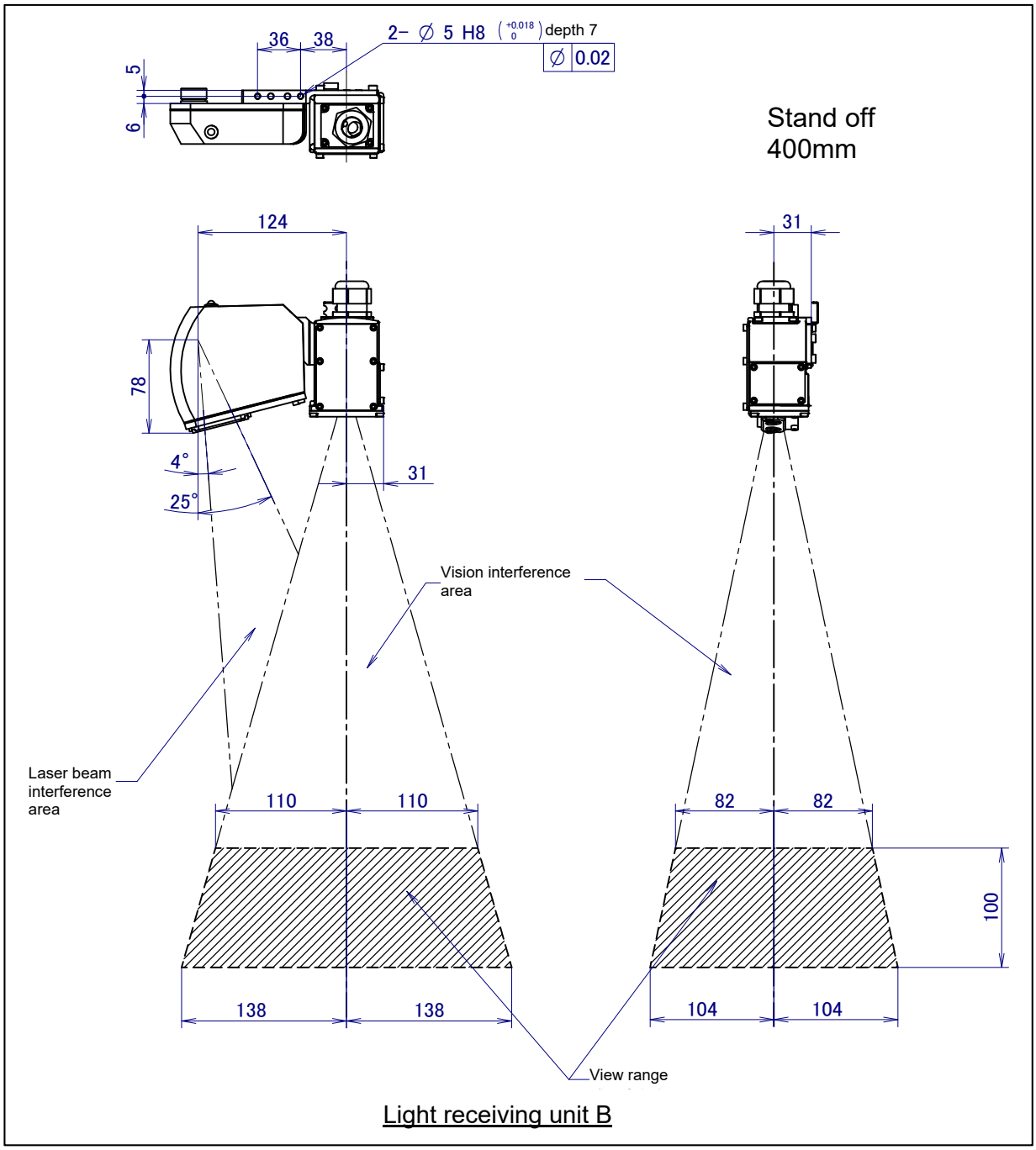


Fig. 4.2 (c) 3D Laser Vision Sensor interference area (Light receiving unit B)

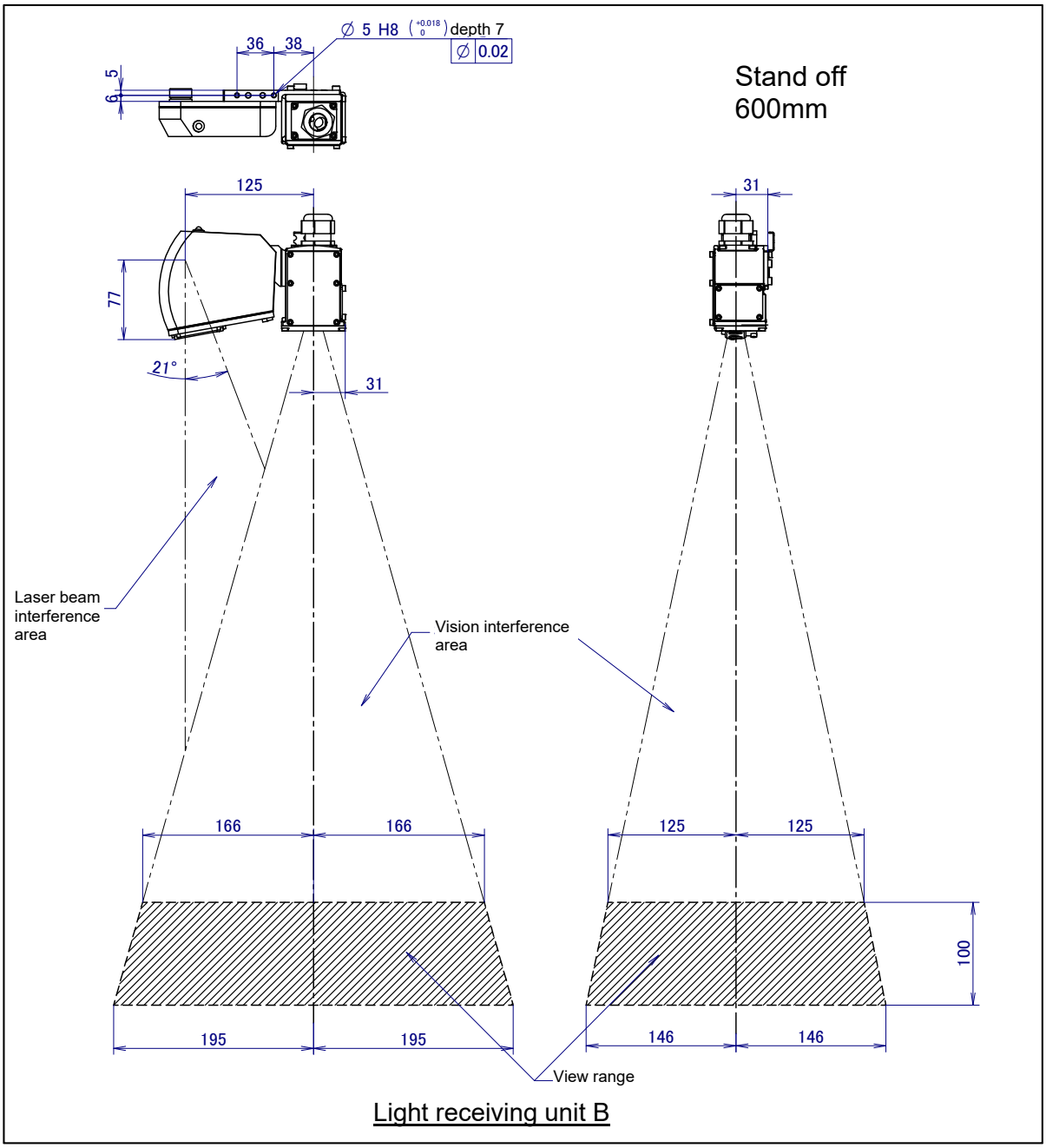


Fig. 4.2 (d) 3D Laser Vision Sensor interference area (Light receiving unit B)

5 PIPING AND WIRING

5.1 PIPING

The piping in a robot loaded with the force sensor is the same as that of the mechanical unit of the robot's mechanical main body. Refer to the specific mechanical unit manual for that robot model.

5.2 WIRING

5.2.1 Robot Which Equipped Force Sensor and 3D Laser Vision sensor

Fig. 5.2.1 (a) shows the schematic drawings of the robot loaded with the force sensor. Refer to the Maintenance Manual for explanations of the wiring of the robot each mechanical unit.

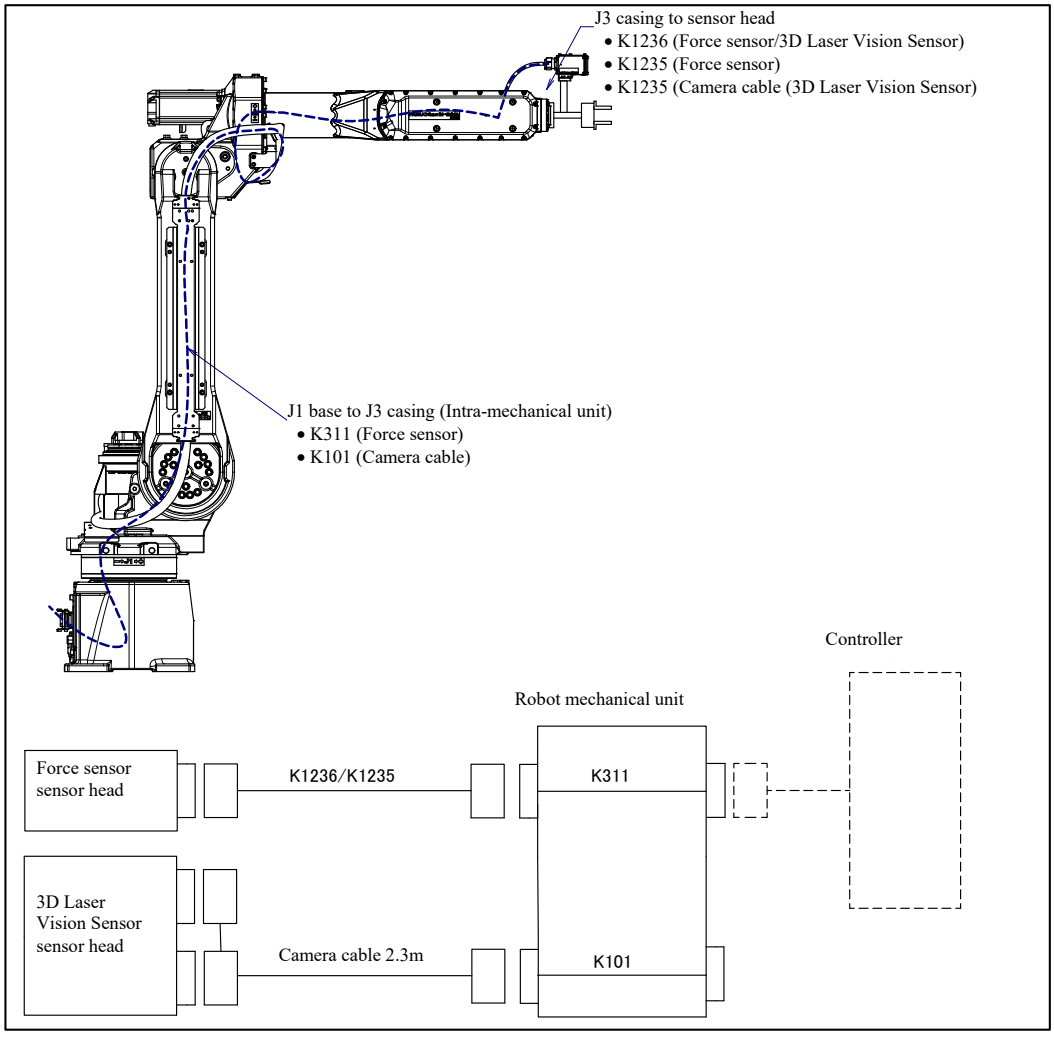


Fig. 5.2.1 (a) Robot with sensor

5.2.2 3D Area Sensor

Fig 5.2.2 (a) shows wiring of 3D Area Sensor.

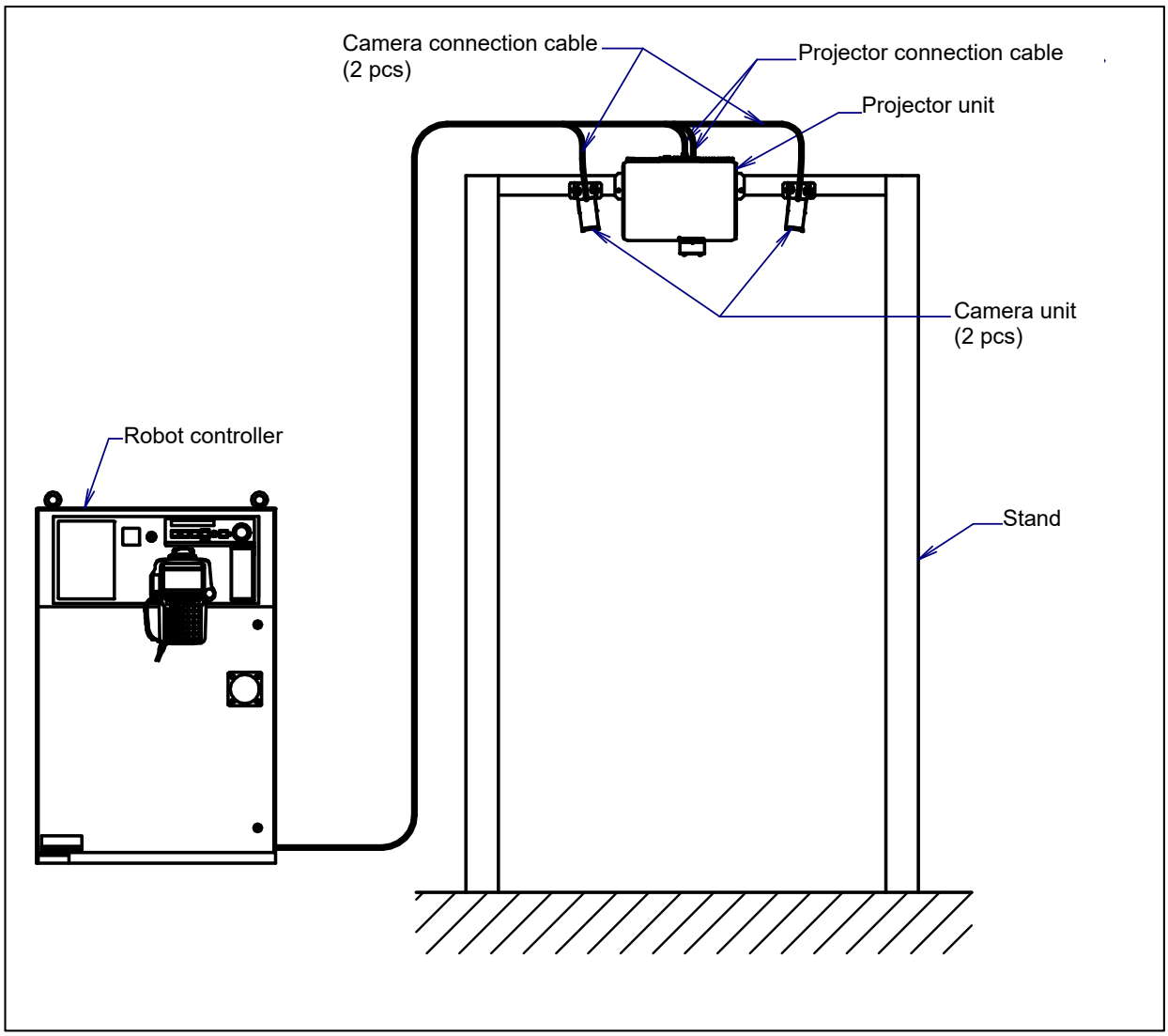


Fig.5.2.2 (a) Wiring of 3D Area Sensor (3DA/1300)

5.2.3 3D Vision Sensor

5.2.3.1. 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400, 3DV/600

Fig. 5.2.3.1 (a), (b) show the wiring of the 3D Vision Sensor.

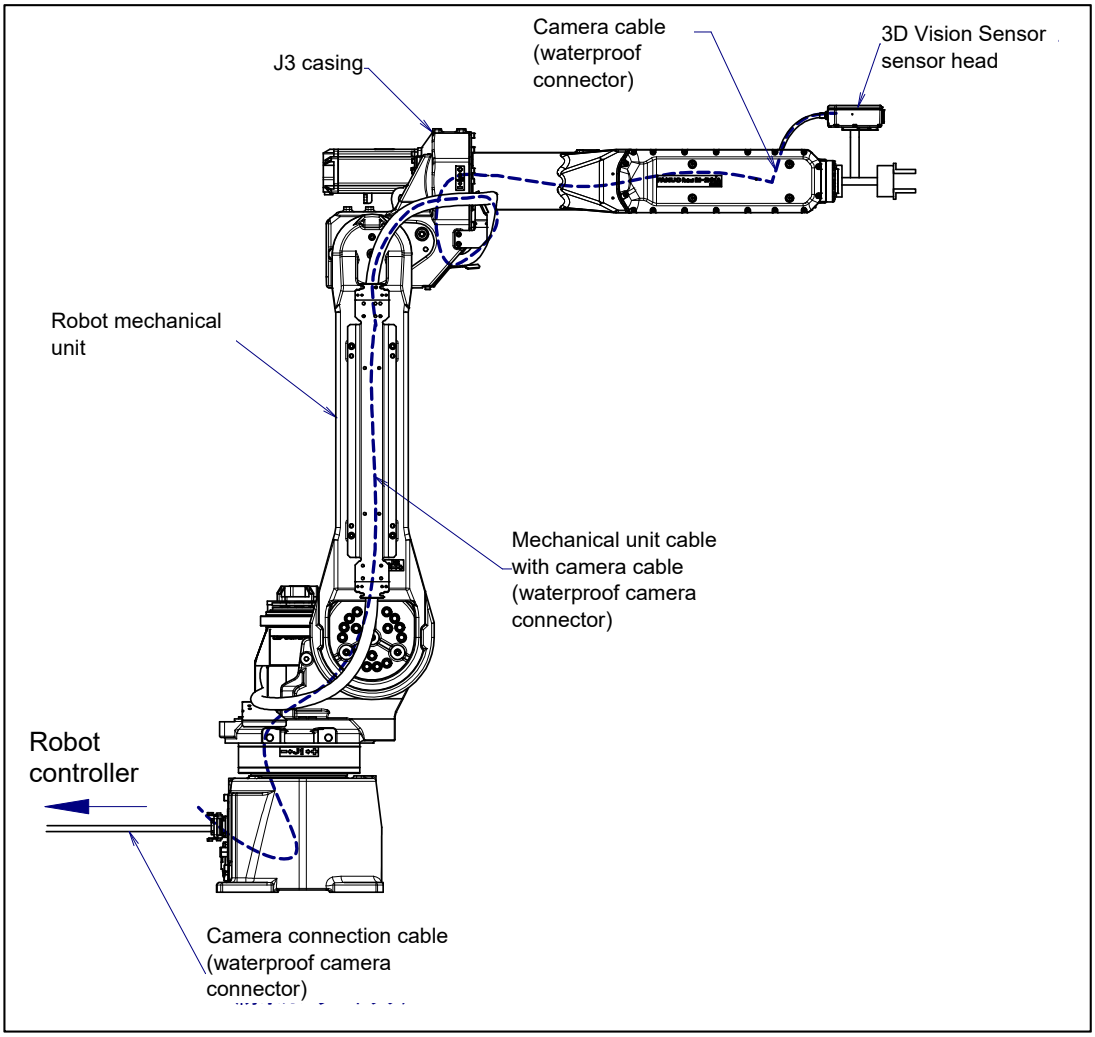


Fig. 5.2.3.1 (a) Wiring of the 3D Vision Sensor (hand camera)

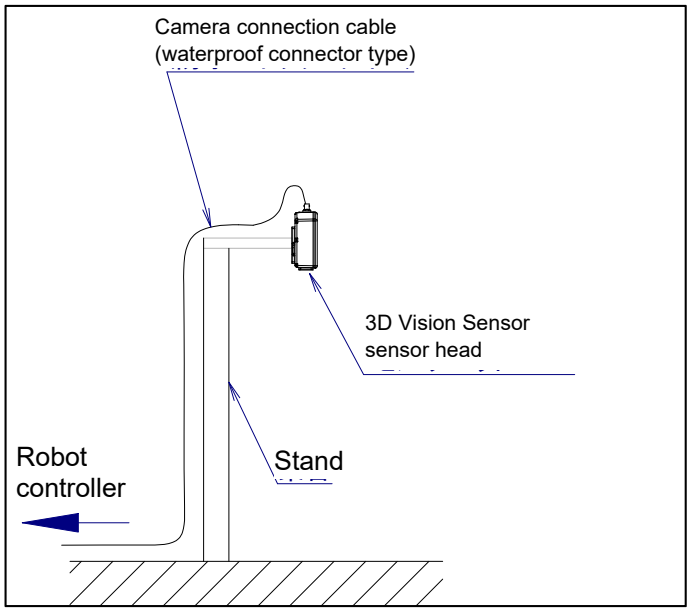


Fig. 5.2.3.1 (b) Wiring of the 3D Vision Sensor (fixed camera)

5.2.3.2. 3D Vision Sensor 3DV/1600

Fig. 5.2.3.2 (a), (b) show the wiring of the 3D Vision Sensor.

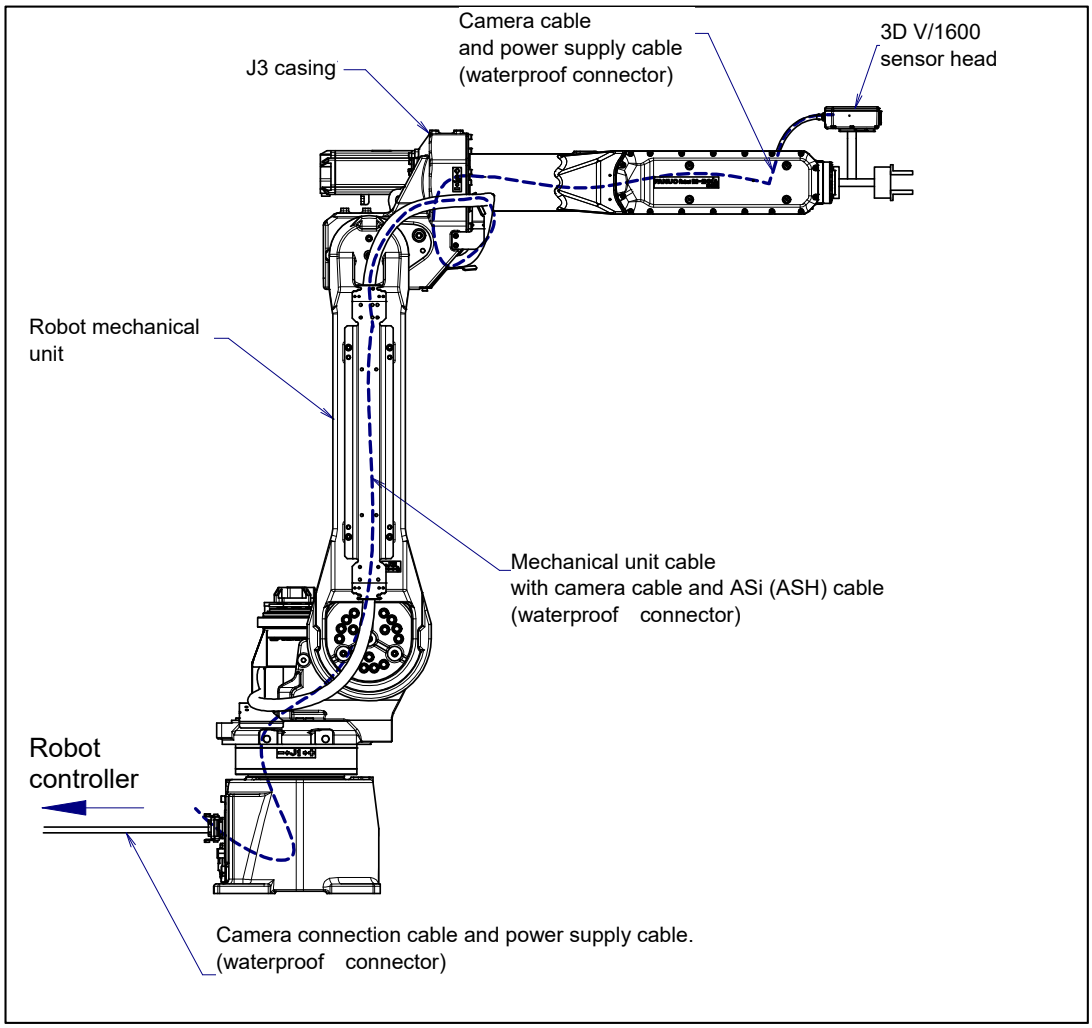


Fig. 5.2.3.2 (a) Wiring of the 3D Vision Sensor (hand camera)

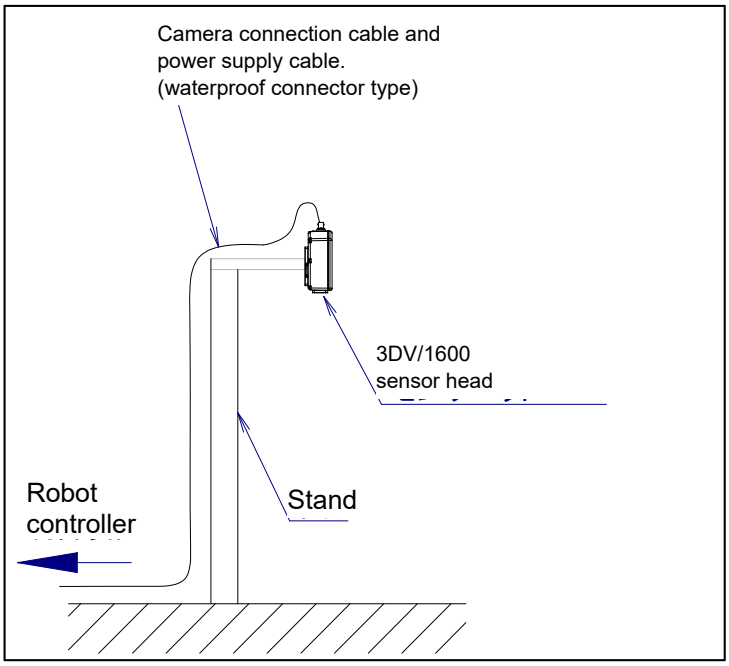


Fig. 5.2.3.2 (b) Wiring of the 3D Vision Sensor (fixed camera)

5.2.4 Wiring of the connection cable for the sensor

There are cables which application is limited to fixation part and stored in the cable carrier and usable at the movable part.

Cable spec.

		For fixed part			For movable part		
		outer dia. (mm)	**weight (kg/m)**	**Minimum Bending radius (mm)**	**outer dia. (mm)**	**weight (kg/m)**	**Minimum Bending radius (mm)**
R-30*i*B Plus Camera cable	Cable for wiring	8.0	0.1	48	9.6	0.13	200(movable) 60(fixed)
	Cable for wrist	-	-	-	6.5	0.056	40
Force sensor cable		-	-	-	7.0	0.07	200(movable) 42(fixed)
Projector unit cable	Power line	6.4	0.065	39	6.4	0.065	200(movable) 39(fixed)
	Signal line	7.4	0.2	45	8.5	0.2	200(movable) 51(fixed)
Power supply cable for 3DV/1600	Cable for wiring				10.4	0.18	200(movable) 63(fixed)
	Cable for wrist				8.5	0.1	51

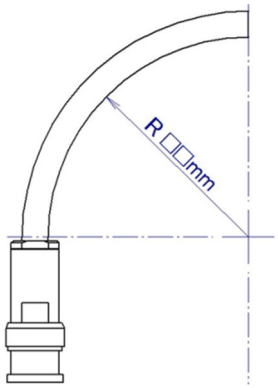
Used condition of the movable cable

1 Use cable carriers to the movable part and set it.
2 Make bending radius (R) of the cable carrier less than 200mm.
3 Fix the both edges of the cable carrier with clamp such as rubber gasket.
4 The size of the hole to support a cable in the cable carrier should be more than 110% of the cable size and should have the gap more than 3mm.
5 When setting the cables, be careful not to twist the cable.

For details, refer to “FLEX CABLE CONDITION” of each controller maintenance manual appendix.

About camera cable

1 Do not kink the camera cable. It might make electrical characteristics worse.
2 In order to prevent connector deformation, before laying the camera cable, keep the minimum bending radius to avoid applying excessive vertical force.



R=□□mm

Minimum bending radius

NOTE

To prevent PWM noise influence, separate the power cable and the camera cable as much as possible.

6 ADJUSTMENT

Each portion of the sensor has been factory-adjusted to the best condition. The customer does not need to adjust the sensor when the machine is installed.

If you kept the robot unused for prolonged time, or have replaced components, make adjustments as stated in this chapter.

6.1 FORCE SENSOR

There are no parts to be adjusted in the force sensor.

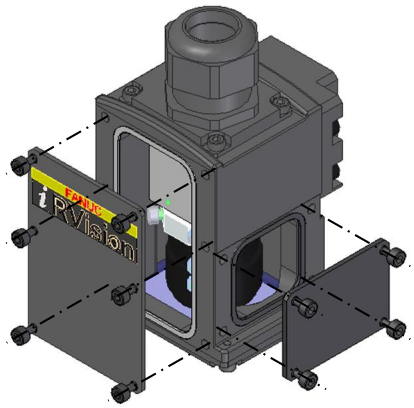
In addition, refer to the CONTROLLER Force Sensor OPERATOR'S MANUAL (B-83934EN) about force control function of force sensor.

6.2 CAMERA PACKAGE

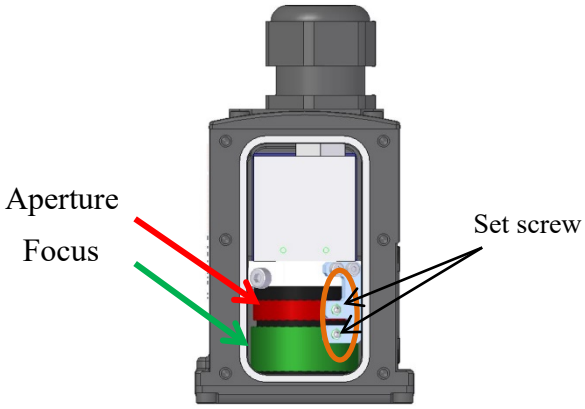
6.2.1 Adjustment of Focus and Aperture

To acquire the image using the camera package, adjusting focus and aperture of the lens beforehand is required. The following shows the procedure.

1 Make the distance of the camera and the work same to when detecting the work.
2 Loosen bolts of the side cover and the front cover, then remove those.



3 Loosen set screws to adjust the aperture and focus.



4 Display the camera image on the *i*Pendant or PC for teaching, adjust the focus and aperture of the lens during checking the image.
5 Put the material letter is written on it to the place for setting work.
6 Adjust the aperture and focus of the lens to make letters on the material clearly visible.
If "LIVE" is pressed before adjusting, images on the camera is continuously displayed. It is very useful. Adjust the brightness by aperture ring (figure below (1)) and the "exposure time" on the setting screen. F value is written in the aperture ring. Image becomes dark by enlarge the F value, it becomes bright by reducing it. Depth of field becomes deep by enlarging the F value, Focus range widen. In addition, image brightness can be adjusted by exposure time. Image becomes bright by enlarge it, and it becomes dark by reducing it. Adjust the focus with the focus ring (the following figure (2) on the lens. Distance which matches the focus is written on the focus ring. Adjust the focus referring to it, too.

7 Tighten the set screws, confirm the aperture and focus is fixed by set screws, prevent the rotation by locking (TB1401B).
8 Attach the side cover and the front cover. (Tightening torque 1Nm)

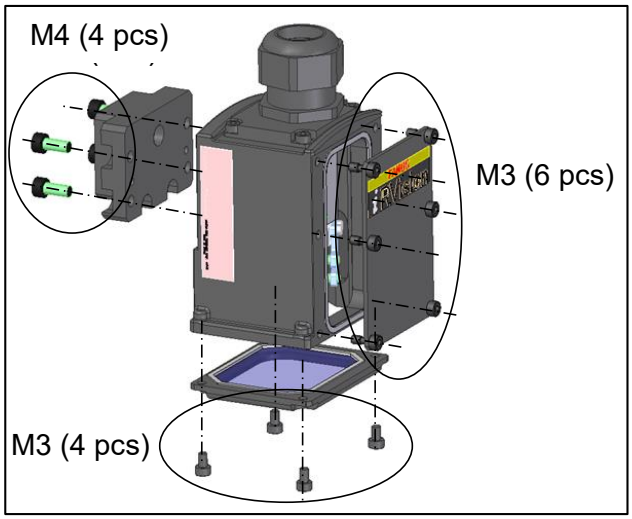
6.2.2 Calibration

Calibration is necessary for normal operation of the sensor. It is also recommended to create a robot program for automatic re-calibration. If the position of the camera is changed or the camera is replaced for some reason after the system is put into operation, the camera needs to be re-calibrated. In such a case, the robot program for automatic re-calibration allows you to restore the camera to its proper position with ease. Refer to the R-30*i*B Plus/R-30*i*B Mate Plus/ R-30*i*B Compact Plus/ R-30*i*B Mini Plus controller *i*RVision OPERATOR'S MANUAL (Reference) (B-83914EN).

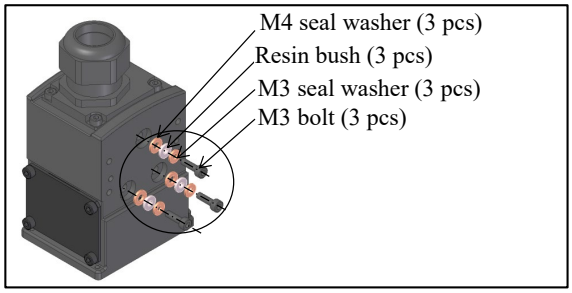
6.2.3 Replacing the Lens

To change the field of view of the camera package, replacing to the lens which focus distance differ is required. The following is the procedure.

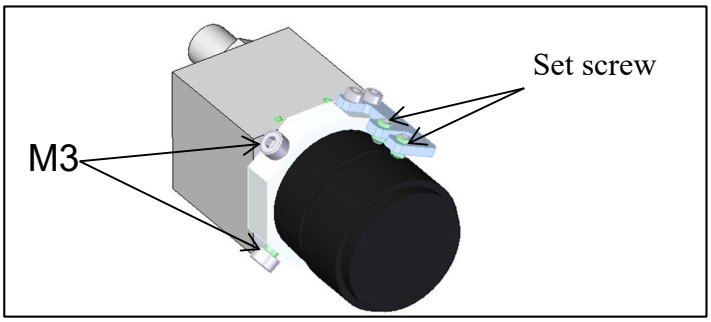
Without LED
1 Remove bolts as figure, then remove each part.



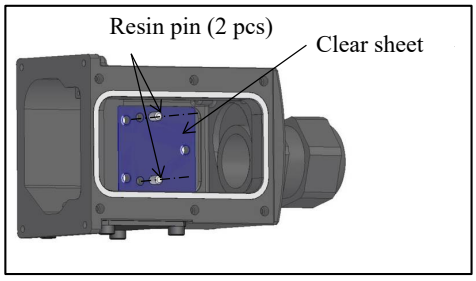
2 Remove bolts which fix the camera.



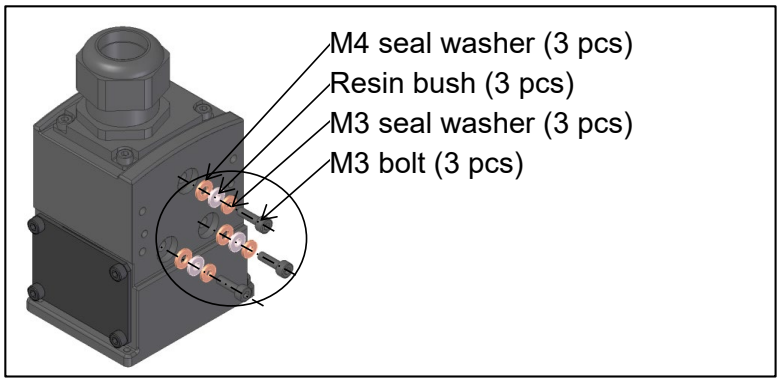
3 Loosen the set screws of the lens holder, then loosen the M3 bolts of the lens fixation member.



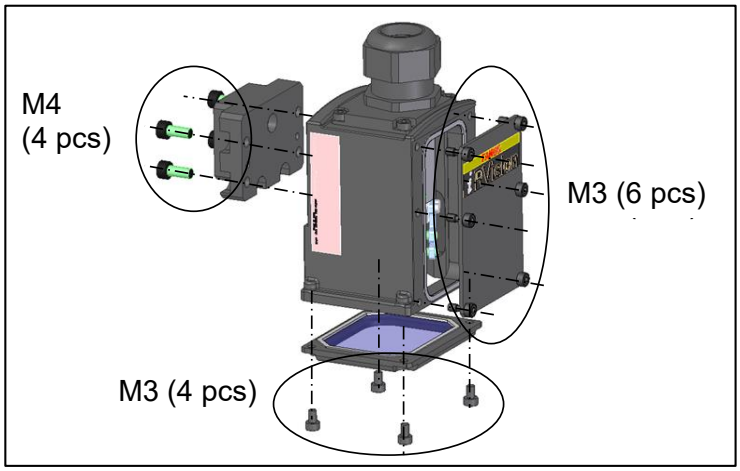
4 Remove the lens.
5 Attach the lens during pass the lens holder to the camera tip.
6 Fix the lens holder with M3 bolts during pushing it to the lens. Apply LOCTITE 243 on the bolt thread, then tighten it. (Tightening torque 0.12[N/m])
7 Insert resin pins and lay the clear sheet.



8 Fix the camera with bolts. (Tightening torque 0.6[N/m])

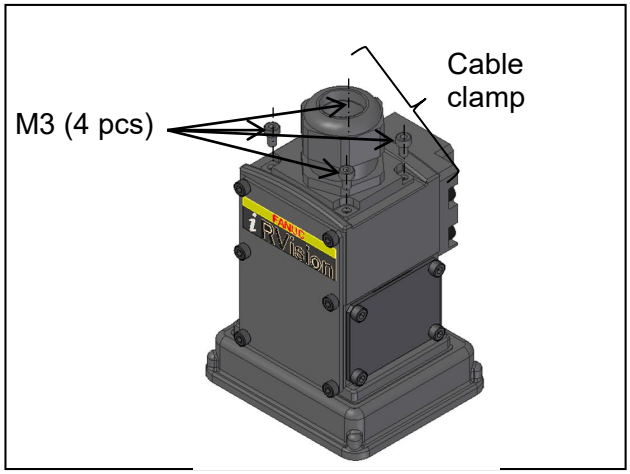


9 Fix each part as figure. (Tightening torque 1.0[N/m])

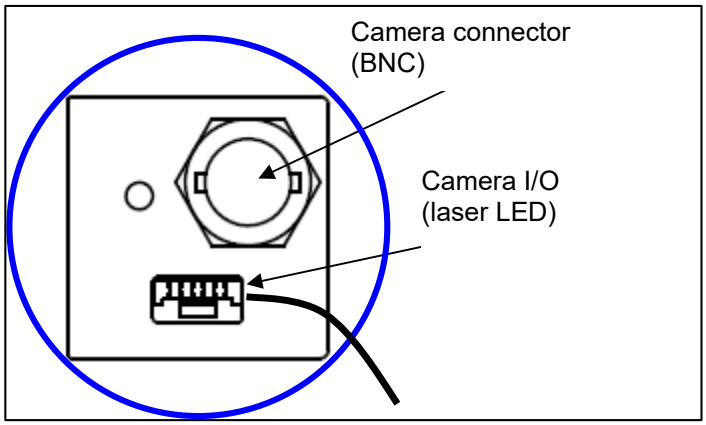


With LED

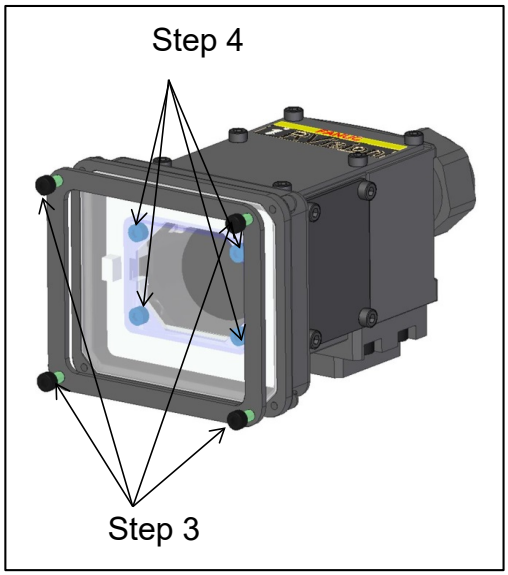
1 Remove bolts and the cable clamp.



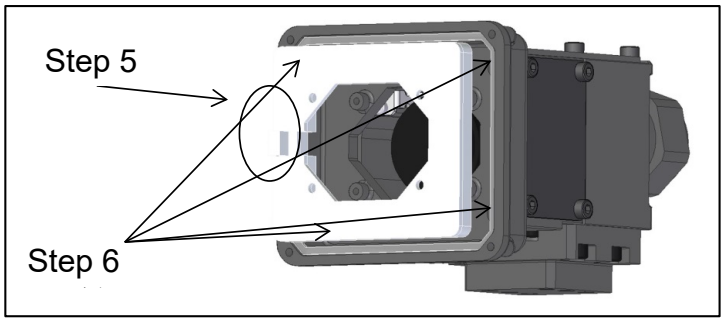
2 Remove the camera I/O cable connected to the camera.



3 Remove the lid of the LED unit, then remove the clear window plate.
4 Remove the bolts which fix the resin in the LED.



5 Remove the LED cable.
6 Remove the LED, then remove the bolts which fix the LED case.



7 Replace the lens with the same procedure of “without lens”
8 After attaching the camera, then attach the LED case on the camera package main body. (Tightening toruque 1.0[N/m])
9 Set the LED, connect the cable, attach bolts removed at installation step 4. (Tightening torque is not specified)
10 Attach the clear window plate, attach the cover remove at step 3 with bolts. (Tightening torque 1.0[N/m])

6.3 3D LASER VISION SENSOR

6.3.1 Calibration

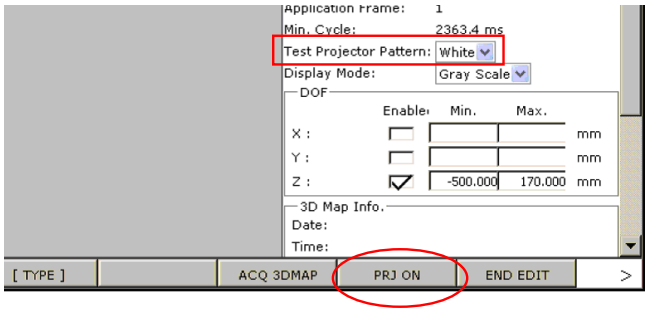
To use it, calibration is required. It is also recommended to create a robot program for automatic re-calibration. If the position of the 3D Laser Vision Sensor is changed or the camera is replaced for some reason after the system is put into operation, the 3D Laser Vision Sensor needs to be re-calibrated. In such a case, the robot program for automatic re-calibration allows you to restore the 3D Laser Vision Sensor to its proper position with ease.
Refer to "2 3DL SENSOR DATA SETTING" of the Know-how section of the R-30*i*B Plus/R-30*i*B Mate Plus/ R-30*i*B Compact Plus/ R-30*i*B Mini Plus controller *i*RVision 3D Laser Vision Sensor operator's manual (B-83914EN-4).

6.4 3D AREA SENSOR

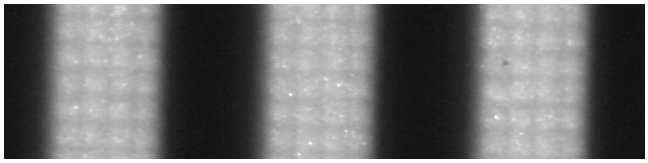
6.4.1 Change of Field of View Area of Projector

To detect with high precision by using projector, it is necessary to change the projection area according to the required detection area. In case of using narrower area than standard projection area, shorten the distance between projector and center of projection area. Adjust the focus of the projector according to the distance. Procedure is below.

1 Place a material which has a flat surface in the center of 3D Area Sensor measuring area.
2 Loosen M3 set screws for lens cover fixation. (See Fig. 6.4.1 (a).)
3 Rotate the lens cover to counterclockwise, then remove the lens cover and the gasket.
4 Loosen M3 set screw 2 pcs (back and front) for focus adjustment ring fixation. Be careful not to loosen the M3 screws for zoom adjustment ring fixation.
5 Display teach screen of 3D Area Sensor.
6 In the 3D Area Sensor setting screen, select "Chess" at the "Test Projector Pattern". Then press "PRJ ON". Chess board pattern is projected from the projector unit.



7 During visual checking the projected pattern, rotate the focus adjustment ring and adjust the focus. When small grid patterns are seen in the projection device (DMD), this means focus is adjusted.



8 Tighten M3 set screws 2 pcs for focus adjustment ring fixation by turns little by little, then fix the focus adjustment ring. If only one set screw is tightened too much, it cause excessive force, please be careful.

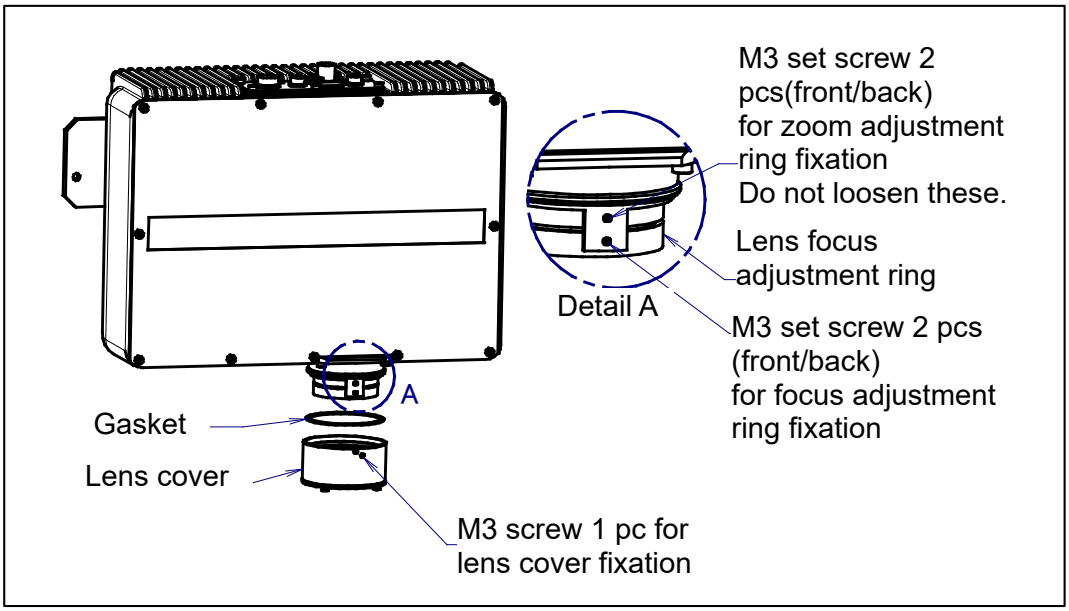


Fig.6.4.1 (a) Adjusting focus of the projector

Table. 6.4.1 (a) Maintenance item list

Order spec.	Items arranged	Note
A290-7422-X260	Gasket	For lens cover

6.5 ADJUSTMENT OF THE CAMER UNIT FOCUS

When the distance of 3D Area Sensor and work differs from standard position, it is necessary to adjust the focus and aperture of the lens. According to Subsection 6.2.1, adjust it. In addition, focus and aperture of the lens was set to most suitable at standard positon when it is shipped.

6.6 3D VISION SENSOR

3D Vision Sensor is set to best condition when it is shipped, adjusting by user is not required when loading it.
When a strong impact or vibration is applied to the 3D Vision Sensor, measurement performance may degrade. In that case, you can re-adjust the 3D Vision Sensor. Refer to “Setup 2.4.6 Re-Adjustment the 3D Vision Sensor” of the R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus//R-30*i*B Mini Plus controller *i*RVision OPERATOR’S MANUAL (Reference) (B-83914EN).

7 CHECKS AND MAINTENANCE

Performing daily and periodic inspection enables the sensors to maintain stable performance for a long period.

The periodic inspection items for the sensors are listed below:

Refer to the manual for explanations of the each robot mechanical unit.

Also, refer to the controller maintenance manual for explanations of the controller.

7.1 DAILY INSPECTION

(1) Before starting operation (before turning on the power)

Target	Inspection item	Inspection procedure
Force sensor	Cracking in the rubber cover	Check for cracking or any other abnormality in the sensor head rubber cover.
	Sensor cable abnormality	Check for a kink, abnormal bending, cracking, or any other abnormality in the sensor cable.
3D Laser Vision Sensor	Soiled window	Check to see if the window is soiled. If soiled, clean it. (See Subsection 8.3.1.)
	Sensor cable abnormality	Check for a kink, abnormal bending, cracking, or any other abnormality in the sensor cable.
Camera package	Soiled light cover and window	Check to see if the light cover and window are soiled. If soiled, clean it. (See Subsection 8.2.1.)
	Sensor cable abnormality	Check for a kink, abnormal bending, cracking, or any other abnormality in the sensor cable.
3D Area Sensor	Soiled window	Check to see if the window is soiled. If soiled, clean it. (See Section 8.4.1.)
	Sensor cable abnormality	Check for a kink, abnormal bending, cracking, or any other abnormality in the sensor cable.
3D Vision Sensor	Soiled window	Check to see if the window is soiled. If soiled, clean it. (See Subsection 8.2.1.)
	Sensor cable abnormality	Check for a kink, abnormal bending, cracking, or any other abnormality in the cable.

(1) Before starting operation (after turning on the power)

Target	Inspection item	Inspection procedure
3D Vision Sensor	Lighting of the lamp	Check the lamp on the sensor head is lighting.

(3) After finishing operation

Target	Inspection item	Inspection procedure
Force sensor	Cleaning and inspection of individual components	Clean the sensor head and its surroundings. Check for cracking or any other abnormality in the rubber cover, cable, and other components.
3D Laser Vision Sensor	Cleaning and inspection of individual components	Clean the sensor head and its surroundings. Check for cracking or any other abnormality in the cable and other components.
Camera package	Cleaning and inspection of individual components	Clean the sensor head and its surroundings. Check for cracking or any other abnormality in the cable and other components.

Target	Inspection item	Inspection procedure
3D Area Sensor	Cleaning and inspection of individual components	Clean the sensor and its surroundings. Check for cracking or any other abnormality in the cable and other components.
3D Vision Sensor	Cleaning and inspection of individual components	Clean the sensor head and its surroundings. Check for cracking or any other abnormality in the cable and other components.

After finishing operation, return the robot to its zero point, and then switch off the controller power supply.

7.2 THREE-MONTH INSPECTION

Target	Inspection item	Inspection procedure
Force sensor	Loose mounting	Check that the sensor and sensor adapter are mounted securely.
	Loose connector	Check that the sensor head section and J3 casting section connectors are attached securely.
3D Laser Vision Sensor	Loose mounting	Check that the sensor, sensor adapter, are mounted securely.
	Loose connector	Check that the sensor head section and J3 casting connectors are attached securely.
Camera package	Loose mounting	Check that the sensor is mounted securely.
	Loose connector	Check that the sensor head section and J3 casting connectors are attached securely.
3D Area Sensor	Loose mounting	Check that the sensor, sensor adapter, are mounted securely.
	Loose connector	Check that the projector unit connectors are attached securely.
3D Vision Sensor	Loose mounting	Check that the sensor, sensor adapter, are mounted securely.
	Loose connector	Check that the sensor head section and J3 casting connectors are attached securely.

7.3 ANNUAL INSPECTION

Target	Inspection item	Inspection procedure
Force sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Laser Vision Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
Camera package	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Area Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Vision Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection

7.4 THREE-YEAR INSPECTION

Target	Inspection item	Inspection procedure
Force sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Laser Vision Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection

Target	Inspection item	Inspection procedure
Camera package	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Area Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection
3D Vision Sensor	Loose mounting	Same as for three-month inspection
	Loose connector	Same as for three-month inspection

7.5 MAINTENANCE AND INSPECTION TOOLS

The following instruments and tools should be prepared for maintenance and inspection work.

(1) Measuring instrument
Calipers (150 mm)

(2) Tools

Torque wrenches:	M3 to M16 (Caution)
Hexagonal wrench set:	Dihedral width 1.5, 2, 3, 4, 5, 6, 8, 10, 12, 14 (for replacing parts)
Cross-head screwdrivers:	Large, medium, and small
Straight-head screwdrivers:	Large, medium, and small
Nut driver:	M3 to M6

Adjustable wrench
Pliers
Long-nose pliers
Diagonal cutter
Closed-end, double-head wrench
Grease gun
C-ring pliers
Flashlight

⚠ CAUTION
For M4, M5 and M6 torque wrenches, prepare a space-saving torque wrench head as shown the Fig. 7.5 (a) and (b) in the following examples.
M4 torque wrench
Used for replacing the force sensor and FS-40*i*A sensor adapter.
M5 torque wrench
Used for replacing the force sensor and FS-15*i*A sensor adapter.
M6 torque wrench
Used for replacing the force sensor and FS-100*i*A, FS-250*i*A sensor adapter.

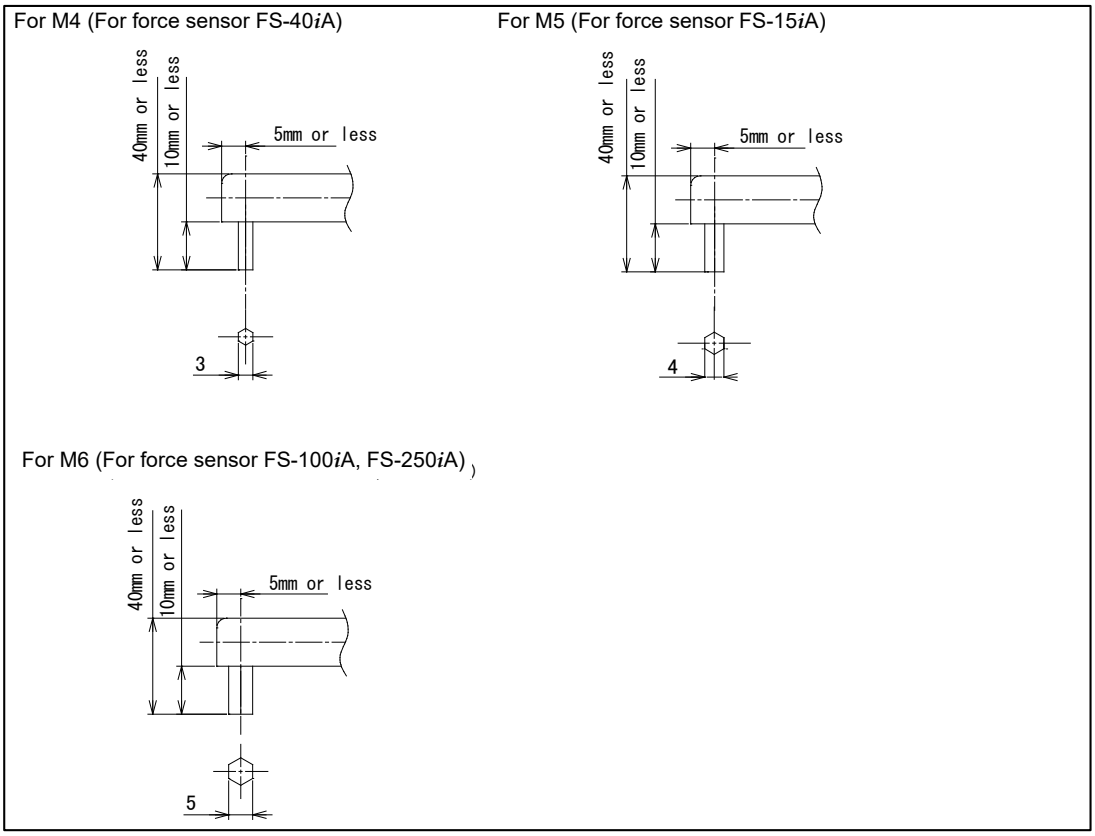


Fig. 7.5 (a) Example of torque wrench heads 1

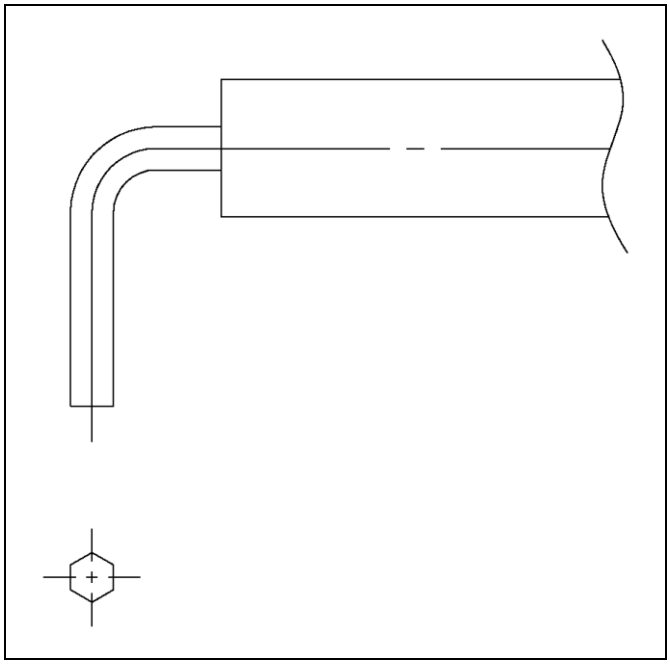


Fig. 7.5 (b) Example of torque wrench heads 2
(Some commercially available torque wrench heads such as Fig. 7.5 (b) can be used.)

7.6 AUTOMATIC RE-CALIBRATION

If the position of the camera is changed or the camera is replaced for some reason after the system is put into operation, the camera needs to be re-calibrated. In such a case, the use of automatic re-calibration allows you to restore the camera to its proper position with ease. Since no manual operation is involved in re-calibrating the camera, automatic re-calibration prevents the operator's mistakes and other human errors. For details of the automatic re-calibration, refer to the "*i*RVision OPERATOR'S MANUAL (Reference) (B-83914EN)".

8 PERIODIC MAINTENANCE PARTS REPLACEMENT

Replacing maintenance parts periodically can prolong the normal performance of the sensor.

Replace periodic maintenance parts according to the procedures described below.

8.1 FORCE SENSOR

There are no periodic maintenance parts in the force sensor. However, do not skip periodic inspections. (See Chapter 2.)

8.2 CAMERA PACKAGE

If you find stains on the surface of the light cover and window of the camera package, clean it. If it is impossible to remove stains from it by cleaning, or there are scratches or cracking on it, replace the sensor.

8.2.1 Cleaning the Window Plate

To clean the surface of the light cover and window, follow the procedure described below: (See Fig. 8.2.1 (a).)

1 Stop the robot with the light cover and window facing downward and switch off the robot controller power. Be aware of an axis not equipped with a brake, because it might drop by gravity.
2 Blow off any dust from the window holder surface light cover and window plate using clean, dry air blast.
3 Wipe the light cover and window with lens cleaning paper dipped in alcohol. Repeat cleaning until stains are wiped off completely. If it is impossible to clean completely, replace the light cover and window according to the procedure described in Subsection 8.2.2.

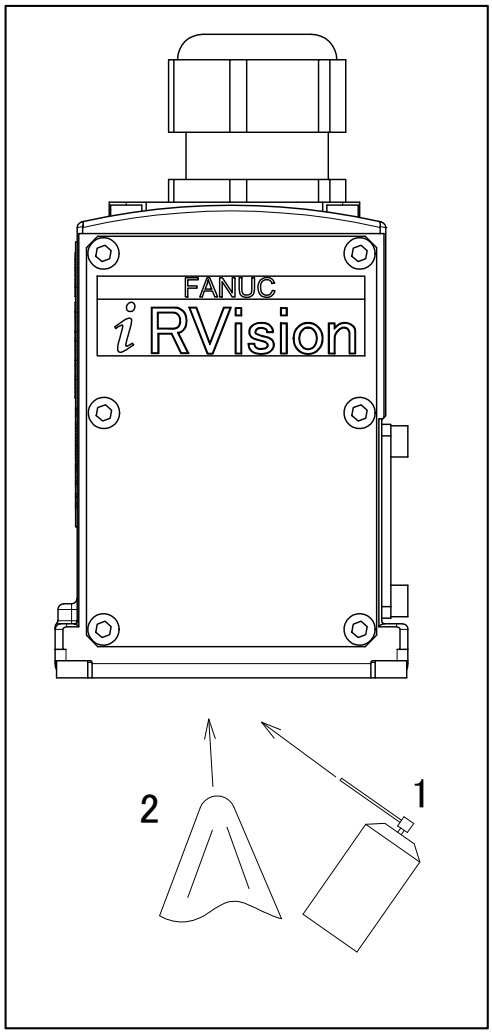


Fig. 8.2.1 (a) Window plate cleaning

8.2.2 Replacing the Window Plate

To replace the window plate, follow the procedure described below: (See Fig. 8.2.2 (a).)

1 Stop the robot with the sensor head window plate facing downward and turn off robot controller power, be aware of an axis not equipped with a brake, because it might drop by gravity.
2 Blow off any dust from the holder surface and window plate using clean, dry air blast.
3 Remove the window plate fastening bolts, and detach it together with the holder.
4 Blow off dust and dirt from the inside of the holder using clean, dry air blast, or wipe them off using lens cleaning paper or clean cloth.
5 Assemble new window plate and the holder with fasting bolt, and then put it back to the previous place. If there is no LED, attach the gasket on the window plate so that the gasket comes to the camera side.
6 Check that no stains are on the window plate surface. If there is any stain on the window plate, clean it by following the procedure described in Subsection 9.3.1.

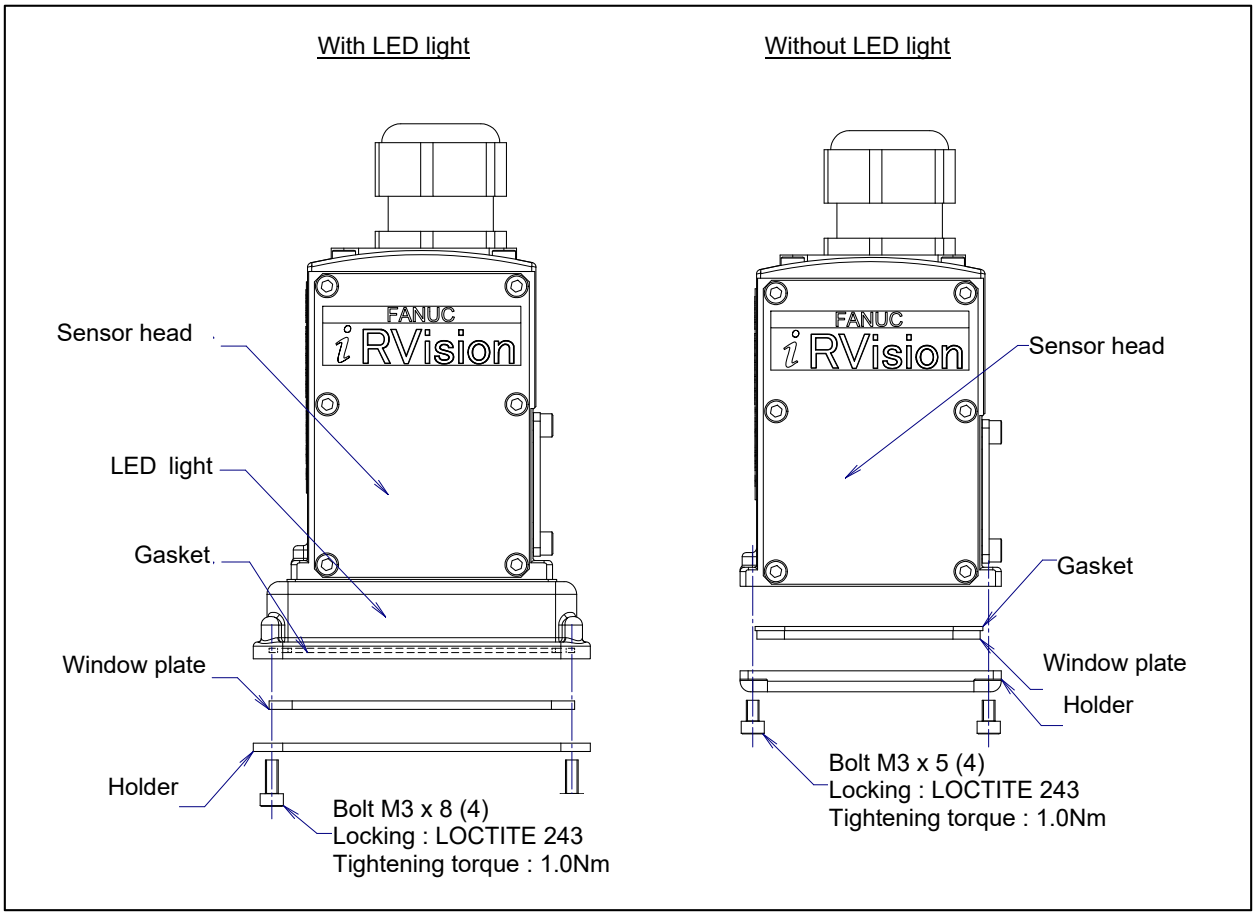


Fig. 8.2.2 (a) Replacing the window plate

Table. 8.2.2 (a) Maintenance item list

Order spec.	Items arranged for maintenance	Note
A05B-1426-K011	Window plate, Gasket	Without LED light.
A05B-1426-K012	Window plate, Gasket	With LED light.

8.3 3D LASER VISION SENSOR

If you find stains on the window surface of the 3D Laser Vision Sensor, clean it. If it is impossible to remove stains by cleaning, or if there are scratches or cracking on the window, replace the sensor.

8.3.1 Cleaning the Window Plate

To clean the window plate of the sensor, follow the procedure described below: (See Fig. 8.3.1 (a).)

1 Stop the robot with the sensor head window plate facing downward and turn off the robot controller power, be aware of an axis not equipped with a brake, because it might drop by gravity.
2 Blow off any dust from the window holder surface and window plate using clean, dry air blast.
3 Wipe the window plate with lens cleaning paper dipped in alcohol. Repeat cleaning until stains are wiped off completely from the window plate. If it is impossible to clean completely, replace the window plate according to the procedure described in Section 8.3.2.

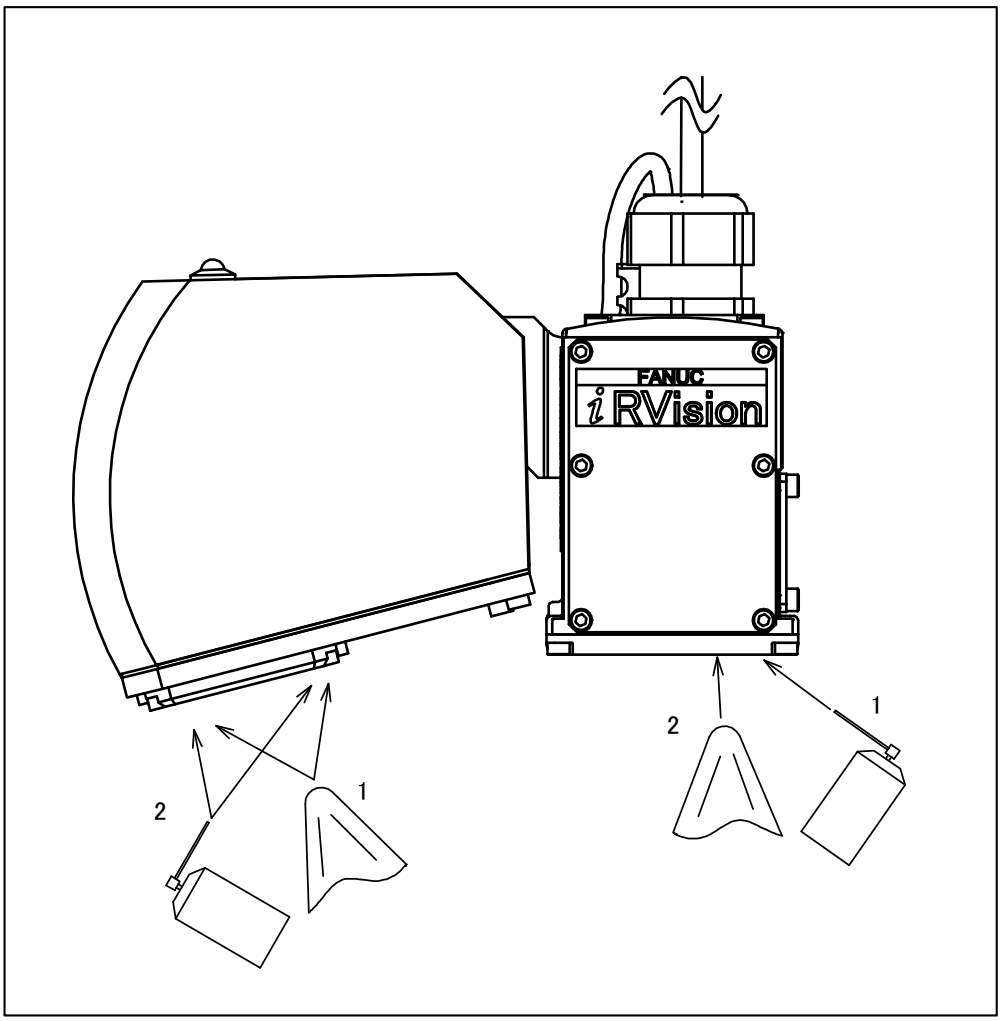


Fig. 8.3.1 (a) Cleaning the window plate

8.3.2 Replacing the Window Plate

To replace the window plate, follow the procedure described below. (See Fig.8.3.2 (a).)

1 Stop the robot with the window plate of the camera unit facing downward and turn off the robot controller power, be aware of an axis not equipped with a brake, because it might drop by gravity.
2 Wipe off dust from the holder surface and window plate using clean cloth.
3 Remove the window holder fastening bolts, and detach the window plate together with the window holder.
4 Take out the window plate from the window holder, blow off dust and dirt from the inside of the window holder using clean, dry air blast, or wipe them off using lens cleaning paper or clean cloth.
5 Assemble a new window plate into the window holder, and fix the window holder with the window holder fastening bolts, to put it back in the previous place.
6 Check that no stains are on the window surface. If there is any stain on the window surface, clean it by following the procedure described in Subsection 8.3.1.

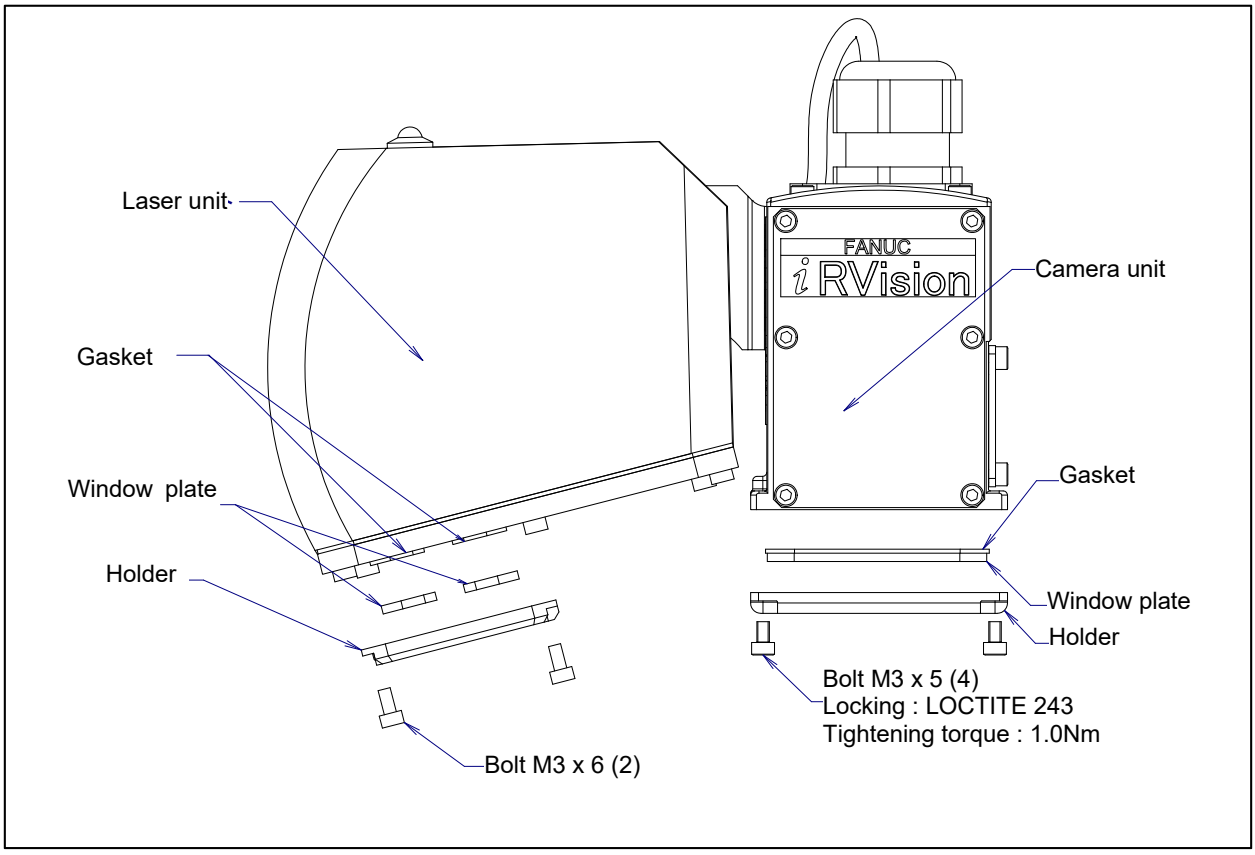


Fig. 8.3.2 (a) Replacing the window plate

Table. 8.3.2 (a) Maintenance item list

Order spec.	Items arranged for maintenance	Note
A05B-1426-K011	Window plate, Gasket	Only parts on the camera unit. For camera unit without LED light.
A05B-1426-K012	Window plate, Gasket	Only parts on the camera unit. For camera unit with LED light.
A290-7405-X122	Window plate	Only part on the laser unit side
A290-7405-X124	Gasket	Only part on the laser unit side. For window plate.

8.4 3D AREA SENSOR

8.4.1 Cleaning the Widow Plate of the Projector Unit

To clean the window plate of projector unit, follow the procedure described below. (See Fig.8.4.1 (a).)

1 Turn off the robot controller power.
2 Blow off the dust of window holder surface and window plate with clean and dried air, and remove it.
3 Wipe off the window plate with lens cleaning paper which is soaked with alcohol. Repeat it until dirt vanish. If dirt cannot be removed, replace the window plate referring to procedure of Subsection 8.4.2.

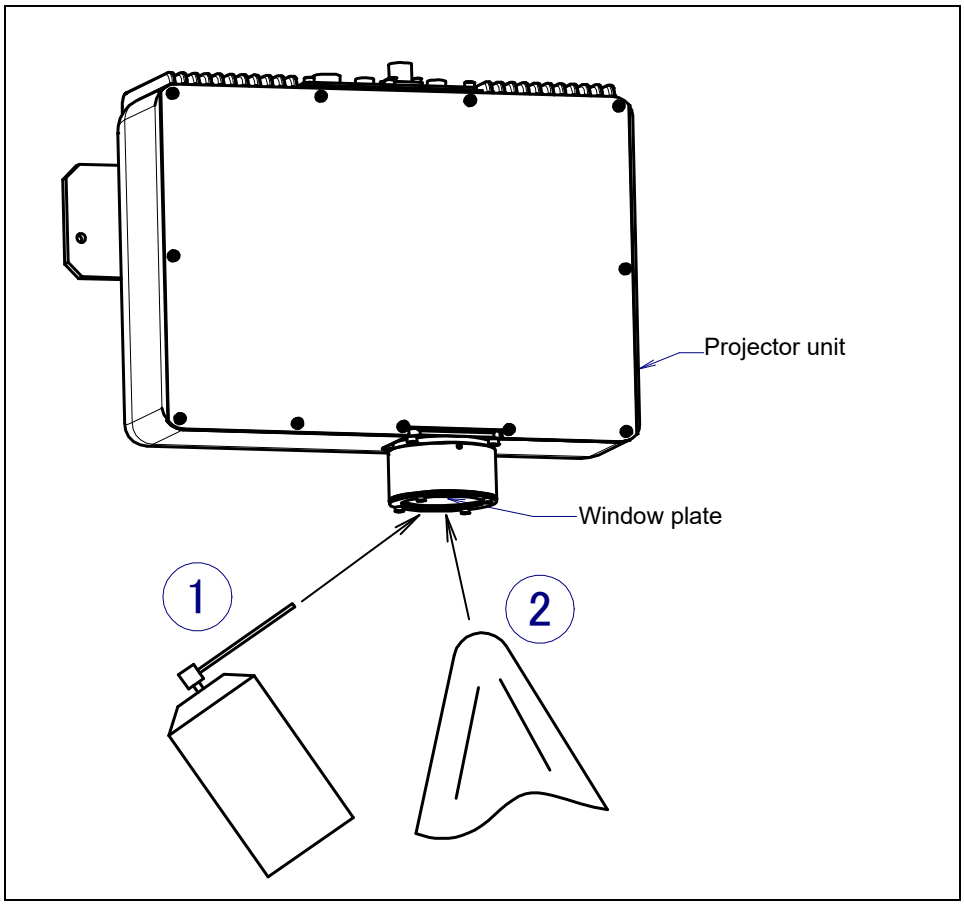


Fig. 8.4.1 (a) Cleaning the window plate of the projector unit (3DA/1300)

8.4.2 Replacing of Projector Unit Window Plate

To replace the window plate of projector unit, follow the procedure described below. (See Fig.8.4.2 (a).)

1 Turn off the robot controller power.
2 Wipe off the dirt of window holder surface and window plate with clean lens cleaning paper.
3 Remove the bolts, then remove the window plate with window holder and gasket.
4 Blow off the dirt and dust inside the window holder with clean and dried air or wipe them off with lens cleaning paper or clean cloth.
5 Fix new window plate, the gasket and the window holder with bolts and put them back.
6 Confirm there is no dirt on the window plate surface. If there is dirt, clean it by the procedure of Subsection 8.4.1.

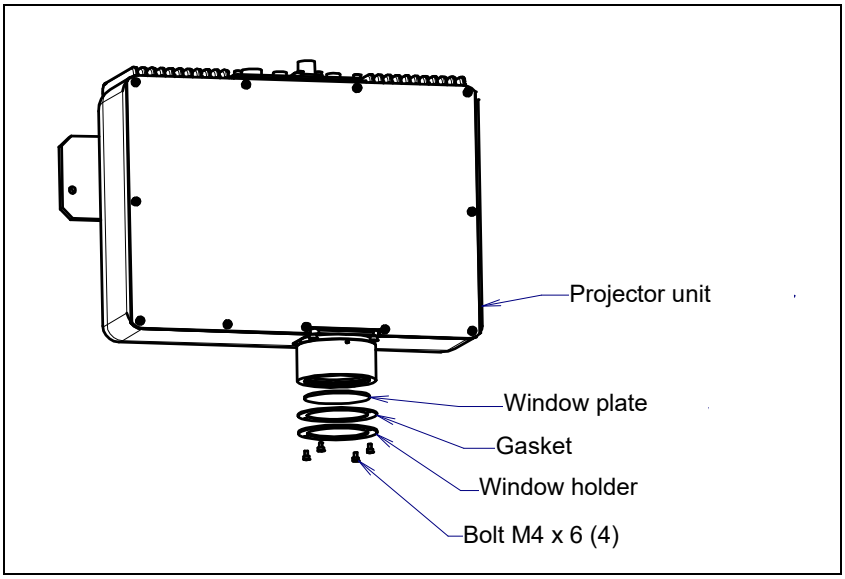


Fig. 8.4.2 (a) Replacement of projector unit window plate (3DA/1300)

Table. 8.4.2 (a) Maintenance item list

Order spec.	Items arranged for maintenance	Note
A290-7422-X251	Window plate	
A290-7422-X253	Gasket	For window plate

8.5 3D Vision Sensor

If you find stains on the dust protection glass of the 3D Vision Sensor, clean it. If it is impossible to remove stains by cleaning, or if there are scratches or cracking on the glass, replace the dust protection glass.

8.5.1 Cleaning the Dust Protection Glass

To clean the dust protection glass, follow the procedure described below. (See Fig. 8.5.1 (a), (b).)

1 Stop the robot with the dust protection glass of the sensor head facing downward and turn off robot controller power. Be aware of an axis not equipped with a brake, because it might drop by gravity.
2 Blow off any dust from the window holder surface and dust protection glass using clean, dry air blast.
3 Wipe the dust protection glass with lens cleaning paper dipped in alcohol. Repeat cleaning until stains are wiped off completely. If it is impossible to clean completely, replace the dust protection glass according to the procedure described in Subsection 8.5.2.

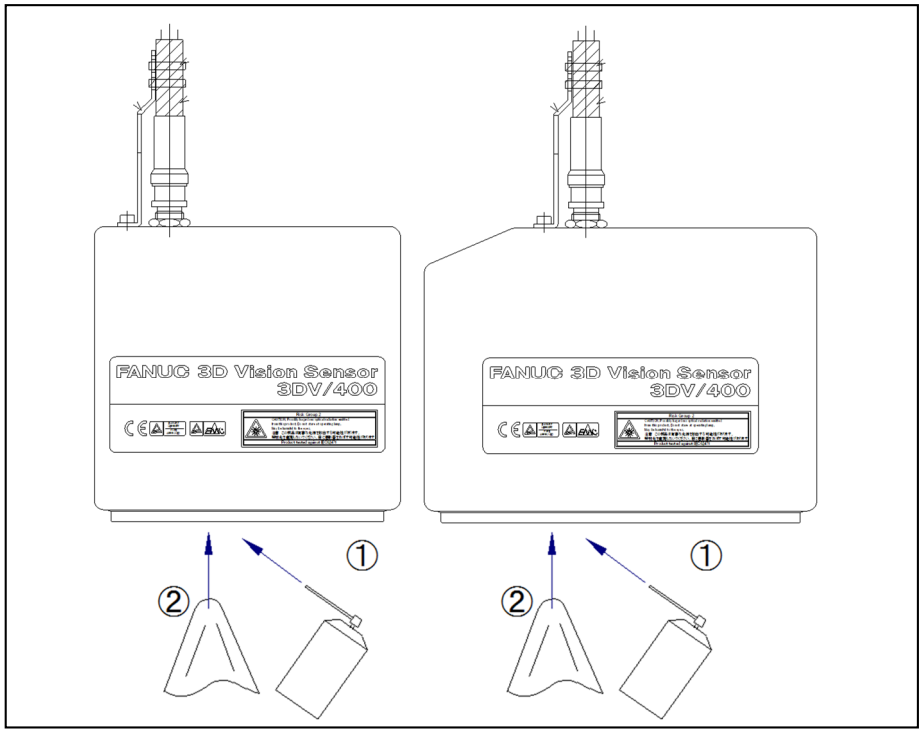


Fig. 8.5.1 (a) Cleaning the dustproof glass (3DV/70, 3DV/200, 3DV/400, 3DV/600)

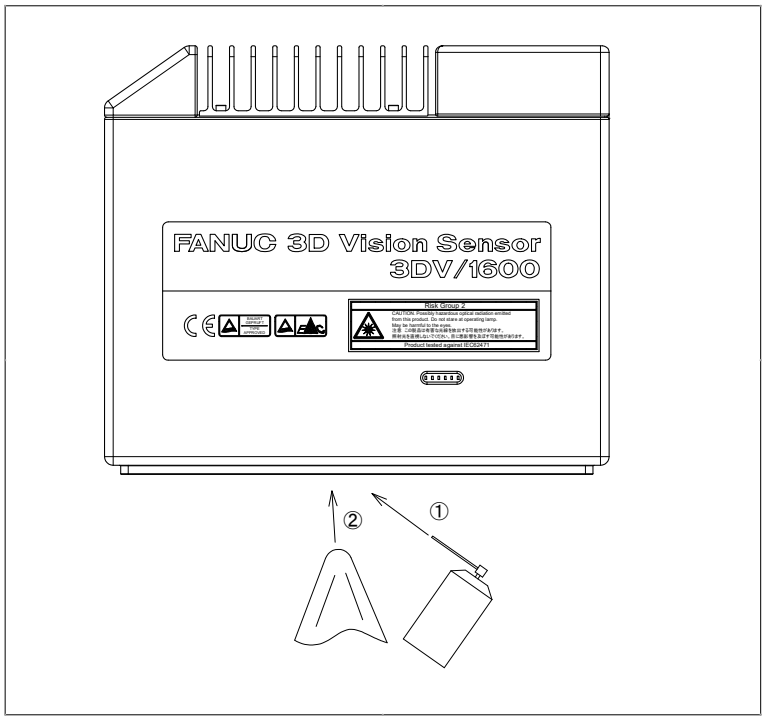


Fig. 8.5.1 (b) Cleaning the dustproof glass (3DV/1600)

8.5.2 Replacing the dust protection glass

To clean the dust protection glass, follow the procedure described below. (See.Fig.8.5.2 (a), (b), (c).)

1 Stop the robot with the dust protection glass holder facing downward and turn off robot controller power.
2 Wipe off the dirt of the holder surface and dust protection glass with clean lens cleaning paper.
3 Remove bolts, then remove the dust protection glass.
4 Fix new dust protection glass with bolts and put it back.
5 Confirm there is no dirt on the dust protection glass surface. If there is dirt, clean it by the procedure of Subsection 8.5.1.

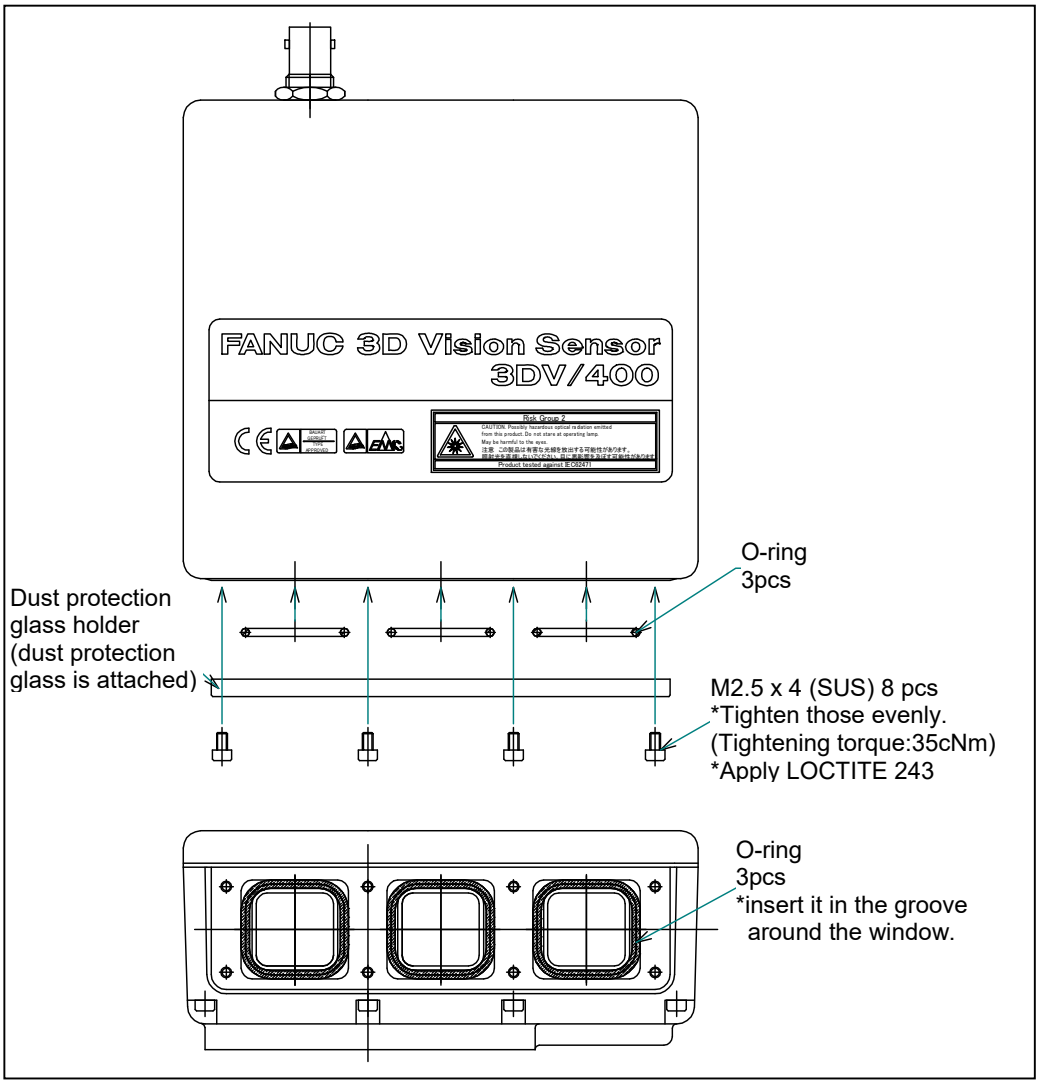


Fig. 8.5.2 (a) Replacing the dustproof glass (3DV/400 without LED light)

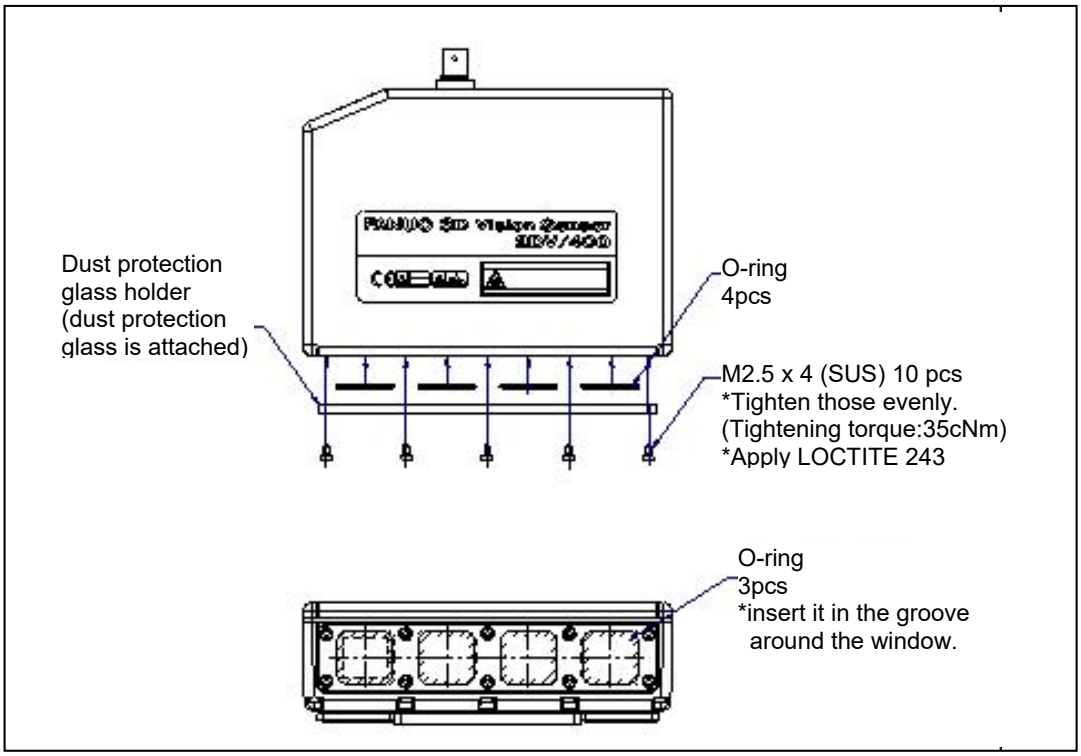


Fig. 8.5.2 (b) Replacing the dustproof glass (3DV/70, 3DV/200, 3DV/400, 3DV/600 with LED light)

Table. 8.5.2 (a) Maintenance item list

Order spec.	Items arranged for maintenance	Note
A05B-1426-K106	Dust protection glasses, O-rings, Dust protection glass holder, Bolts	For 3DV sensor without LED light
A05B-1426-K107	Dust protection glasses, O-rings, Dust protection glass holder, Bolts	For 3DV sensor with LED light
A05B-1426-K147	Dust protection glasses, O-rings, Dust protection glass holder, Bolts	For 3DV sensor with LED light

	Window maintenance kit		
	A05B-1426-K106	**A05B-1426-K107**	**A05B-1426-K147**
3DV/70 A05B-1426-K152	-	-	●
3DV/200 A05B-1426-K142	-	-	●
3DV/400 (without LED) A05B-1426-K101	●	-	-
3DV/400 A05B-1426-K102	-	●	●
3DV/600 A05B-1426-K122	-	●	●

● : Available -: Unavailable

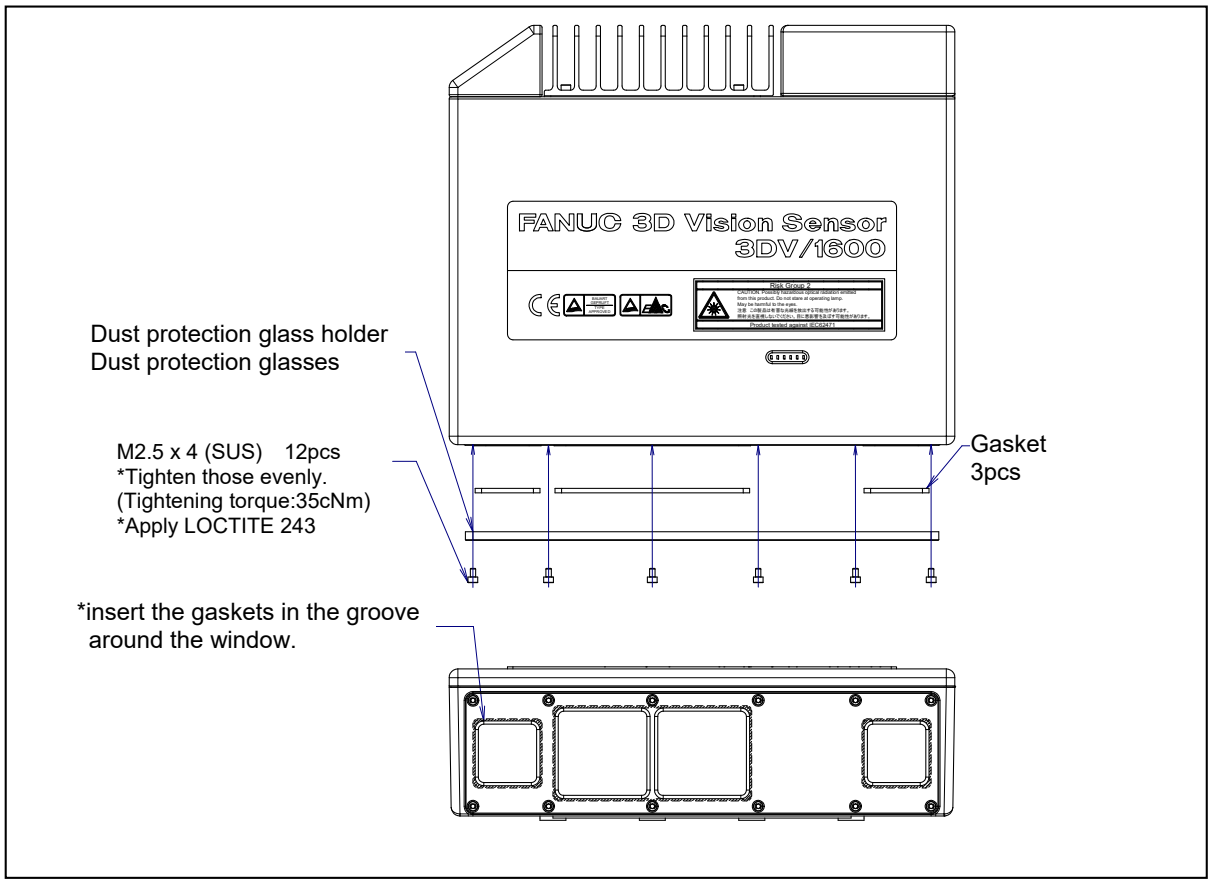


Fig. 8.5.2 (c) Replacing the dustproof glass (3DV/1600)

Table. 8.5.2 (c) Maintenance item list

Order spec.	Items arranged for maintenance	Note
A05B-1426-K137	Dust protection glasses, Gaskets, Dust protection glass holder, Bolts	

9 REPLACING PARTS

NOTE
When applying LOCTITE to the important bolt tightening points, make sure that it is applied to the entire length portion of the engaging area of the female threads. If it is applied to the male threads, the bolts could become loose due to insufficient adhesion. Clean the bolts and threaded holes and wipe off oil on the engaging section. Make sure that there is no solvent in the threaded holes. Be sure to wipe the excess LOCTITE after tightening the bolt.

9.1 FORCE SENSOR MECHANICAL UNIT

9.1.1 Replacing the Sensor Head

If the force sensor head becomes faulty, replace it according to the following procedure. (See Fig. 9.1.1(a) to (j).)

Removal procedure

1 Set the robot to a position for replacing the sensor head. Ideally, the robot should be set to such a position that all of J1 to J4 are at 0°, J5 is at +90°, and J6 is at 0°. If this position cannot be achieved, the robot should be set so that J4 is at 0° and J3 + J5 are at +90°.
2 Press the emergency stop button.
3 Remove the hand (or the like) and hand mounting adapter. When the robot has a 3D Laser Vision sensor mounted, remove the sensor together with its sensor adapter. Put markings so that the mounting positions of these components can be determined later.
4 Loosen the sensor head mounting bolts, and put back the force sensor parameter to initial state.
To put back, follow installation procedure 5 to 8. (About FS-15*i*Ae is described later.)
Confirm the force and moment on the force sensor status screen of teach pendant.
If absolute value is less than the standard value listed below, sensor head is normal. So replacing sensor head is not necessary. Attach them by installation procedure 1, 10 and later without replacing sensor head.
In case of FS-15*i*Ae: Set 6 system variables below to 0. Refer to the CONTROLLER OPERATOR'S MANUAL (Basic Operation) (B-83284EN) Appendix C.1 about display method of system variables.
$CCC_GRP.$CLR_FORCE[1] to [6].

Table 9.1.1 (a) Standard values (absolute values) after the sensor head is removed:

	FS-15*i*A	FS-40*i*A	FS-100*i*A	FS-250*i*A	FS-15*i*Ae
Fx	10N or less	20N or less	50N or less	100N or less	-
Fy	10N or less	20N or less	50N or less	100N or less	-
Fz	30N or less	60N or less	150N or less	300N or less	60N or less
Mx	0.3Nm or less	0.6Nm or less	1.5Nm or less	3.0Nm or less	0.6Nm or less
My	0.3Nm or less	0.6Nm or less	1.5Nm or less	3.0Nm or less	0.6Nm or less
Mz	0.6Nm or less	1.2Nm or less	3.0Nm or less	6.0Nm or less	-

5 Turn off the controller power.
6 Remove the sensor cable of the force sensor from the sensor head.
7 Remove the sensor head mounting bolts together with the washers, and remove the sensor head from the sensor adapter of the force sensor.

Cautions for removal

Do not disassemble the force sensor head. If it is disassembled, it becomes difficult for it to measure force and moment accurately after it is reassembled. In addition, the service life of the sensor may be significantly reduced.

Installation procedure

A torque wrench having a special shape is required. Also, see Section 7.5, "MAINTENANCE AND INSPECTION TOOLS."

1 Attach a new sensor head to the sensor adapter loosely with the mounting bolts and insulating washers. Tighten the bolts lightly in an even, crisscross pattern.
2 Attach the sensor cable.
3 Turn on the controller power.
4 Press the emergency stop button.
5 A CD-R is attached to sensor head. The CD-R including parameter file is attached. (File name CCSCB2. CM, it is called "CCSCB2.CM "below.) First, copy CCSCB2.CM to memory card by using personal computer. (Note 1)
Next, insert memory card to memory card slot of robot controller, press [MENU] key, [7] (file) and display file menu screen. Press [F2] (DIR) and select (*.*) among the displayed list, and display file list. Move cursor to CCSCB2.CM press [ENTER], and finally press [F4] (YES). (Note 2) If it is finished correctly, message "Execution is completed successfully" is displayed bottom of the screen.
Note 1) Refer to Chapter 8 [FILE INPUT//OUTPUT] of the controller operator's manual (Basic Operation) (B-83284EN) about kind of usable memory card and basic operation.
Note 2) Press the [ENTER] key. Do not press [F3] (LOAD).
In case of FS-15*i*Ae: Procedure 5 is not necessary.
6 Turn off controller power and then back on.
7 Press the emergency stop button.
8 While observing the sensor temperature on the force sensor status screen of the teach pendant, wait for 15 to 60 minutes until the temperature becomes stable and constant. (The time before the stability of the temperature is achieved depends on the ambient temperature.)
In case of FS-15*i*Ae: Procedure 8 is not necessary.
9 Check the force and moment values displayed on the force sensor status screen of the teach pendant. When the values are not greater than the standard values listed below, follow step 10 and later to continue with the mounting. If any of the values are greater than the appropriate standard values, the sensor head may be in some defective condition. Remove the sensor head, and return to step 1 to redo mounting from the beginning.

Table 9.1.1 (b) Standard values (absolute values) after the sensor head is lightly attached:

	FS-15*i*A	FS-40*i*A	FS-100*i*A	FS-250*i*A	FS-15*i*Ae
Fx	20N or less	40N or less	100N or less	200N or less	-
Fy	20N or less	40N or less	100N or less	200N or less	-
Fz	60N or less	120N or less	300N or less	600N or less	60N or less
Mx	0.6Nm or less	1.2Nm or less	3.0Nm or less	6.0Nm or less	0.6Nm or less
My	0.6Nm or less	1.2Nm or less	3.0Nm or less	6.0Nm or less	0.6Nm or less
Mz	1.2Nm or less	2.4Nm or less	6.0Nm or less	12.0Nm or less	-

10 Tighten the sensor head mounting bolts completely in an even, crisscross pattern with specified torques given in Fig. 9.1.1 (a) to (j).
11 Confirm the system variables of below of teach pendant. When the values are not greater than the standard values listed below, follow step 12 and later to continue with the mounting. If any of the values are greater than the appropriate standard values, the sensor head mounting bolts may be tightened unevenly. Loosen all the bolts, and return to step 10 to retighten them. If bolts are tightened completely, however force displayed in the screen becomes larger, it is not the abnormality of the sensor.
In case of FS-15*i*Ae : Reconfirm the force and moment value which are displayed in the force sensor situation screen of the teach pendant.

Table 9.1.1 (c) Standard value after temporary fixing bolts (absolute value):

$CCC_GRP[1].$GAGE_DATA	FS-15*i*A, FS-40*i*A, FS-100*i*A, FS-250*i*A
[1]	15000 or less
[2]	15000 or less
[3]	15000 or less
[4]	15000 or less
[5]	15000 or less
[6]	15000 or less
[7]	15000 or less
[8]	15000 or less

Table 9.1.1 (d) Standard value after completely tightening bolts (absolute value):

	FS-15*i*Ae
Fz	60N or less
Mx	0.6Nm or less
My	0.6Nm or less

12 Wrap a sponge around the sensor cable connector section and fasten them with a cable tie.
13 Attach the hand mounting adapter. To mount the 3D Laser Vision sensor, first mount its sensor adapter. When tightening the bolts for these components, monitor the force and moment values displayed on the force sensor status screen of the teach pendant, and take caution to prevent all the values from changing significantly from the values checked in step 11.
14 Attach hand to hand mounting adapter.
15 While observing the sensor temperature on the force sensor status screen of the teach pendant, wait for 15 to 60 minutes until the temperature becomes stable and constant. (The time before the stability of the temperature is achieved depends on the ambient temperature.)
16 Confirm the absolute value of the system variable below of teach pendant.

Table 9.1.1 (e) Rated loads for measurement (absolute values):

$CCC_GRP[1].$GAGE_DATA	FS-15*i*A, FS-40*i*A, FS-100*i*A, FS-250*i*A
[1]	28000 or less
[2]	28000 or less
[3]	28000 or less
[4]	28000 or less
[5]	28000 or less
[6]	28000 or less
[7]	28000 or less
[8]	28000 or less

Be sure to reset the force display after confirmation. To perform the reset, display force sensor status screen of the teach pendant. If [F →] button is pressed, [F1] changes to [Clear]. When [F1] is pressed in this time, force value of the screen is reset and become the neighborhood of 0°.

In case of FS-15*i*Ae :

Confirm force and moment which is displayed in force sensor status screen of the teach pendant. Confirm value is not abnormally apart from the value of before installing them by guessing from the shape and mass of the hands and hand mounting adapter which were installed to the tip of the force sensor. In addition, if value exceeds the measured rating load, the load may exceed allowable wrist load condition of the robot, so confirm the load of the hands.

After confirmation, be sure to reset the force display.

Table 9.1.1 (f) Measured load (absolute value):

	FS-15*i*Ae
Fz	150N or less
Mx	12Nm or less
My	12Nm or less

Cautions for installation

- First, tighten the mounting bolts lightly in an even, crisscross pattern. Then tightening them completely with a specified torque in an even, crisscross pattern.
- The flatness and surface roughness of the member (hand mounting adapter) that contacts the force sensor shall comply with what is specified in Section 4.1, "WRIST SECTION END EFFECTOR MOUNTING SURFACE". If the mounted member does not comply with the specified flatness and surface roughness, the value of the force sensor might exceed the standard value stated above.

⚠ CAUTION

1 In case of FS-15*i*A, FS-40*i*A, FS-100*i*A or FS-250*i*A, it is necessary to load parameter file to robot controller. When sensor head is replaced, load parameter file of attached CD-R and use it.

2 In case of F-15*i*Ae, original parameter is stored in each sensor head. When sensor head is replaced, original parameter is load to the robot controller automatically. So it can be used without any operation.

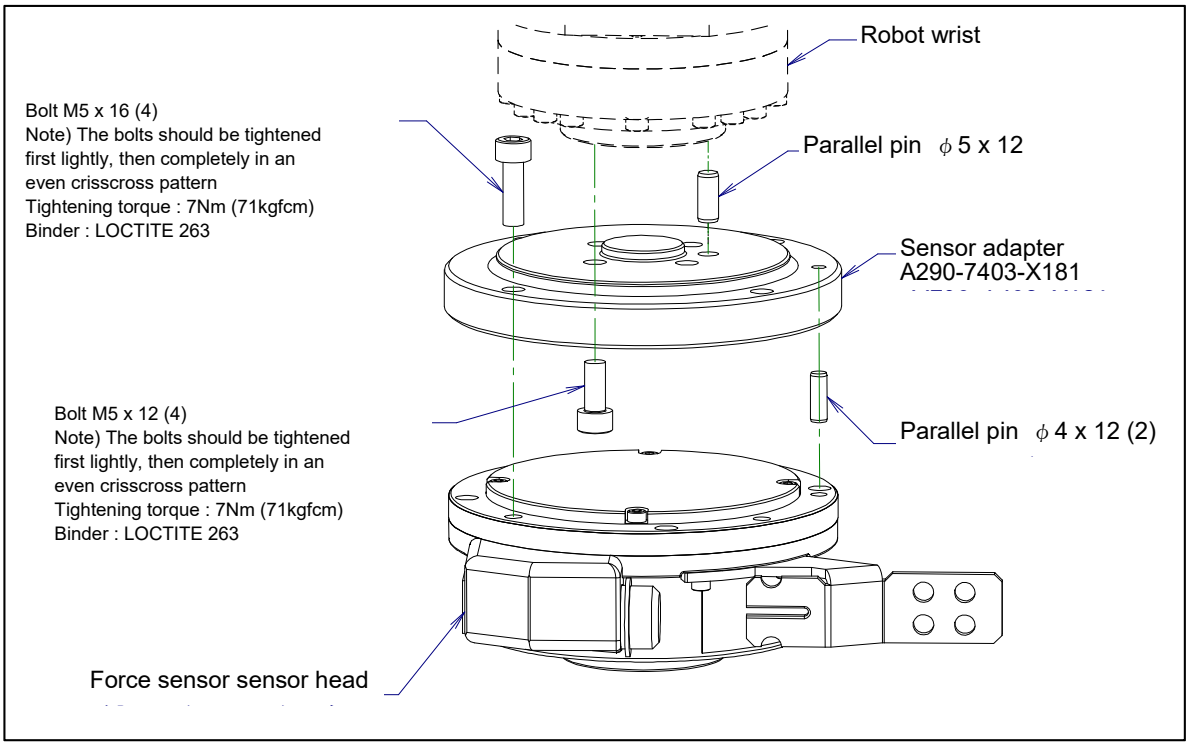


Fig. 9.1.1 (a) Replacing the force sensor, sensor head and adapter (LR Mate 200*i*D + FS-15*i*A)

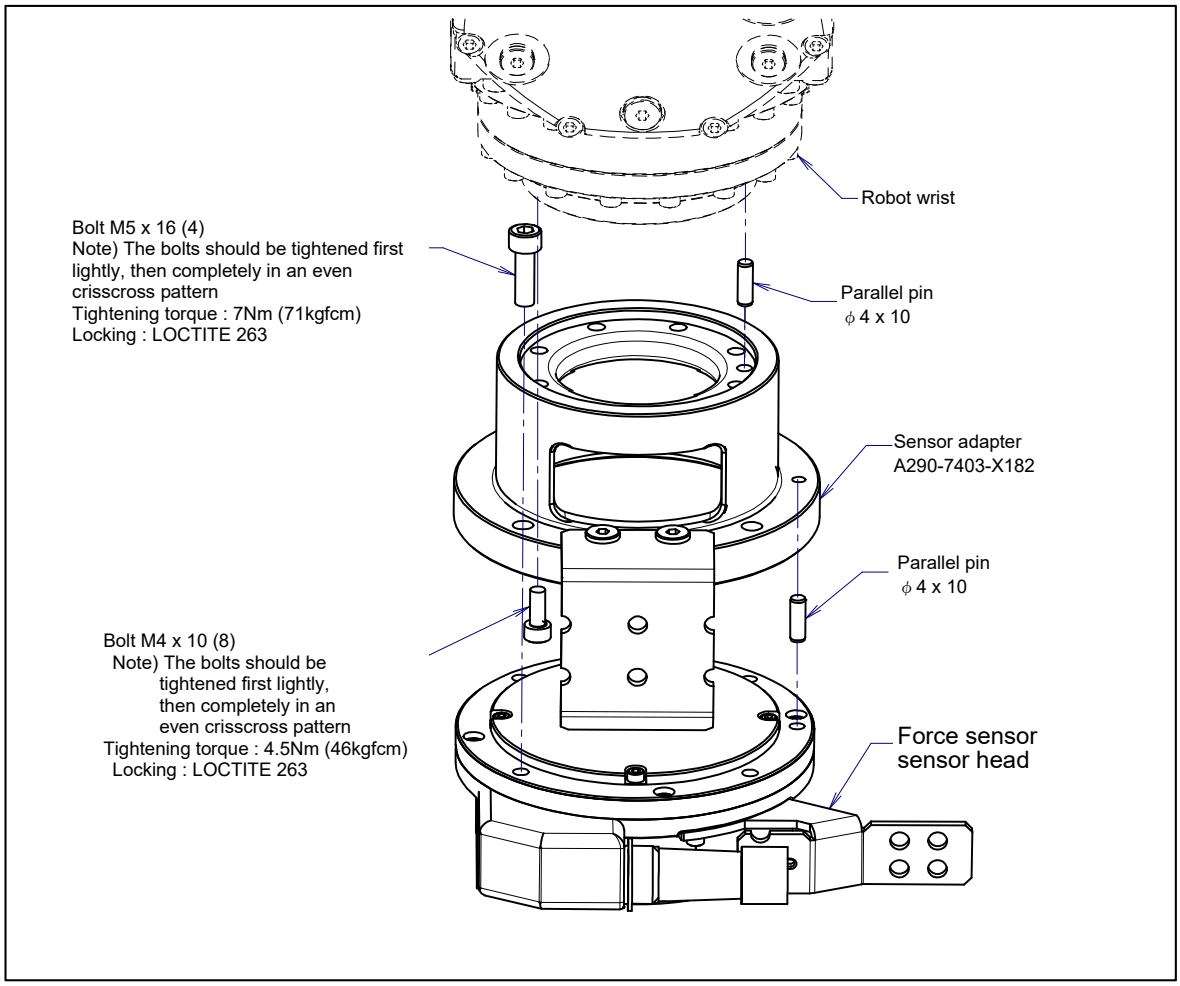


Fig. 9.1.1 (b) Replacing the force sensor, sensor head and adapter (M-10*i*A+FS-15*i*A)

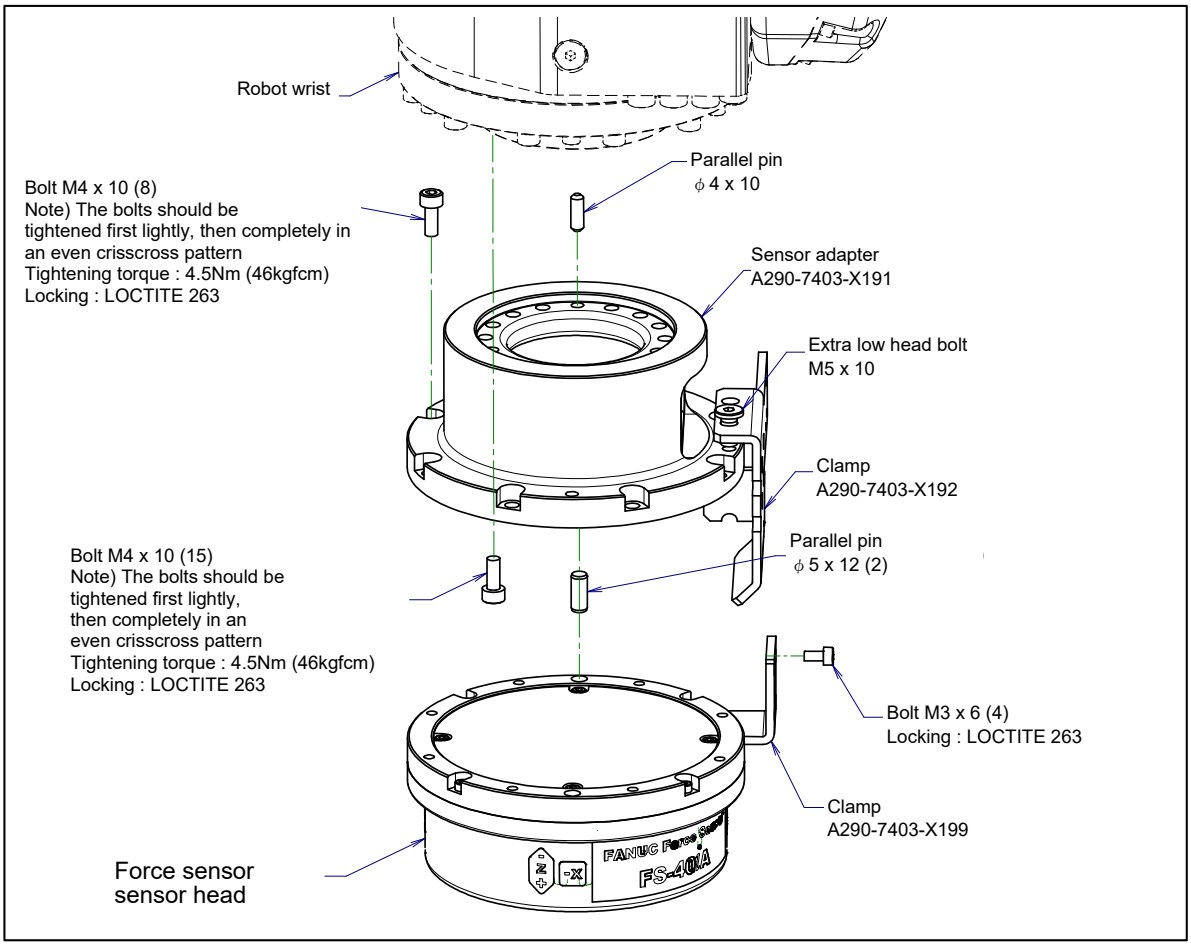


Fig. 9.1.1 (c) Replacing the force sensor, sensor head and adapter (FS-40*i*A)

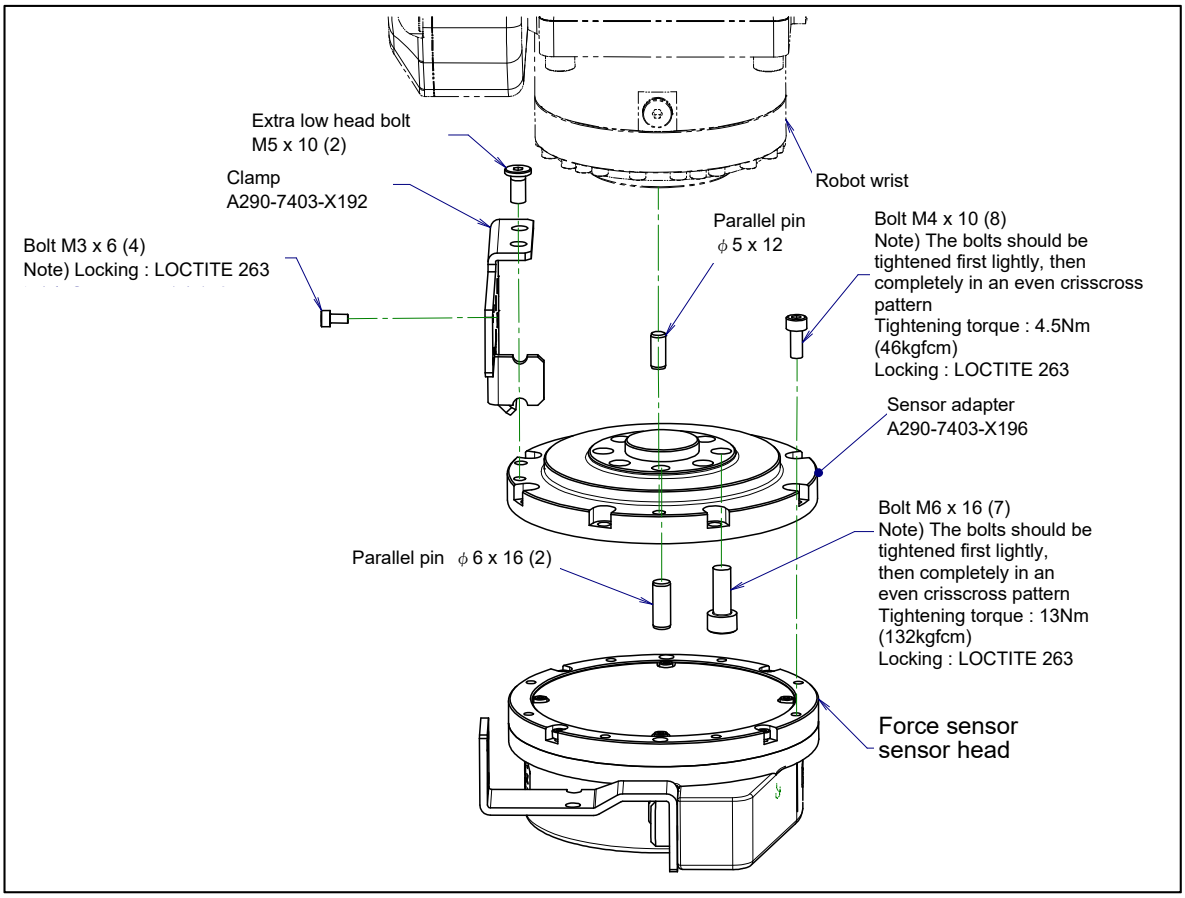


Fig. 9.1.1 (d) Replacing the force sensor, sensor head and adapter (M-20*i*A/20M/35M+FS-40*i*A)

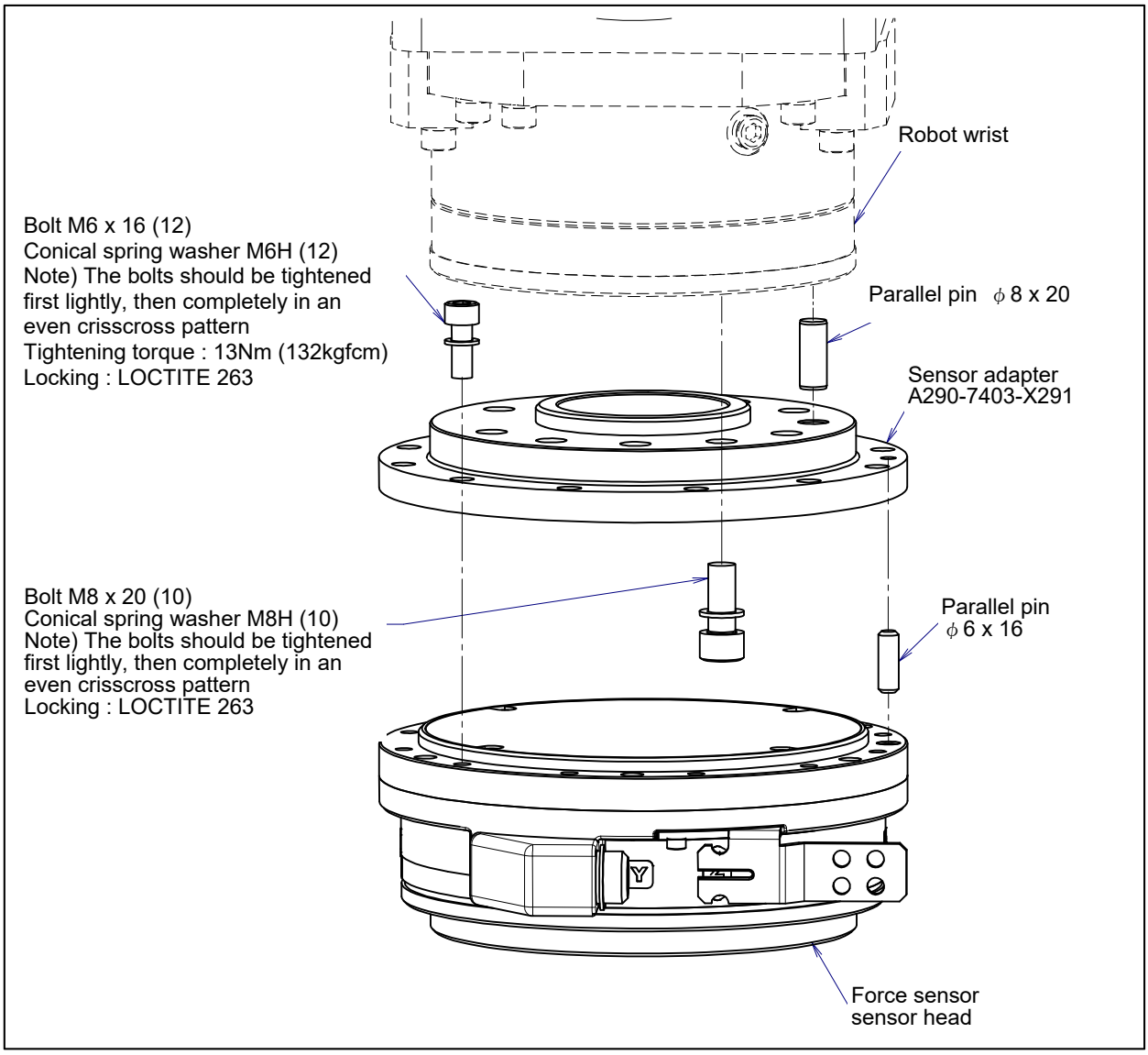


Fig. 9.1.1 (e) Replacing the force sensor, sensor head and adapter (M-710*i*C+FS-100*i*A)

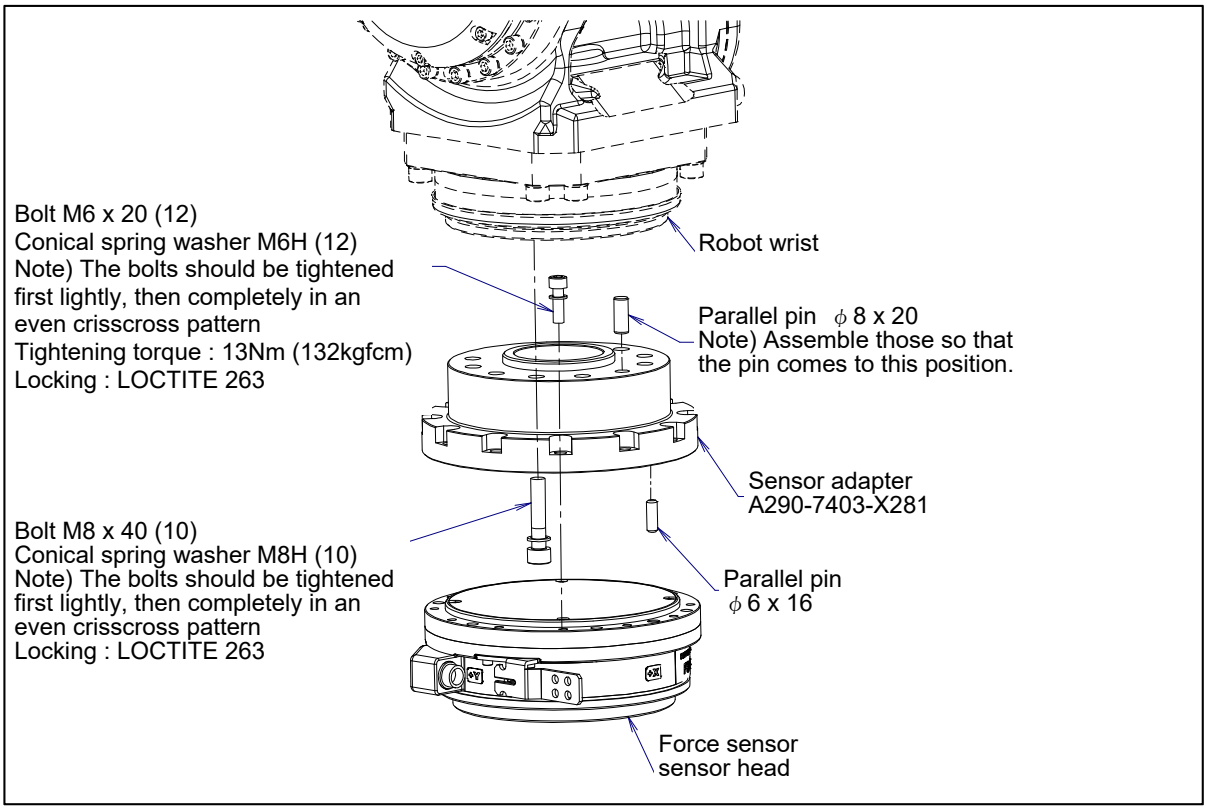


Fig. 9.1.1 (f) Replacing the force sensor, sensor head and adapter (R-1000*i*A/80F+FS-100*i*A)

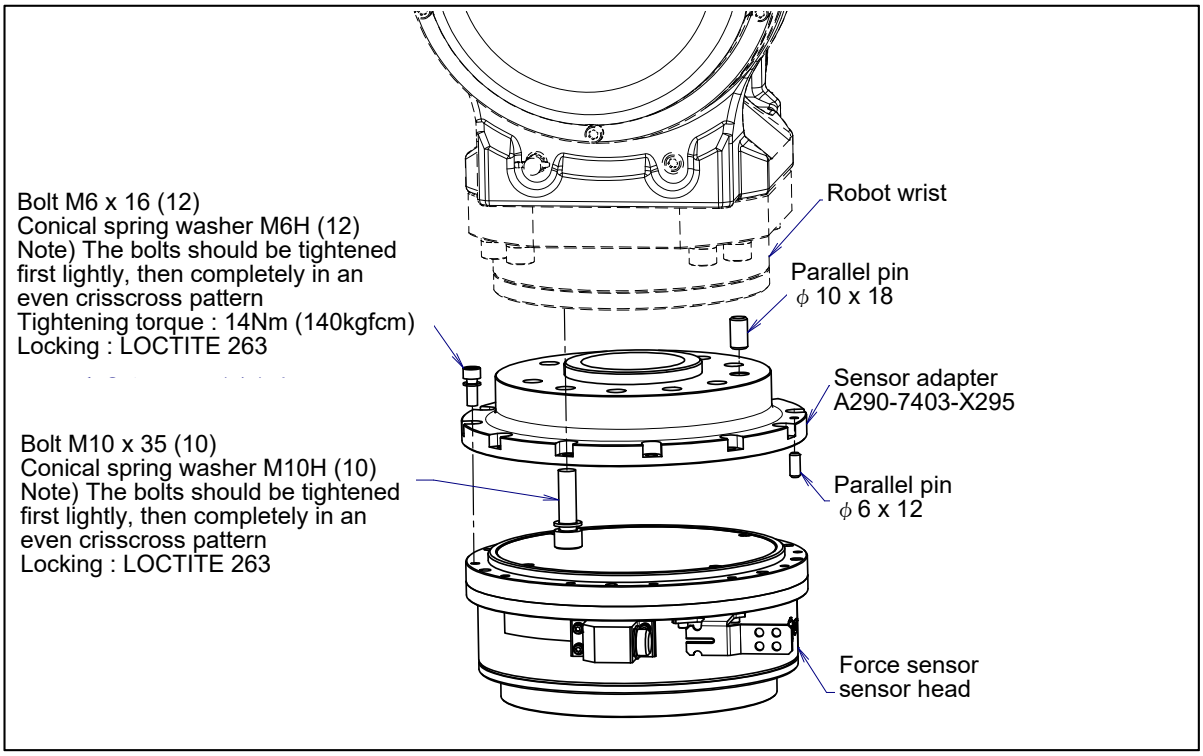


Fig. 9.1.1 (g) Replacing the force sensor, sensor head and adapter (R-2000*i*C+FS-250*i*A with standard adapter)

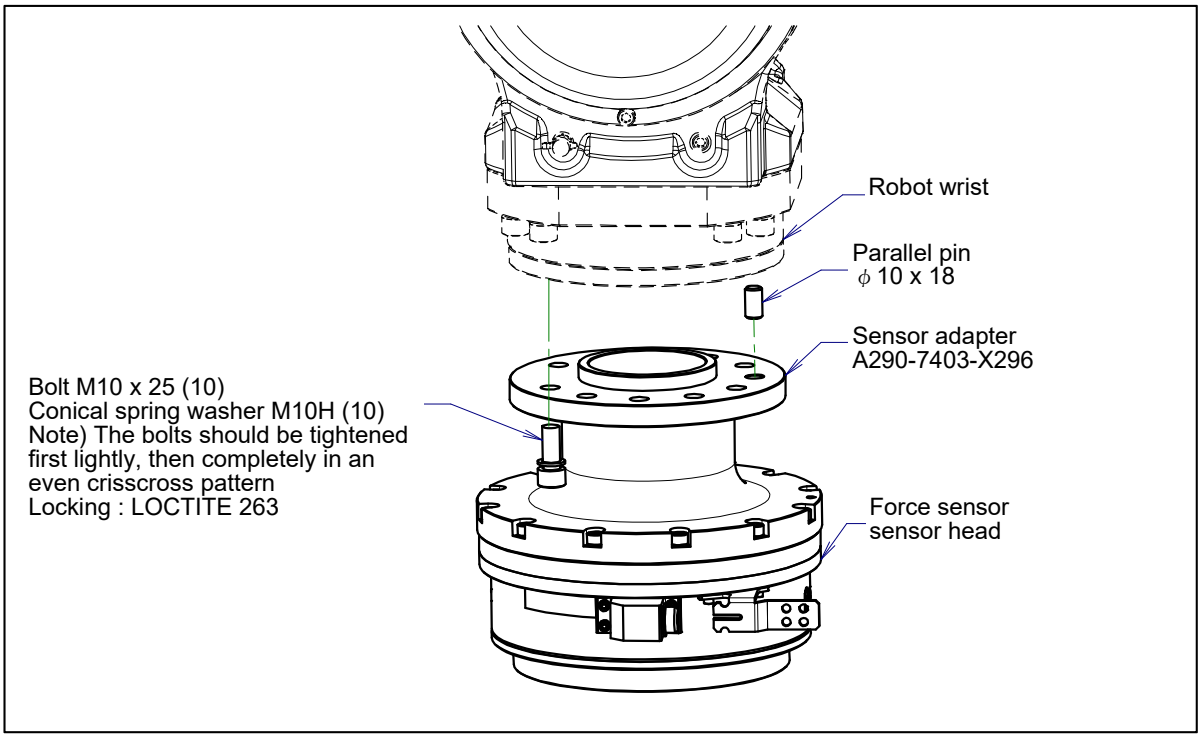


Fig. 9.1.1 (h) Replacing the force sensor, sensor head and adapter (R-2000*i*C+FS-250*i*A with adapter which does not need torque wrench)

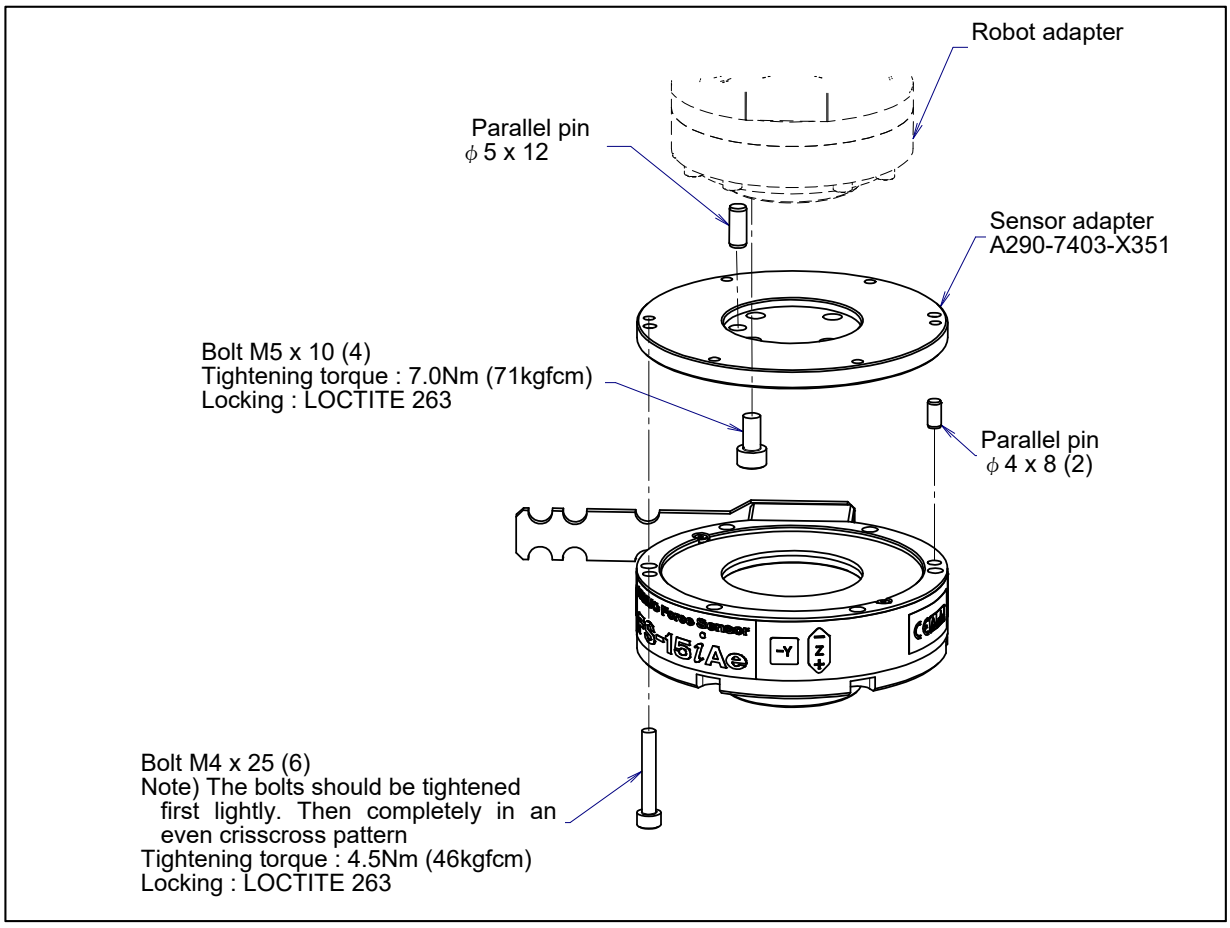


Fig. 9.1.1 (i) Replacing the 3-axes force sensor, sensor head and adapter (LR Mate 200*i*D+FS-15*i*Ae)

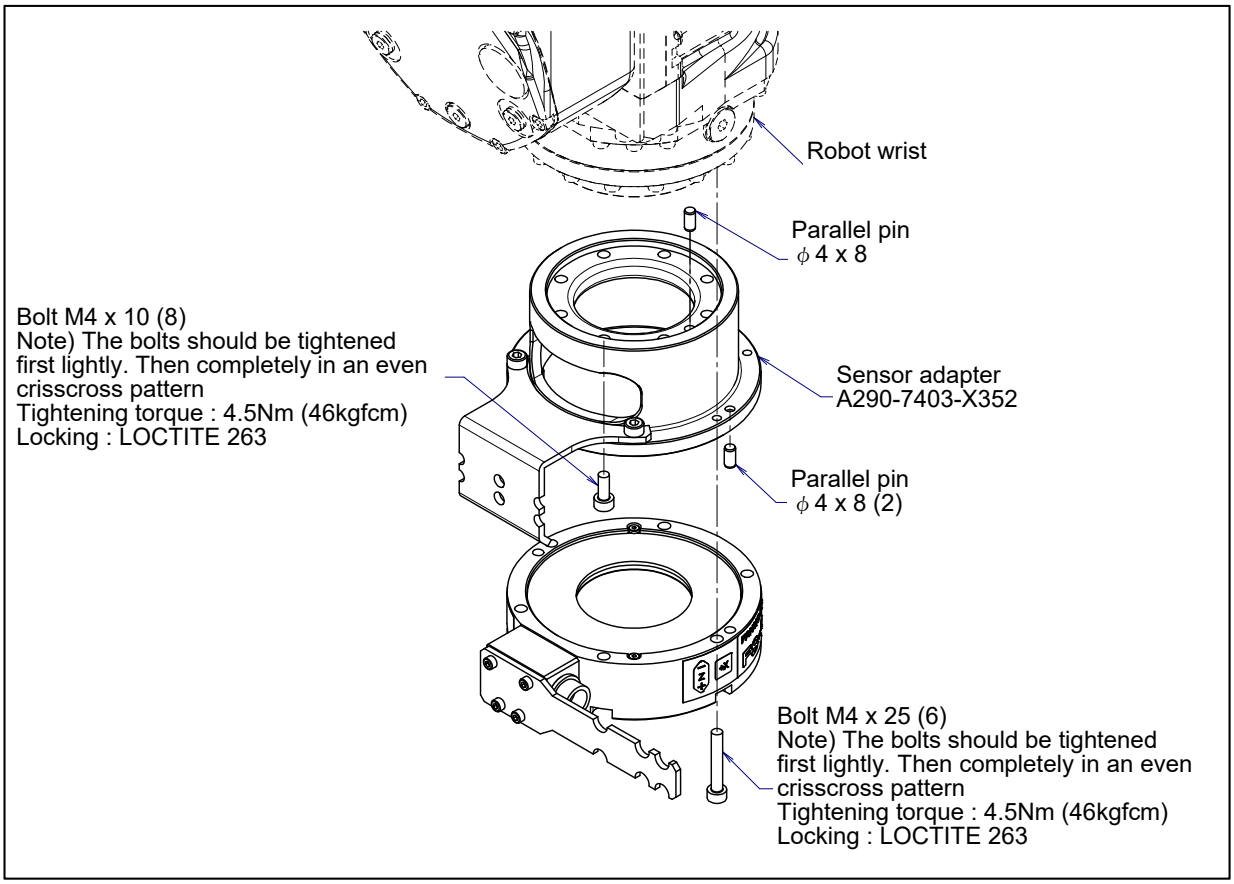


Fig. 9.1.1 (j) Replacing the force sensor, sensor head and adapter (M-10*i*A+FS-15*i*Ae)

9.1.2 Replacing the Sensor Adapter

To replace the sensor mounting adapter, follow the procedure described below. (See Fig. 9.1.1 (a) to (j).) A torque wrench having a special shape is required. Also, see Section 7.5, "MAINTENANCE AND INSPECTION TOOLS."

Removal procedure

1 Remove the force sensor head.
2 Remove the sensor adapter mounting bolts, and detach the sensor adapter and pin.

Installation procedure

1 Attach the pin to the robot flange.
2 Fasten the sensor adapter using the sensor adapter mounting bolts. Be careful about the sensor adapter mounting orientation. Tighten the bolts first lightly, then completely with the specified torque.
3 Mount the force sensor head using the sensor head mounting bolt and the washer.
See the installation procedure of the sub-section 9.1.1 "Replacing the sensor head for detail procedure".

Cautions for installation

If the bolts on which insulating and other washers have been put are tightened unevenly or the specified torque is not used, loose mounting or faulty insulation may be caused. Be sure to tighten the bolts evenly with a specified torque.

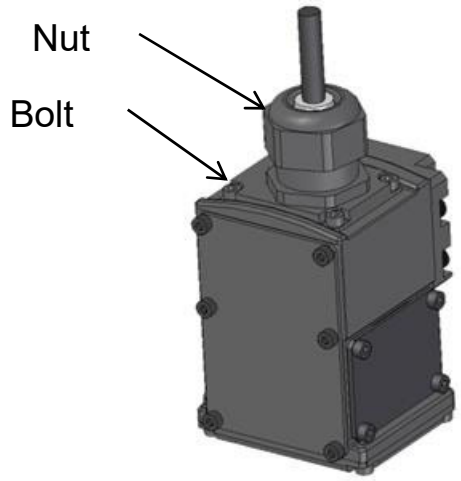
9.2 CAMERA PACKAGE MECHANICAL UNIT

9.2.1 Replacing the Sensor Head of the Camera Package

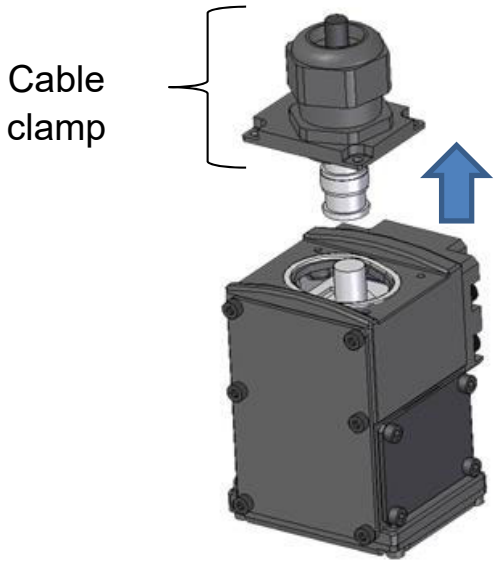
If the camera package becomes failure. replace it according to the following procedure.

Removal procedure

1 Loosen the nut, then remove the four bolts M3.



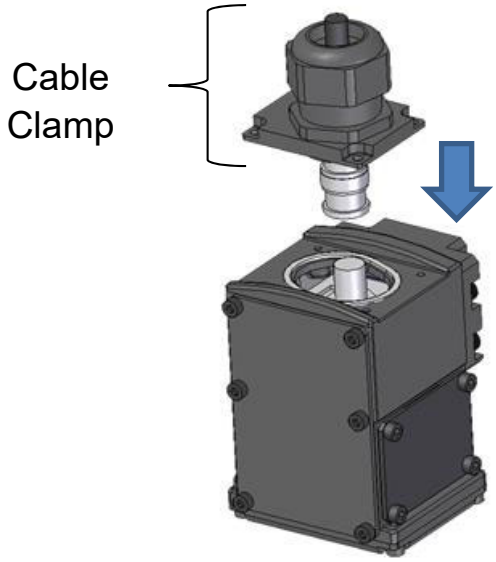
2 Pull up the cable clamp, then remove the camera cable.



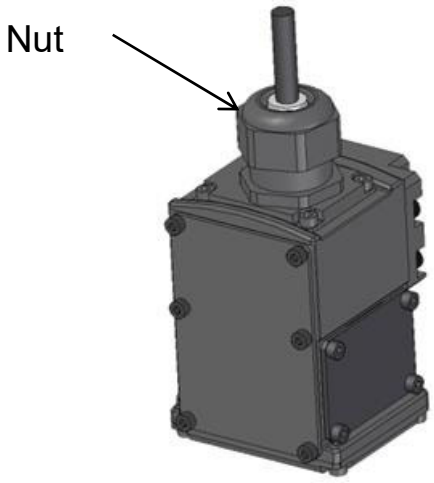
3 Remove the sensor head mounting bolts.
4 Remove the sensor head.

Installation procedure

1 Attach the sensor head with bolts and pins.
2 Pass the cable through the cable clamp, then attach the camera cable to the sensor head.



3 Tighten the cable clamp nut. (recommended tightening torque 2Nm)



9.3 3D LASER VISION SENSOR MECHANICAL UNIT

9.3.1 Replacing the 3D Laser Vision Sensor

If the 3D Laser Vision Sensor head or pre-unit becomes faulty, replace it according to the following procedure. (See Fig. 9.3.1 (a).)

Removal procedure

1 Detach the camera cable from the sensor head.
2 Put a marking to indicate the current mounting position of the sensor head, and then remove the sensor head mounting bolts.
3 Remove the sensor head from the sensor adapter.

Caution for removal

Do not disassemble the 3D Laser Vision Sensor head. If they are disassembled, it becomes impossible for them to make accurate measurement after they are reassembled.

Installation procedure

1 Attach the sensor head to the sensor adapter using mounting bolts and pins.
2 Attach the camera cable to the sensor head.

Caution for installation

The mounting location of the sensor can be selected according to the application for which the robot is used. Be sure to mount the sensor exactly at the same location as before removal.

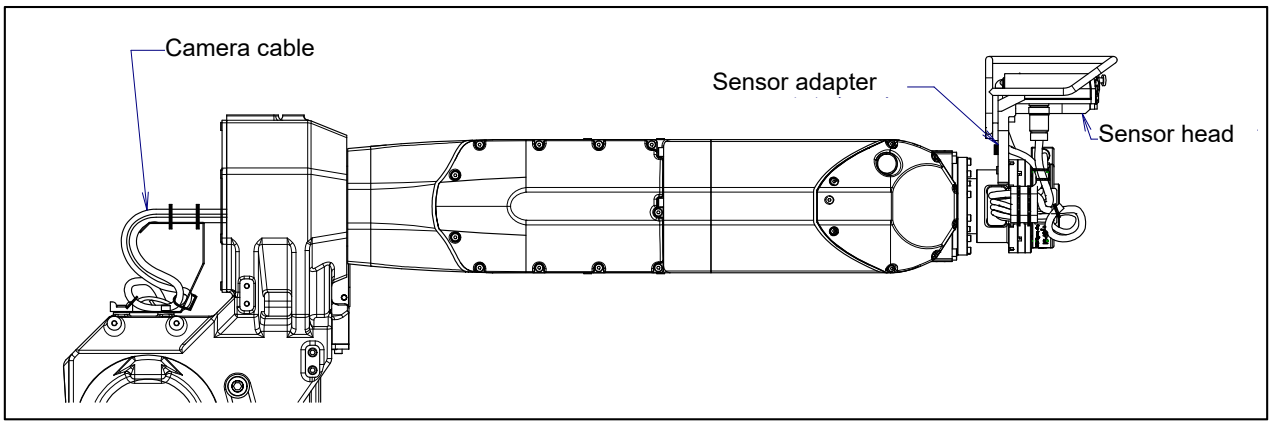


Fig. 9.3.1 (a) Replacing the 3D Laser Vision Sensor head (Example of M-20*i*A)

9.4 3D AREA SENSOR MECHANICAL UNIT

9.4.1 Replacing the 3D Area Sensor Projector Unit and the Camera Unit

If the 3D Area Sensor projector unit or the camera unit becomes failure. replace it according to the following procedure. (See Fig. 9.4.1 (a).)

Removal procedure

1 Turn off the robot controller power.
2 Remove cable from projector unit or camera unit.
3 Remove mounting bolts, and remove projector unit or camera.

Installation procedure

1 Attach the projector unit or camera unit with mounting bolts.
2 Attach cables to the projector unit or camera unit.

In addition, when camera unit is replaced, perform focus adjusting of camera (See Subsection 6.2.1.) and Calibration.

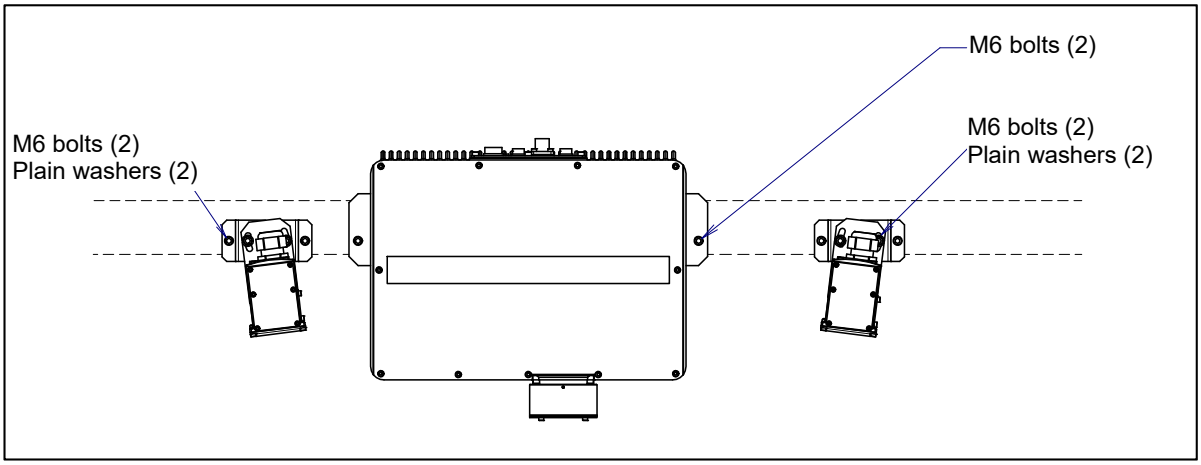


Fig. 9.4.1 (a) Replacement of 3D Area Sensor (3DA/1300)

9.5 3D VISION SENSOR MECHANICAL UNIT

9.5.1 Replacing the Sensor Head of the 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400, 3DV/600

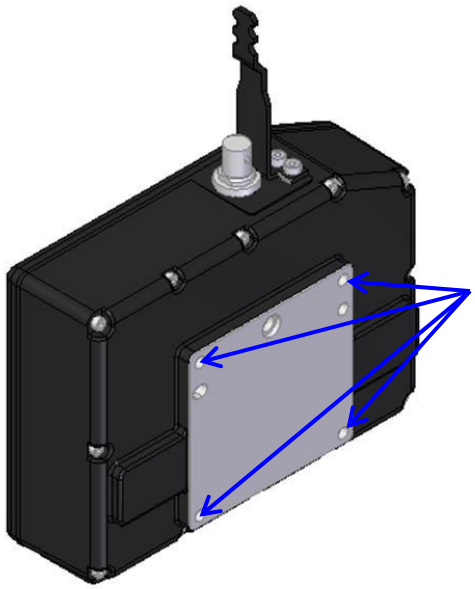
If the sensor head of the 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400 or 3DV/600 becomes failure. Replace it according to the following procedure. (See Fig. 9.5.1 (a), (b).)

Removal procedure

1 Turn off the robot controller power.
2 Cut the cable tie of the cable clamp.
3 Remove the camera cable from the sensor head.
4 Remove the sensor head mounting bolts.
5 Remove the sensor head.

Installation procedure

1 Attach the sensor head with bolts and pins. (Tightening torque 5.0Nm)
2 Attach the camera cable to the sensor head.
3 Wrap a rubber sheet around the cable and use a cable tie to fix the cable to the cable clamp.



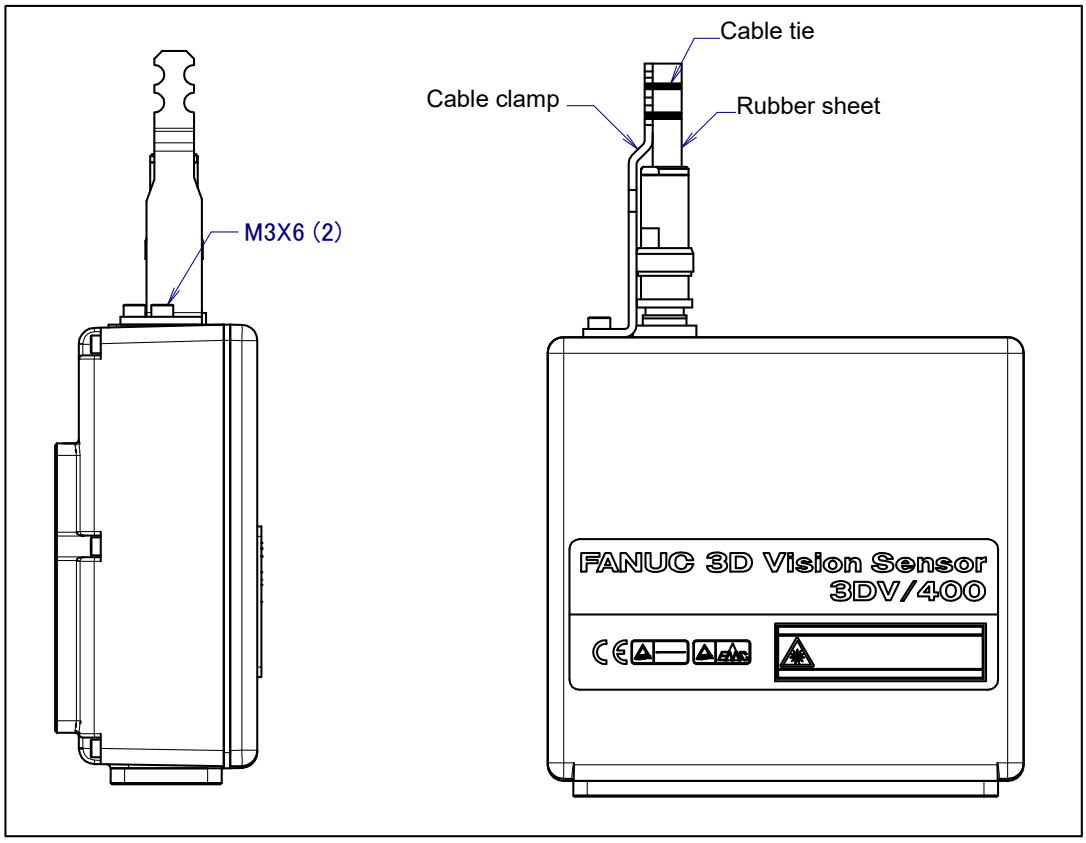


Fig. 9.5.1(a) Replacing the sensor head of the 3D Vision Sensor 3DV/400 without LED light

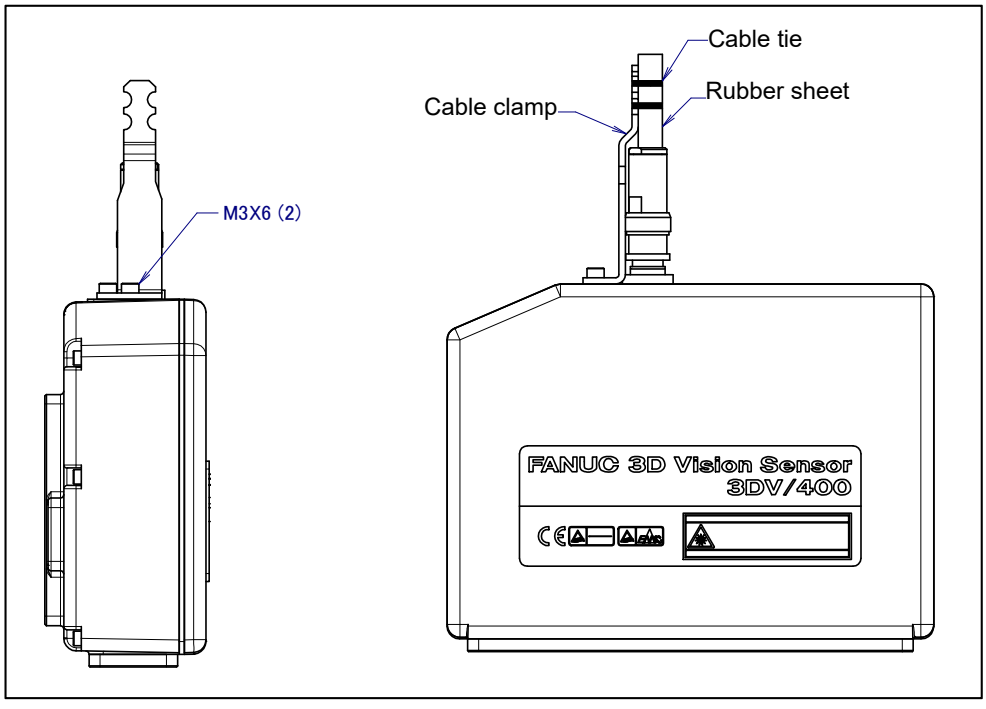


Fig. 9.5.1(b) Replacing the sensor head of the 3D Vision Sensor 3DV/70, 3DV/200, 3DV/400 with LED light and 3DV/600

Table. 9.5.1 (a) Maintenance item list

Order spec.	Items arranged for maintenance
A05B-1426-K108	CABLE CLAMP, RUBBER SHEET, CABLE TIES (2), BOLTS(2)

9.5.2 Replacing the Sensor Head of the 3D Vision Sensor 3DV/1600

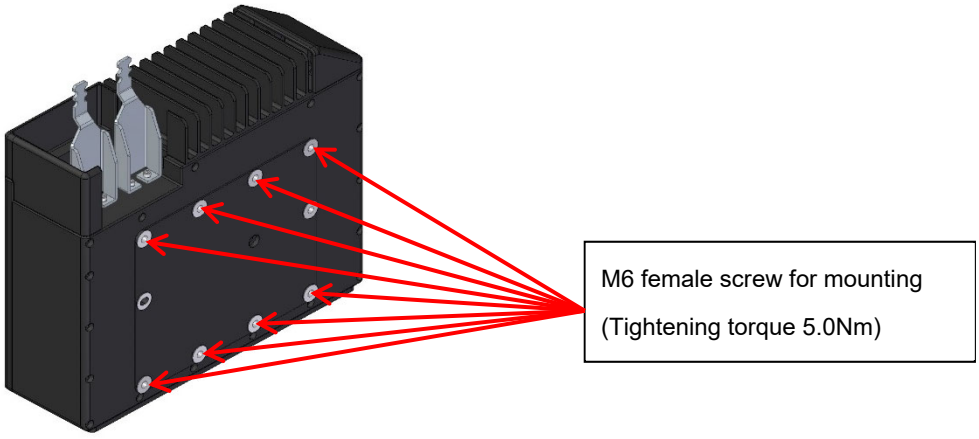
If the sensor head of the 3D Vision Sensor 3DV/1600 becomes failure. Replace it according to the following procedure. (See Fig. 9.5.2 (a).)

Removal procedure

1 Turn off the robot controller power.
2 Cut the cable tie of the cable clamp.
3 Remove the camera cable and the power supply cable from the sensor head.
4 Remove the sensor head mounting bolts.
5 Remove the sensor head.

Installation procedure

1 Attach the sensor head with bolts and pins. (Tightening torque 5.0Nm)
2 Attach the camera cable and the power supply cable to the sensor head.
3 Wrap a rubber sheet around the cable and use a cable tie to fix the cable to the cable clamp.



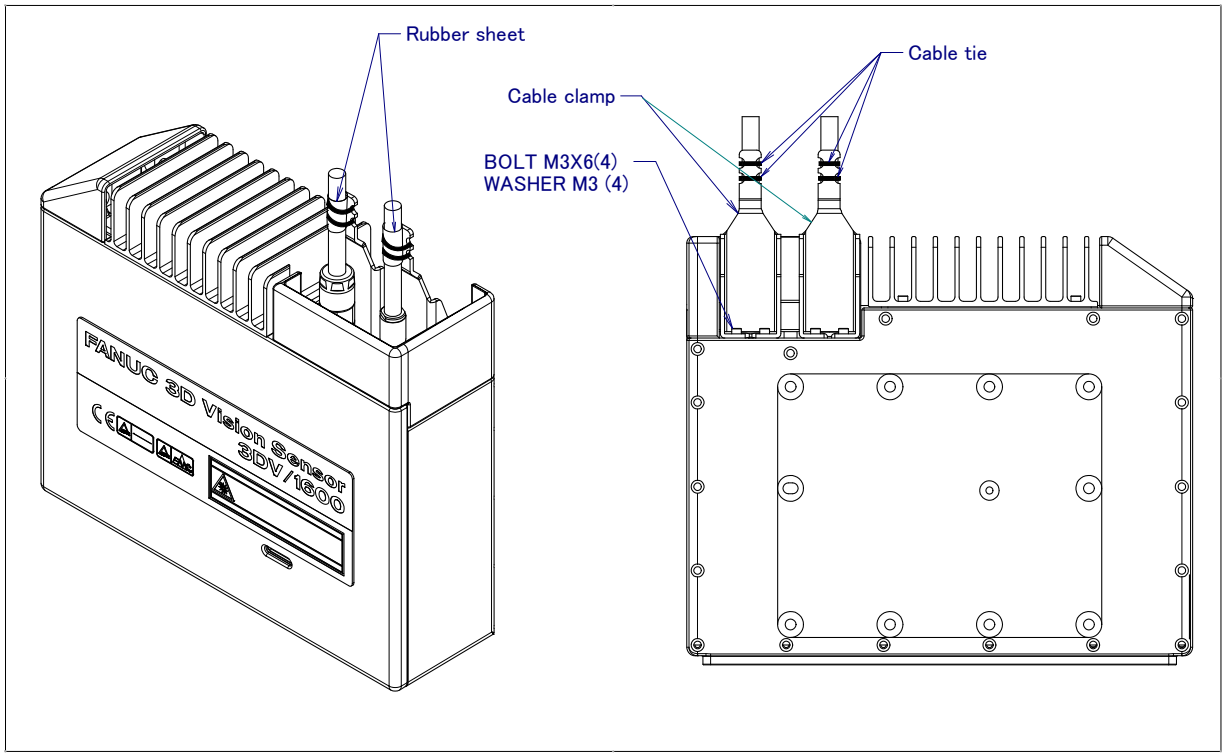


Fig. 9.5.2(a) Replacing the sensor head of the 3D Vision Sensor 3DV/1600

Table. 9.5.2 (a) Maintenance item list

Order spec.	Items arranged for maintenance
A05B-1426-K138	CABLE CLAMPS (2), RUBBER SHEETS (2), CABLE TIES (4), BOLTS(4), WASHERS (4)

10 REPLACING CABLES

The following robot is available to be included with a sensor (see Section 5.2, “WIRING”):

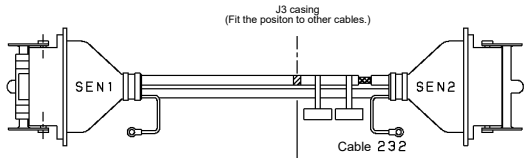
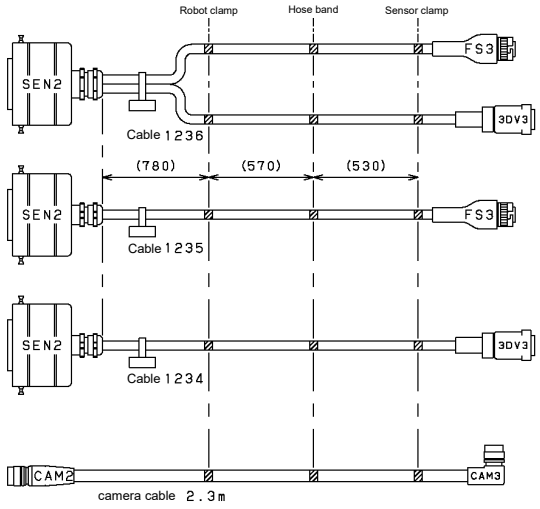
Cable name
Mechanical unit cable (Robot main body)
Mechanical unit cable (Sensor)
Sensor cable (J3 casing to the sensor head)
Camera cable (J3 casing to the sensor head)

Refer to the robot specific manual for explanations of how to replace the each robot’s main body mechanical unit cable.

10.1 CABLE FORMING

Table 10.1 (a) shows those portions of the mechanical unit cable (for sensor), sensor and camera cable, which must be clamped. Be sure to clamp the cables at the specified portions.

Table 10.1 (a) Cable forming

Sensor	Mechanical unit cable	Sensor cable camera cable
Force sensor / 3D vision sensor		
3D vision sensor (camera)		

The measure of the sensor cable and the camera cable are the standard mounting positions.

10.2 REPLACING THE SENSOR CABLE AND CAMERA CABLE

> **⚠ CAUTION**
> For the sensor cable kit, a sponge is attached for protection of the cable from clamping band. When assembling, perform the correct clamping according to Fig. 10.2 (a).

If the force sensor or camera cable is damaged, replace the cable by the following procedure.

Removal

1 Detach the sensor cable from the force sensor head.
2 Detach the cable clamp and cable tie, and then the sensor cable or camera cable.

Assembly

1 To attach the sensor cable, reverse the removal procedure, while using caution for the cable clamping portions.
2 Wrap sponge and tie cable tie around the Sensor side connector positions for each cable as shown in Fig. 10.2 (a).

Caution for installation

After attaching the sensor cable, operate the robot wrist section, and check that the cable is free from excessive tension and twisting.

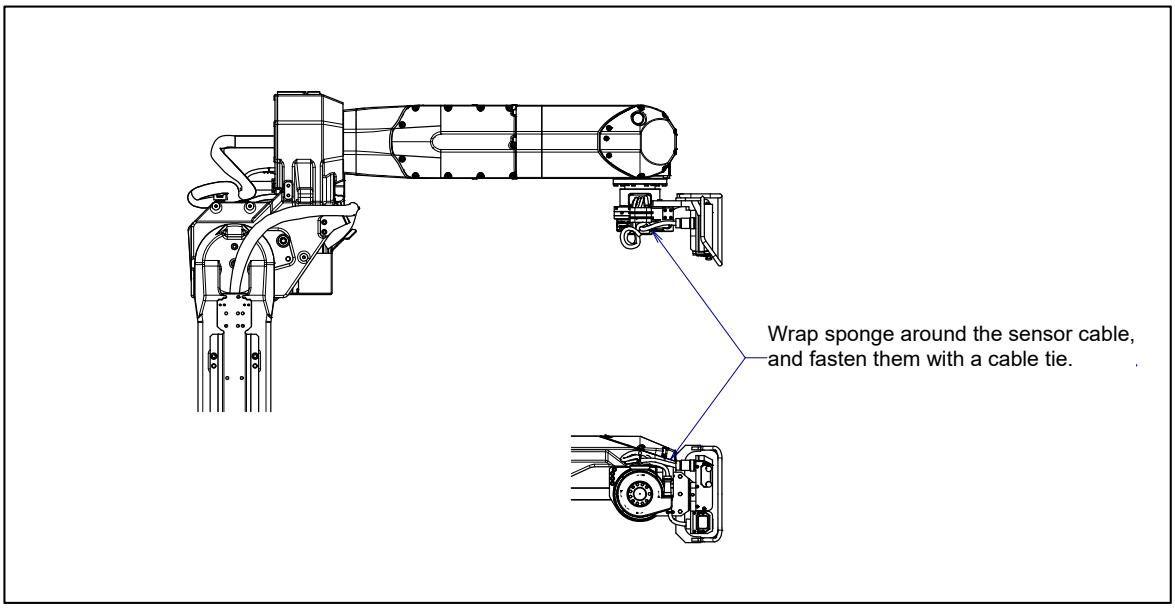


Fig. 10.2 (a) Replacing the sensor cable and the camera cable

> **⚠ CAUTION**
> For the sensor cable kit, a sponge is attached for protection of the cable from clamping band. When assembling, perform the correct clamping according to Fig. 10.2 (b).

If the camera cable of the 3D vision sensor cable is damaged, replace the cable by the following procedure.

The mechanical unit cable has the following difference compared with the standard cable.
When replacing the cable, assemble it so that it's status is equal to the old cable.

Removal

1 Cut the cable tie of the sensor head cable clamp.
2 Remove the camera cable from the sensor head.
3 Remove the camera cable from the J3 casing connector.

Assembly

1 Attach camera cable to the connector of the J3 casing.
2 Attach the camera cable to the sensor head.
3 Wrap a sponge or a rubber sheet around the camera cable and attach cable to cable clamp using cable tie.

Caution for installation

After attaching the sensor cable, operate the robot wrist section, and check that the cable is free from excessive tension and twisting. Check that the connector of the camera cable is free from excessive tension and twisting.

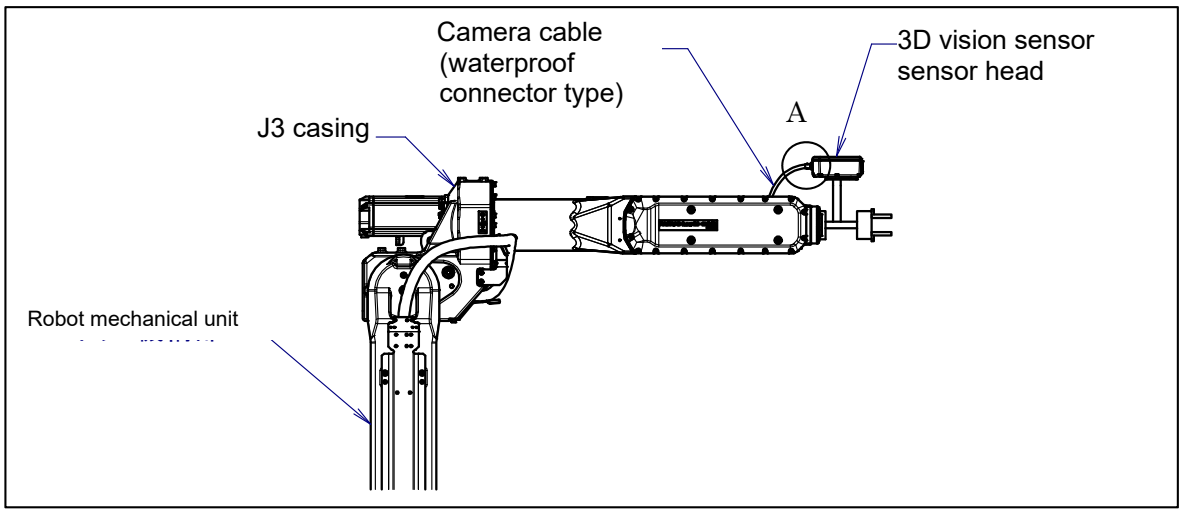


Fig. 10.2 (b) Replacing the camera cable (M-20*i*A)

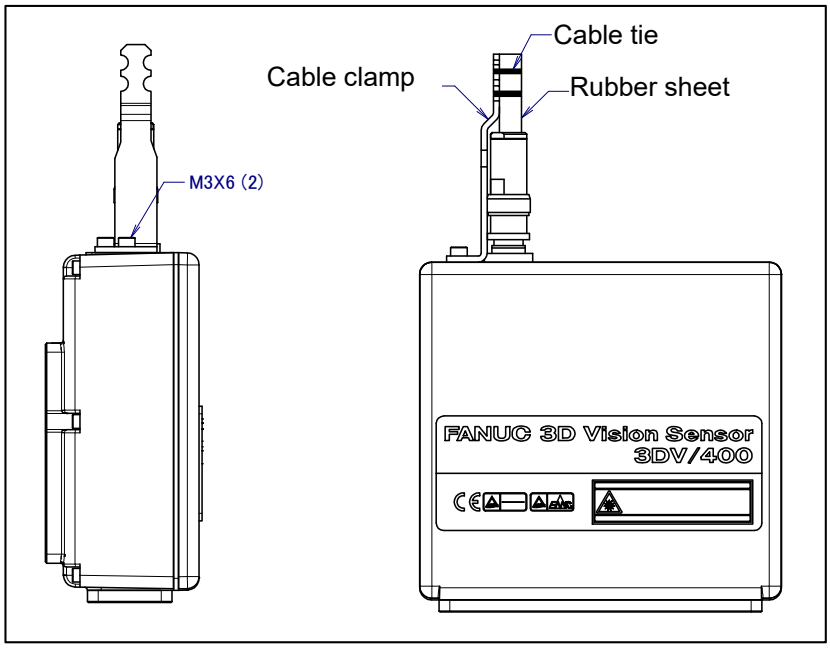


Fig. 10.2 (c) Detail of A (3DV/400 without LED light)

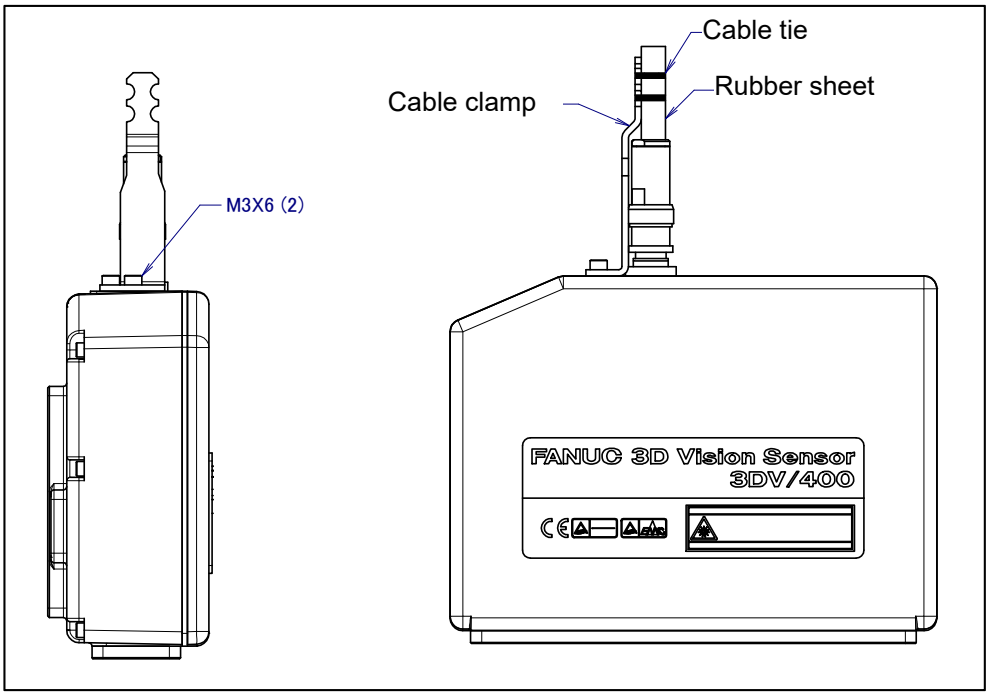


Fig. 10.2 (d) Detail of A (3DV/70, 3DV/200, 3DV/400 and 3DV/600 with LED light)

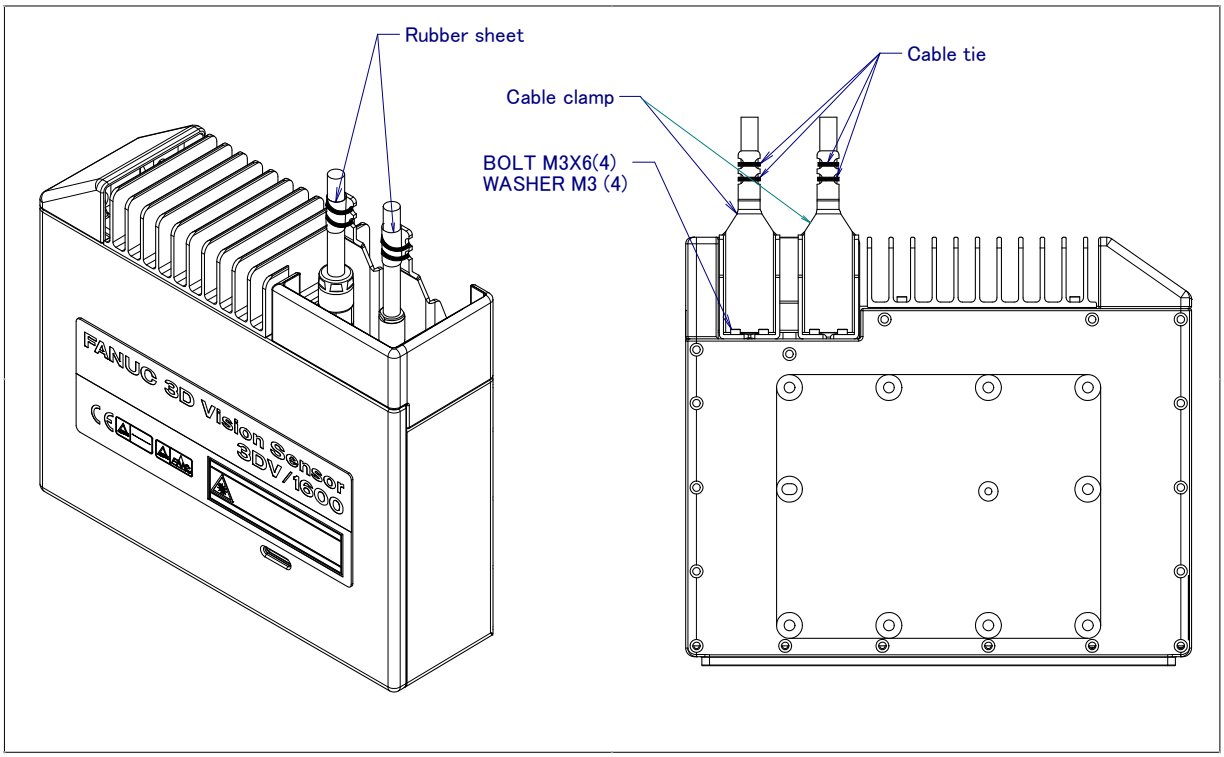


Fig. 10.2 (f) Detail of A (3DV/1600 with light)

11 INTRA-CONTROLLER PCB AND UNIT REPLACEMENT

11.1 REPLACING CAMERA MULTIPLEXER (A-CABINET)

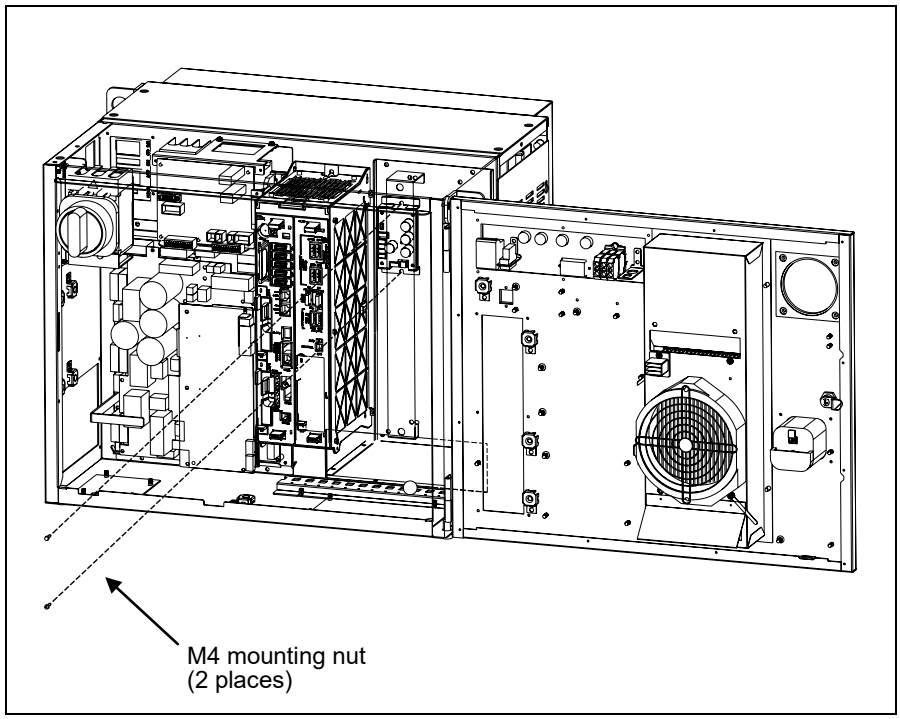


Fig. 11.1 (a) Replacing the camera multiplexer

11.2 REPLACING CAMERA MULTIPLEXER (B-CABINET)

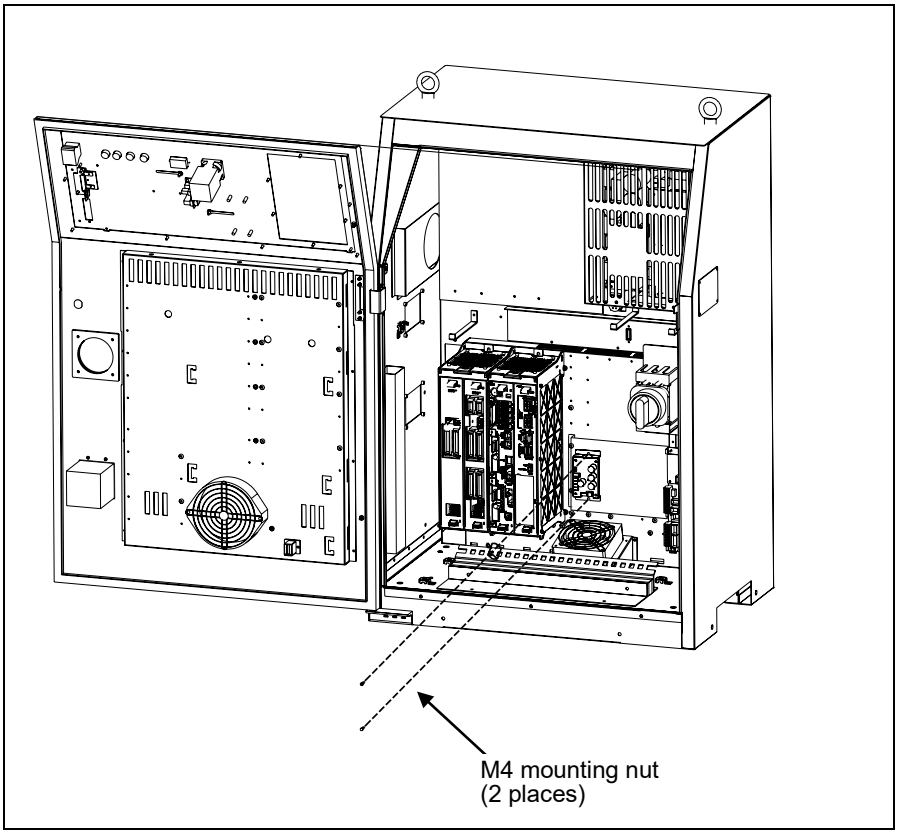


Fig. 11.2 (a) Replacing the camera multiplexer

11.3 REPLACING THE MULTIPLEXER (Mate CABINET)

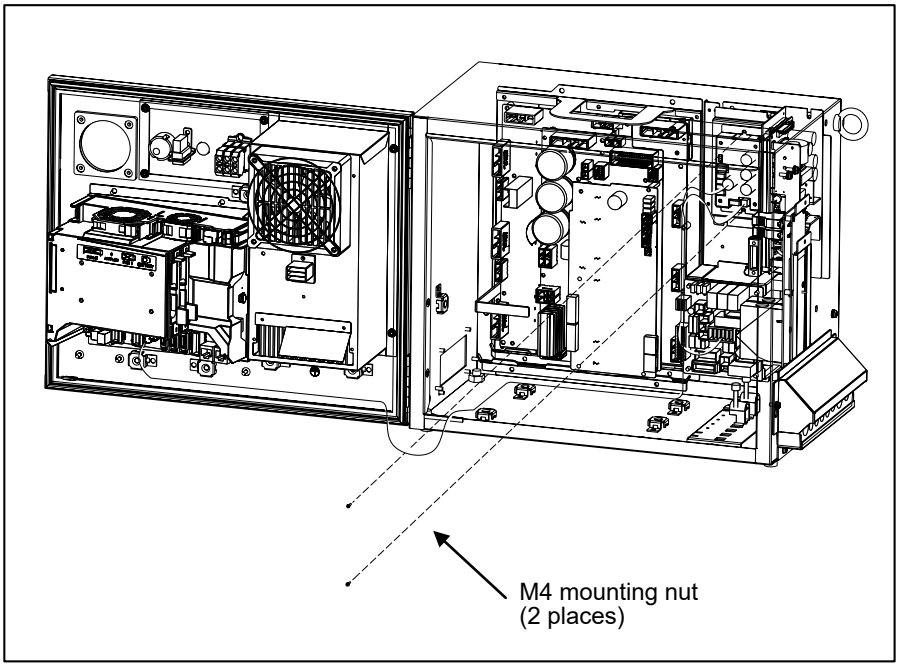


Fig. 11.3 (a) Replacing the camera multiplexer

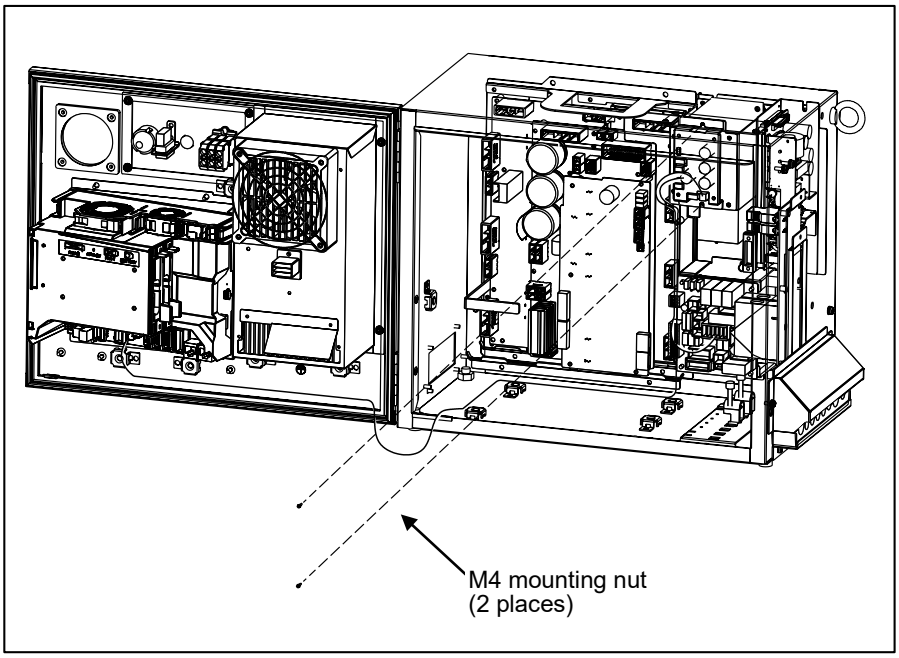


Fig. 11.3 (b) Replacing the camera multiplexer (CE)

11.4 REPLACING 3DV/1600 PSU (A CABINET)

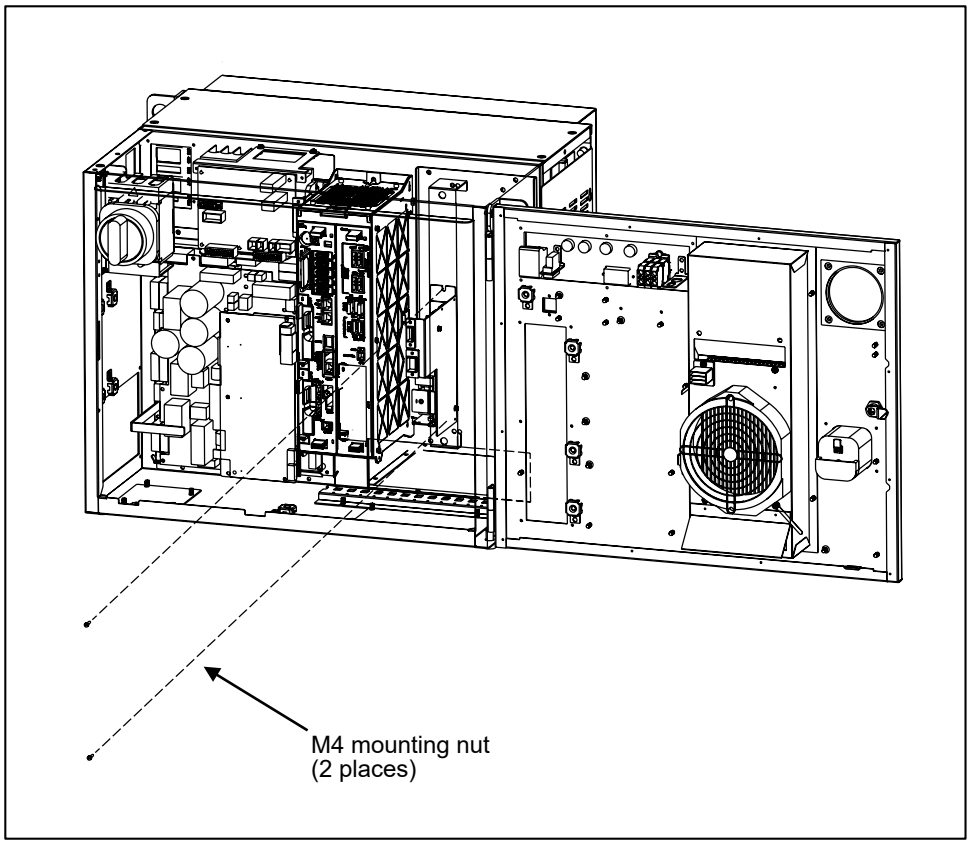


Fig. 11.4 (a) Replacing 3DV/1600 PSU

11.5 REPLACING 3DV/1600 PSU (B-CABINET)

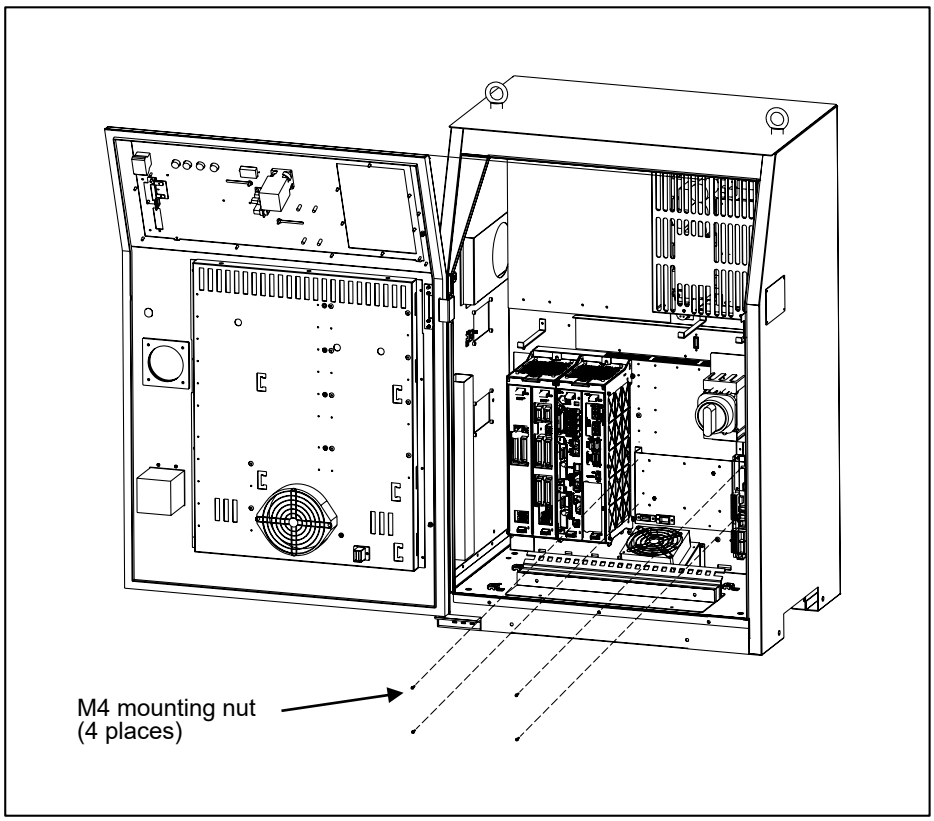


Fig. 11.5 (a) Replacing 3DV/1600 PSU

11.6 REPLACING 3DV/1600 PSU (Mate CABINET)

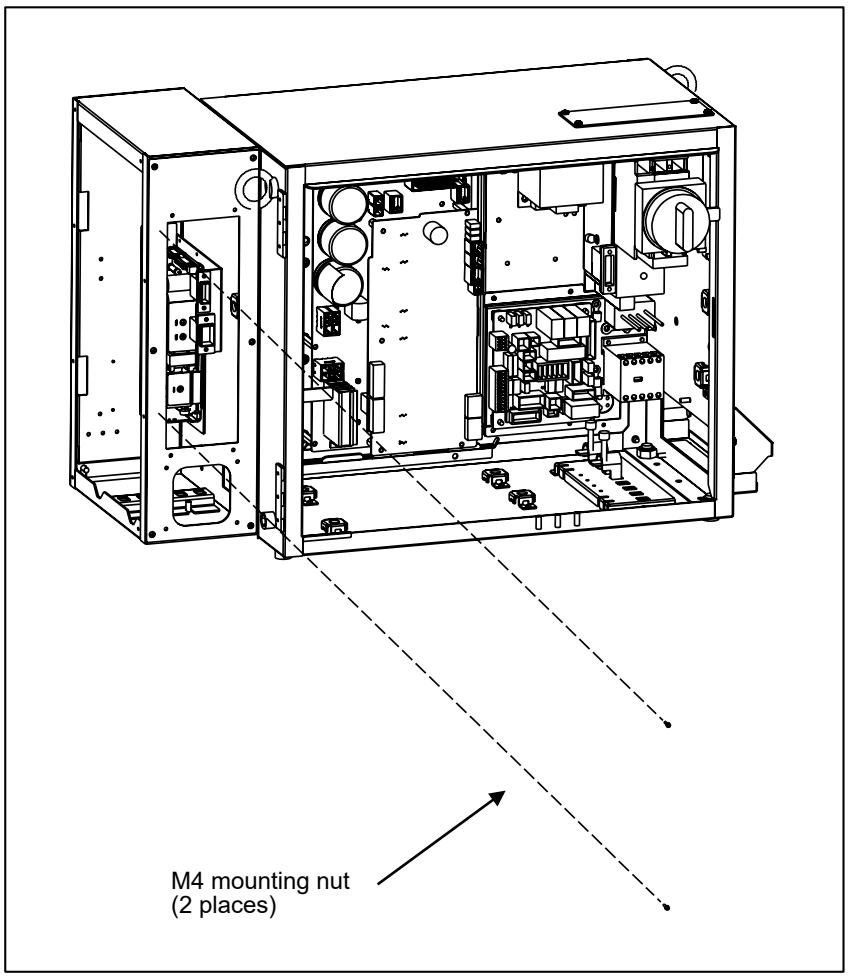


Fig. 11.6 (a) Replacing 3DV/1600 PSU

APPENDIX

A CIRCUIT DIAGRAM

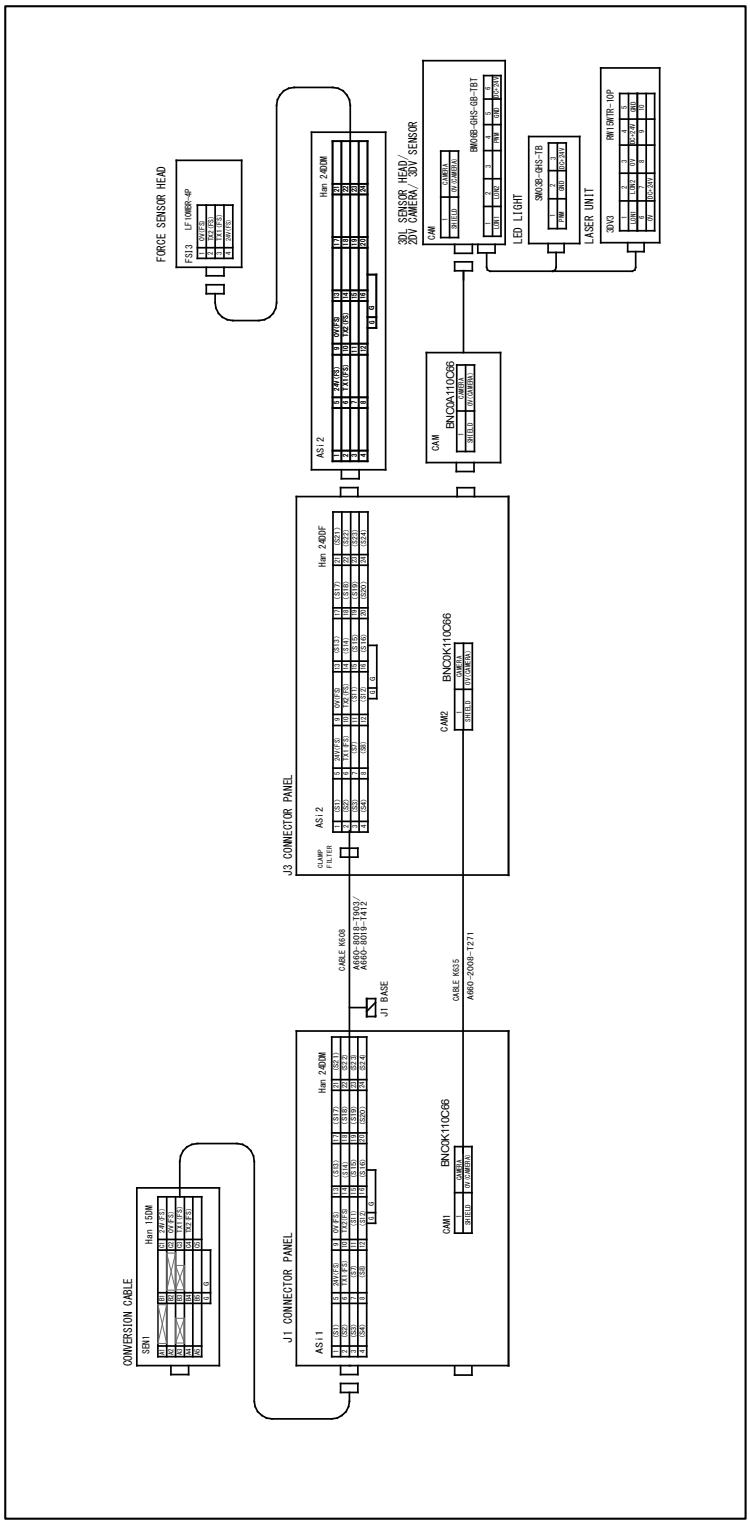


Fig. A (a) Circuit diagram in the mechanical unit (Example of ASi interface with R-2000*i*C)

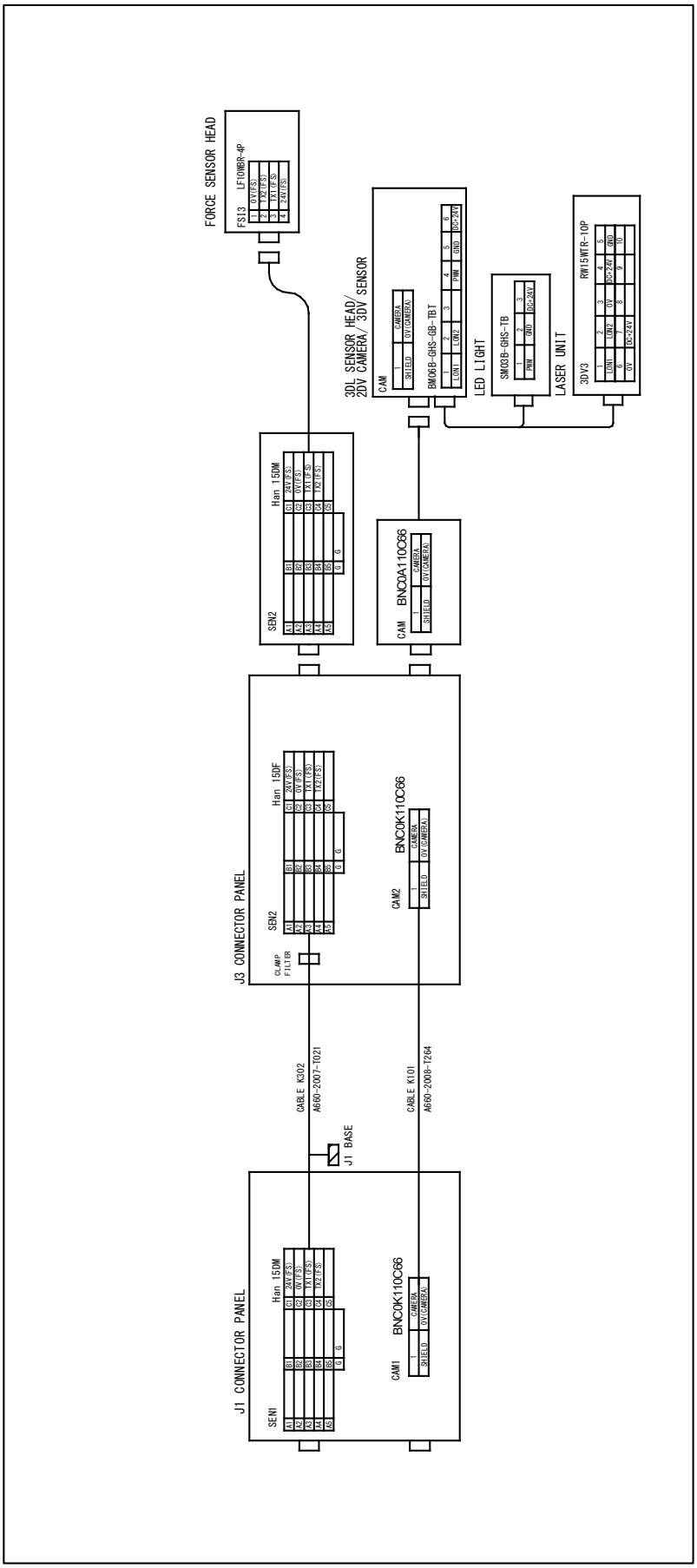


Fig. A (b) Circuit diagram in the mechanical unit (Example of M-20*i*A)

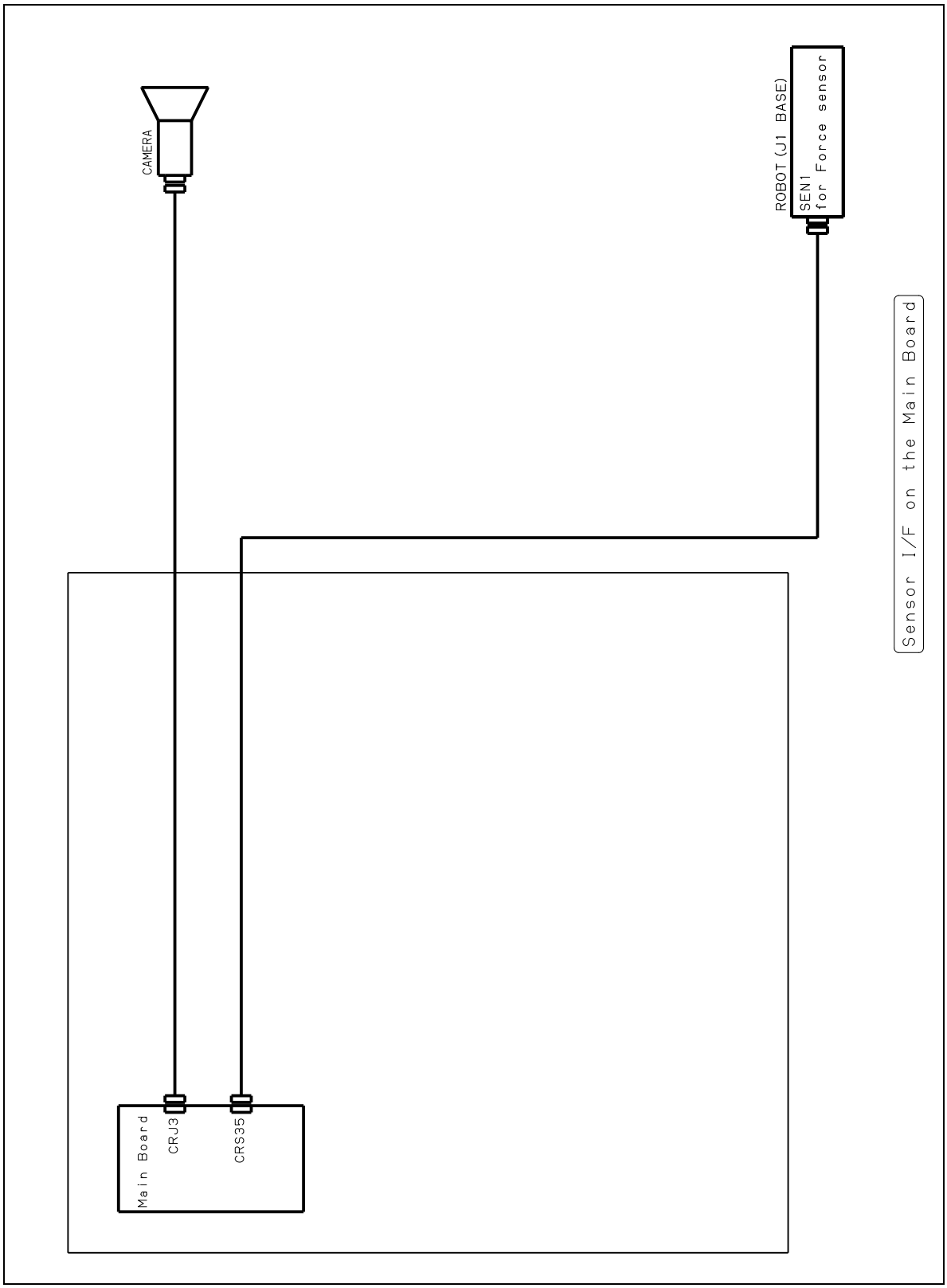


Fig. A (c) Circuit diagram in the controller (*i*RVision and force sensor without multiplexer)

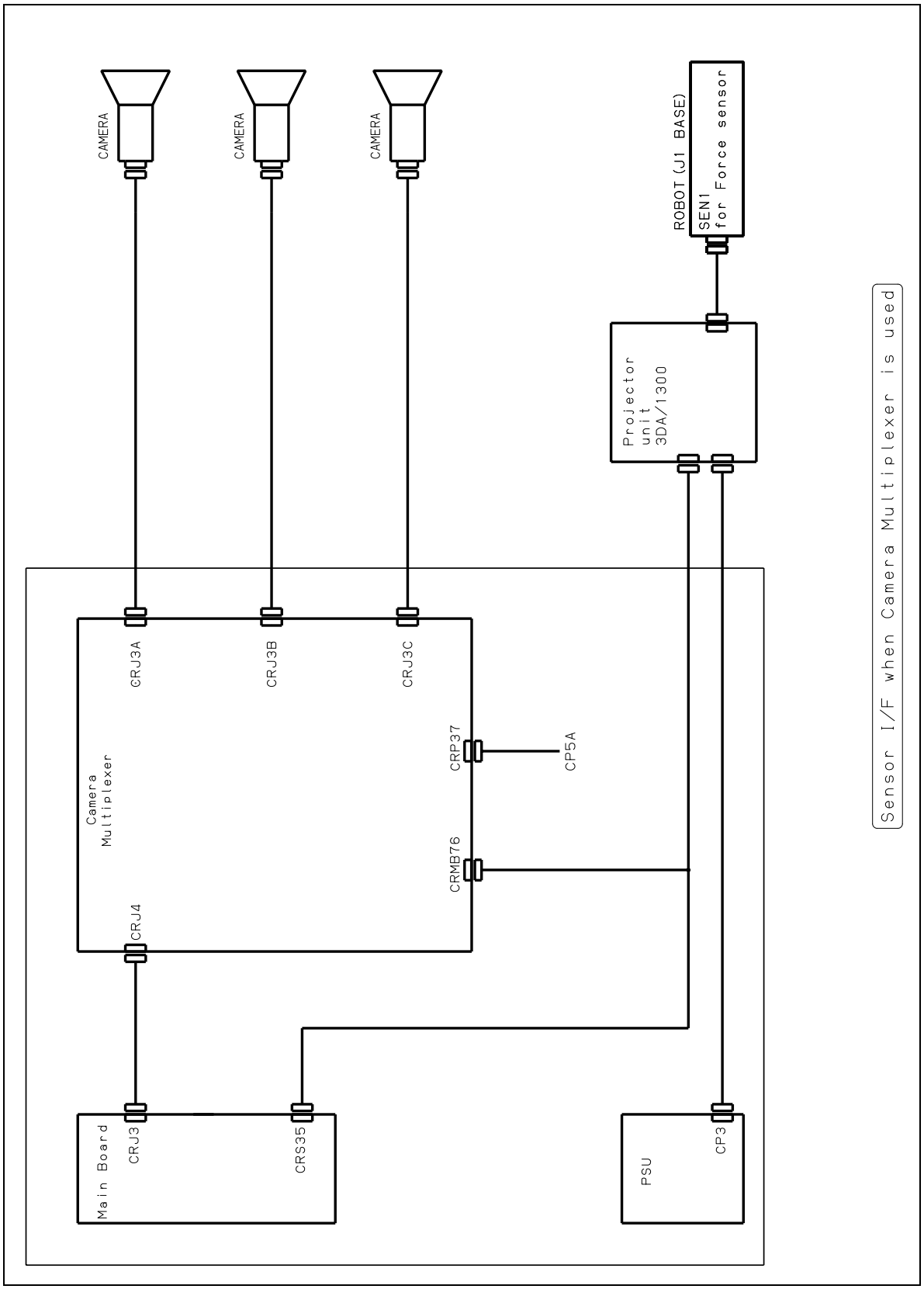


Fig. A (d) Circuit diagram in the controller (with multiplexer, multiple *i*RVIsion, force sensor, 3D are sensor)

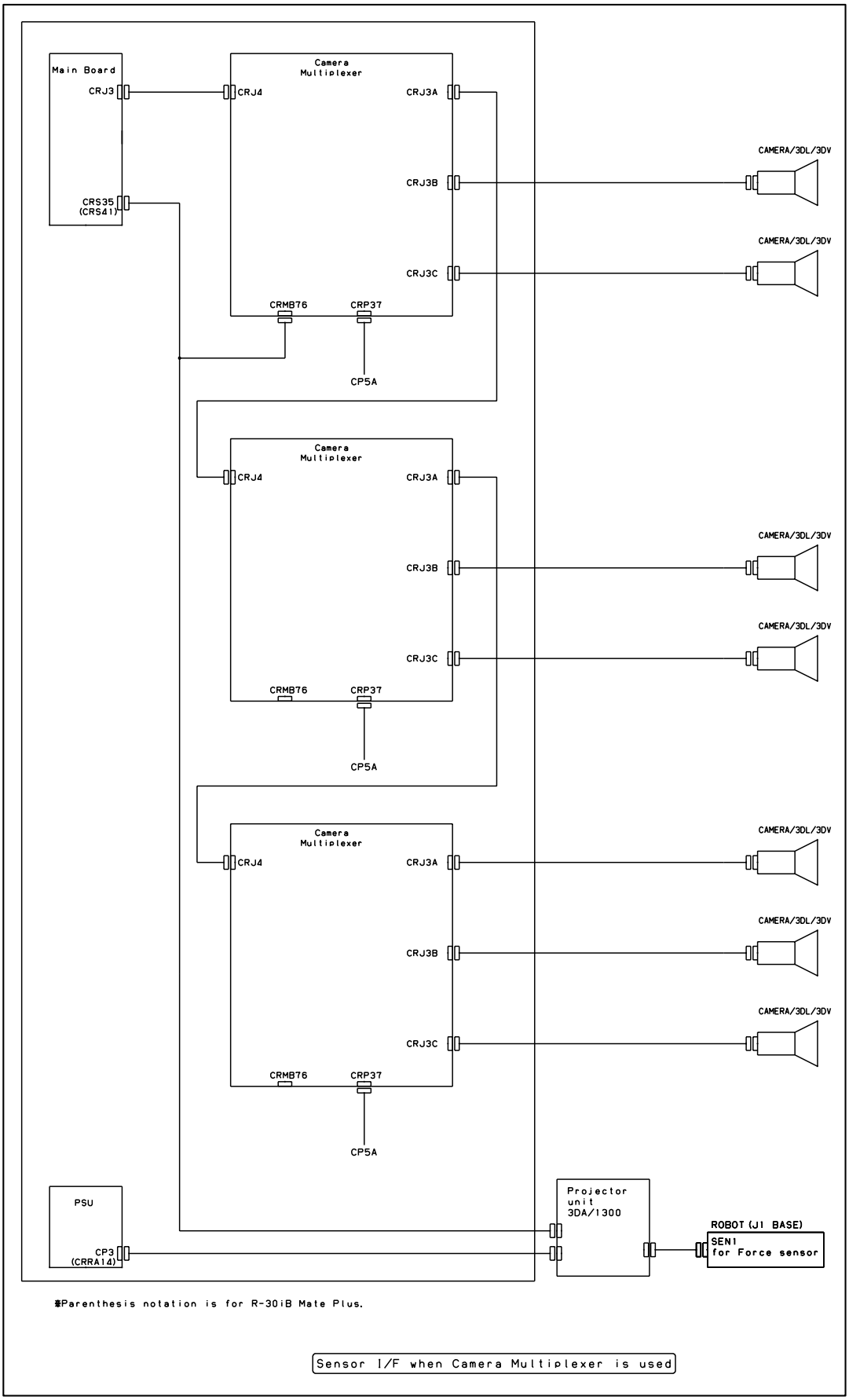


Fig. A (e) Circuit diagram in the controller
(with multiple multiplexer, multiple *i*RVIsion, force sensor, 3D Area Sensor)

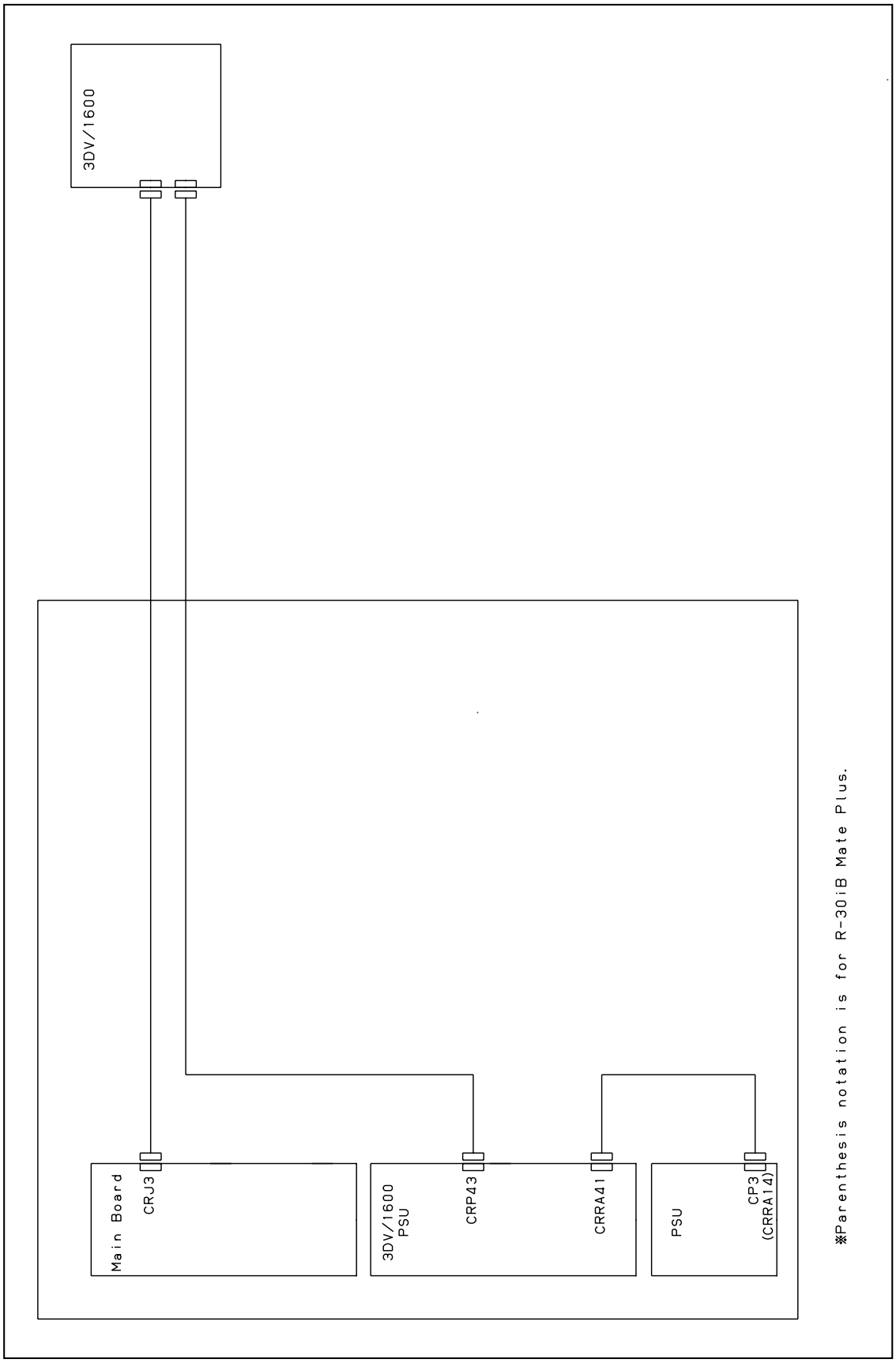


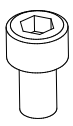
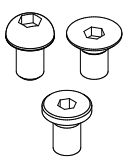
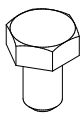
Fig. A (f) Circuit diagram in the controller (3DV/1600)

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE
When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off any oil on the engaging section. Make sure that there is no solvent left in the threaded holes. After you screw the bolts into the threaded holes, remove any excess LOCTITE.

Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:
Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plating bolt: Tensile strength 1000N/mm^2 or more
Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more
Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

Nominal diameter	Hexagon socket head bolt (steel)		Hexagon socket head bolt (stainless steel)		Hexagon socket head button bolt Hexagon socket head flush bolt Low-head bolt (steel)		Hexagon bolt (steel)	
	Tightening torque		Tightening torque		Tightening torque		Tightening torque	
	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit
M3	1.8	1.3	0.76	0.53	———	———	———	———
M4	4.0	2.8	1.8	1.3	1.8	1.3	1.7	1.2
M5	7.9	5.6	3.4	2.5	4.0	2.8	3.2	2.3
M6	14	9.6	5.8	4.1	7.9	5.6	5.5	3.8
M8	32	23	14	9.8	14	9.6	13	9.3
M10	66	46	27	19	32	23	26	19
M12	110	78	48	33	———	———	45	31
(M14)	180	130	76	53	———	———	73	51
M16	270	190	120	82	———	———	98	69
(M18)	380	260	160	110	———	———	140	96
M20	530	370	230	160	———	———	190	130
(M22)	730	510	———	———	———	———	———	———
M24	930	650	———	———	———	———	———	———
(M27)	1400	960	———	———	———	———	———	———
M30	1800	1300	———	———	———	———	———	———
M36	3200	2300	———	———	———	———	———	———
								

INDEX

REVISION RECORD

Edition	Date	Contents
04	Oct., 2021	・ Addition of 3D vision sensor 3DV/70 and 3DV/200
03	Sep., 2020	・ Addition of 3D vision sensor 3DV/1600
02	Mar., 2020	・ Addition of the camera package, 3D Laser Vison sensor, 3D Area sensor and 3D vision sensor
01	Jul., 2017	

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