Multi-purpose Intelligent Robot

R-2000*i* A

FANUC LTD

Intelligent Function

- **Newly developed robot controller R-J3*i*B makes robot intelligent by the newest servo function, network function, sensor control function, etc.**

High Sensitive Collision Detection

This is safety function which detects the symptom of the collision and stops the robot urgently. This can protects robot and peripherals without traditional mechanical clutch.

Automatic Payload Identification

Robot identifies payload by itself and realizes best performance automatically.

Soft Float

Floating function is realized by software. This can reduce the system cost by eliminating mechanical floating device.

Robot Link

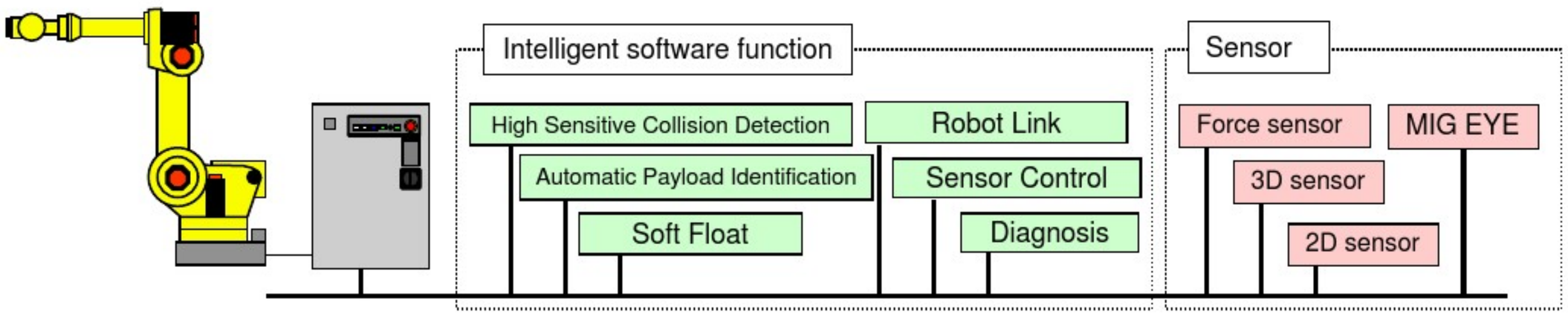
Simultaneous motion or coordinated motion is realized by multiple robots which are connected with ethernet. This can handle heavy /large workpiece which can't be handled by single robot or can reduce system cost by replacing from current special machine to multiple robot handling system.

Sensor Control

By combining various sensors (force sensor, 2D sensor, 3D sensor, etc.), robot can be realized better performance.

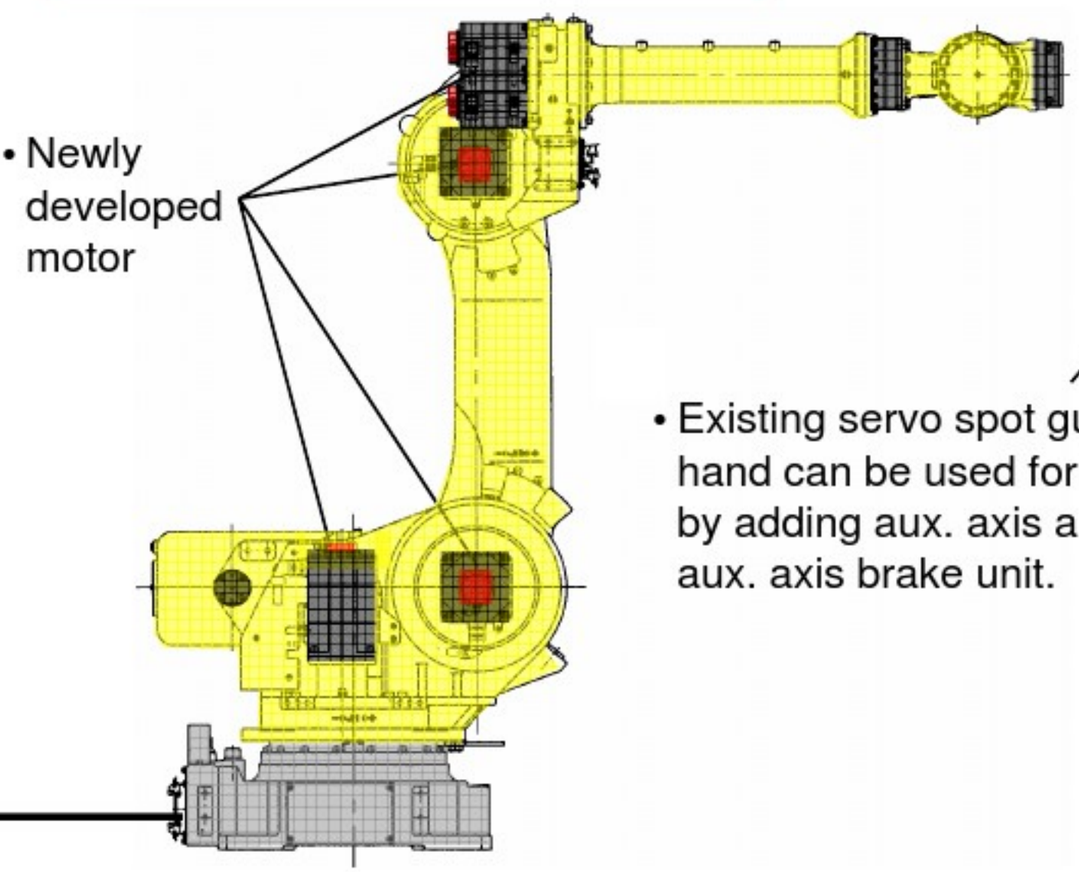
Diagnosis

Diagnostic function for appropriate maintenance is enriched by using various information(voltage, current,temperature, etc.) from amplifier and pulsecoder.



Configuration

R-2000*i*A Mechanical Unit

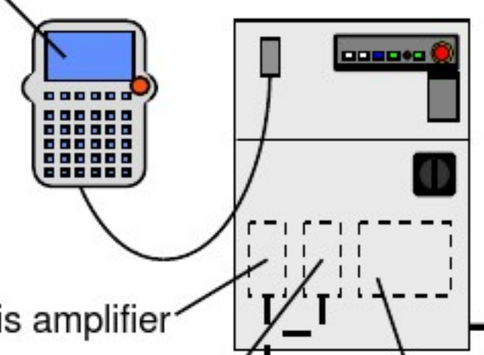


- Newly developed motor

- Existing servo spot gun,servo hand can be used for R-2000*i*A by adding aux. axis amplifier and aux. axis brake unit.

R-2000*i*A Controller (R-J3*i*B)

- Same operation as R-J3
- Same programs of R-J3 can be used



- Aux. axis amplifier (option)
- Aux. axis brake unit (option;this unit is required in case of aux axis with existing motor)
- Newly developed control unit, amplifier, transformer,etc.
- Remote type controller only.

Aux. axis

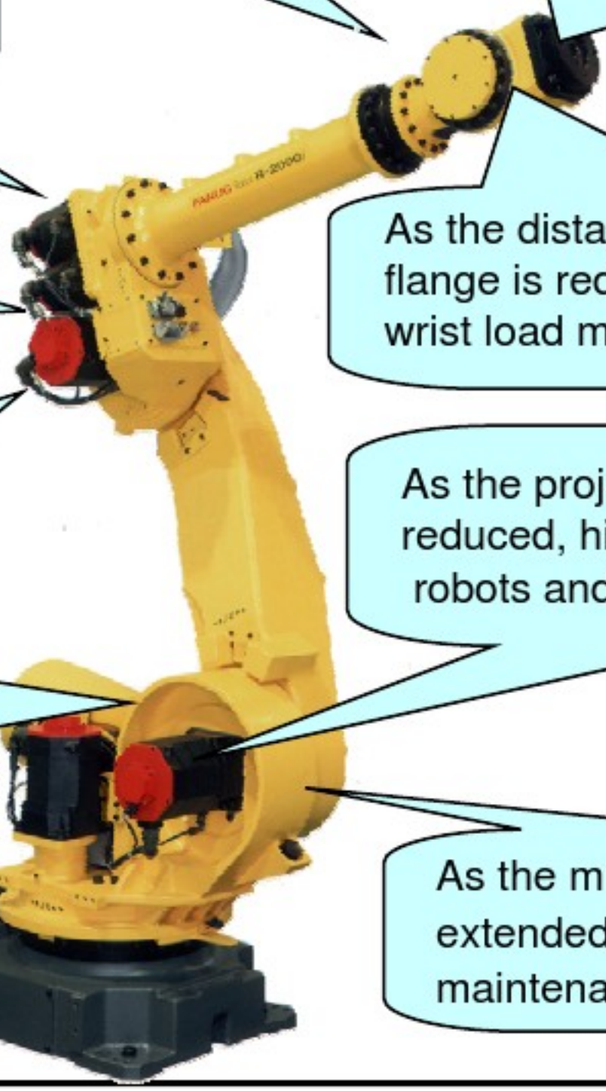
- Existing aux. axis unit can be used for R-2000*i*A by adding aux. axis amplifier and aux. axis brake unit.

Features of the Mechanical Unit

As the wrist size becomes compact, interference with car body is reduced.

As the allowable wrist load moment is increased, it is easily applied spot welding with large size gun or handling of heavy workpiece.

As the height becomes lower, robot can be mounted in low ceiling places.



Flip over mechanism as the standard and 360 degree rotation axis enables operation to all directions.

As the distance from J5 axis center to wrist flange is reduced, the substantial allowable wrist load moment is increased

As the rear side interference area is small, line width can be reduced and floor space is used effectively.

As the projection of J2 and J3 axis motor is reduced, high density installation of the robots and peripherals is possible.

As the various models and options are prepared, customer can choose the most suitable model and use more wider application.

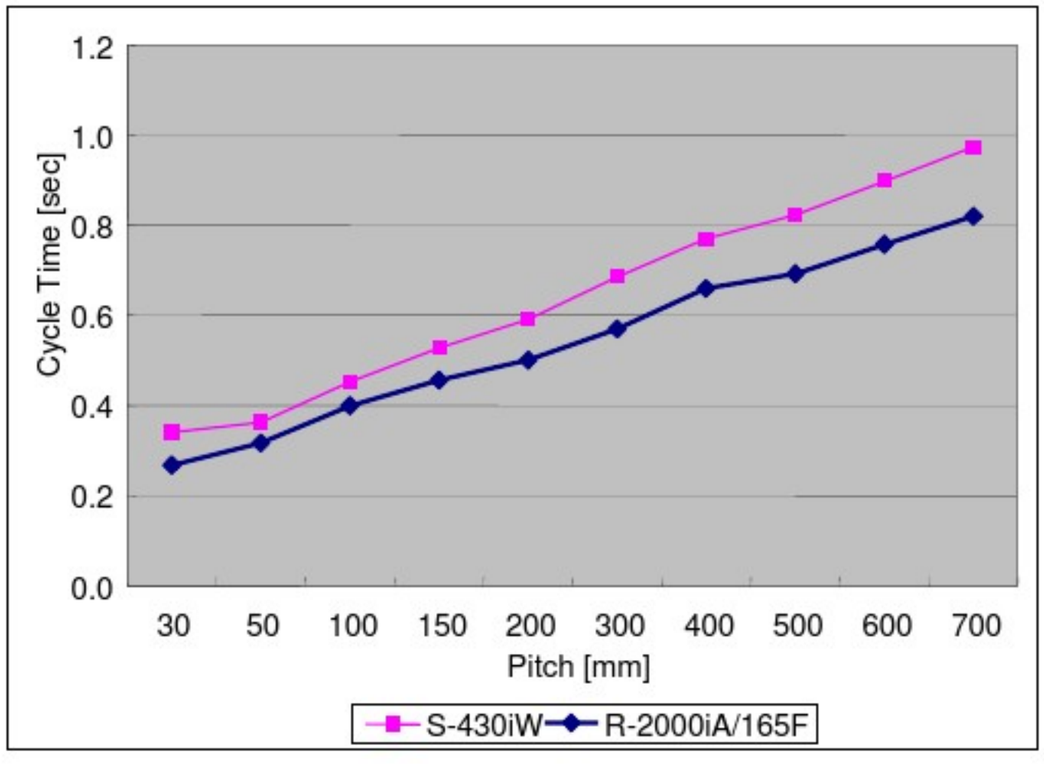
As the minimum maintenance period is extended from 6 months to 1 year, maintenance becomes easier.

As the diagnostic function is enriched, customer can use robot more safely.

Improvement of Motion Performance

In order to evaluate motion performance, the following many programs are used.
- Box pattern - from short pitch to long pitch
- Actual programs used by customers

1) Box pattern



2) Actual programs used by customers

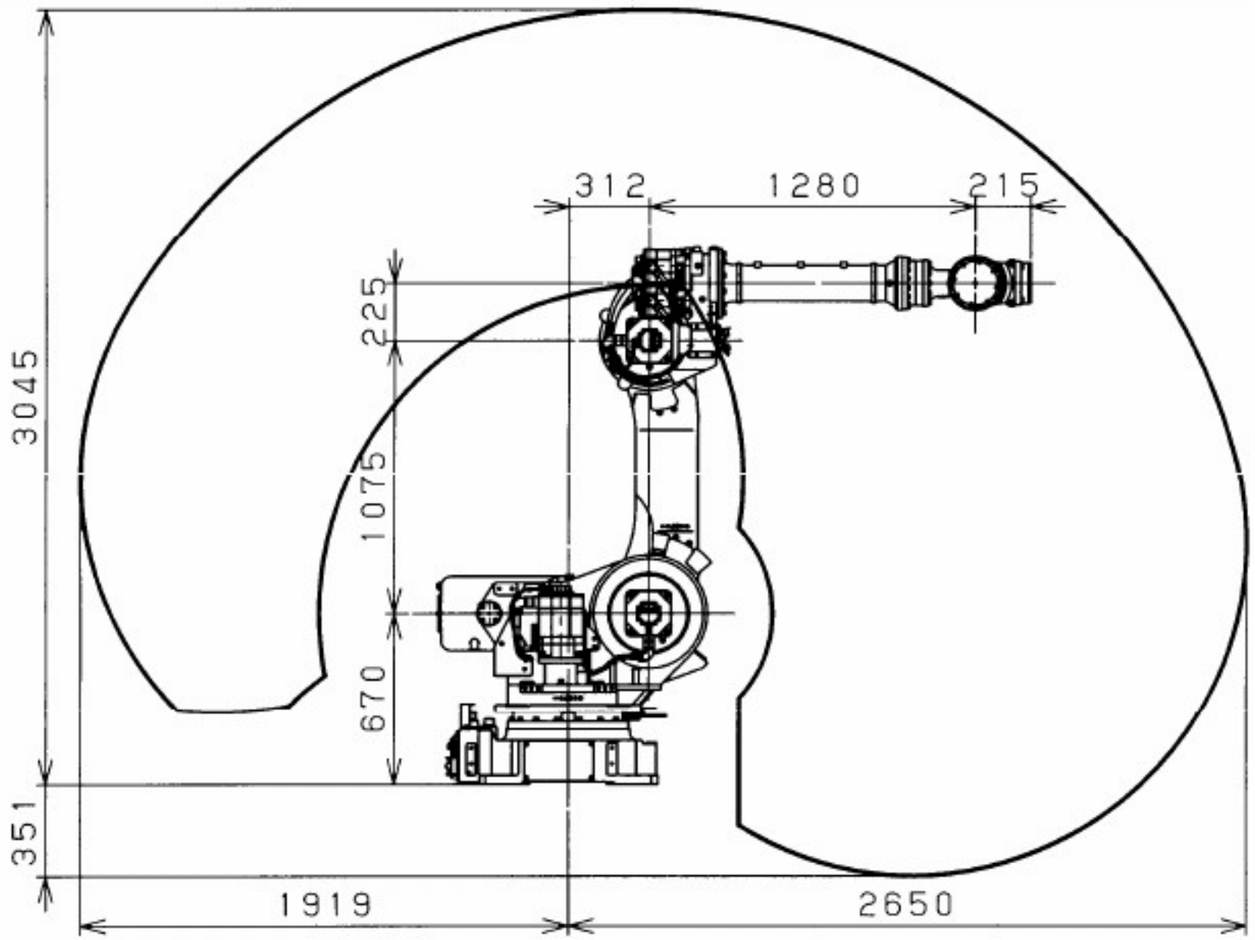
Programs with servo weld gun

	Cycle Time [sec]		Improve-ment
	S-430iW	R-2000iA/165F	
No.1	29.3	23.1	-21%
No.2	18.0	13.4	-26%
No.3	25.0	22.0	-12%
No.4	25.8	21.7	-16%
	Average Improvement		-19%

Programs without servo weld gun

	Cycle Time [sec]		Improve-ment
	S-430iW	R-2000iA/165F	
No.1	25.8	24.7	-4.2%
No.2	21.9	21.7	-1.2%
No.3	19.3	17.3	-10.5%
No.4	22.9	22.6	-1.5%
No.5	18.1	15.8	-13.1%
No.6	29.2	28.8	-1.5%
No.7	14.5	14.1	-2.5%
No.8	17.5	17.6	0.6%
	Average Improvement		-4.2%

Outer view and Specification (R-2000*i*A/165F)

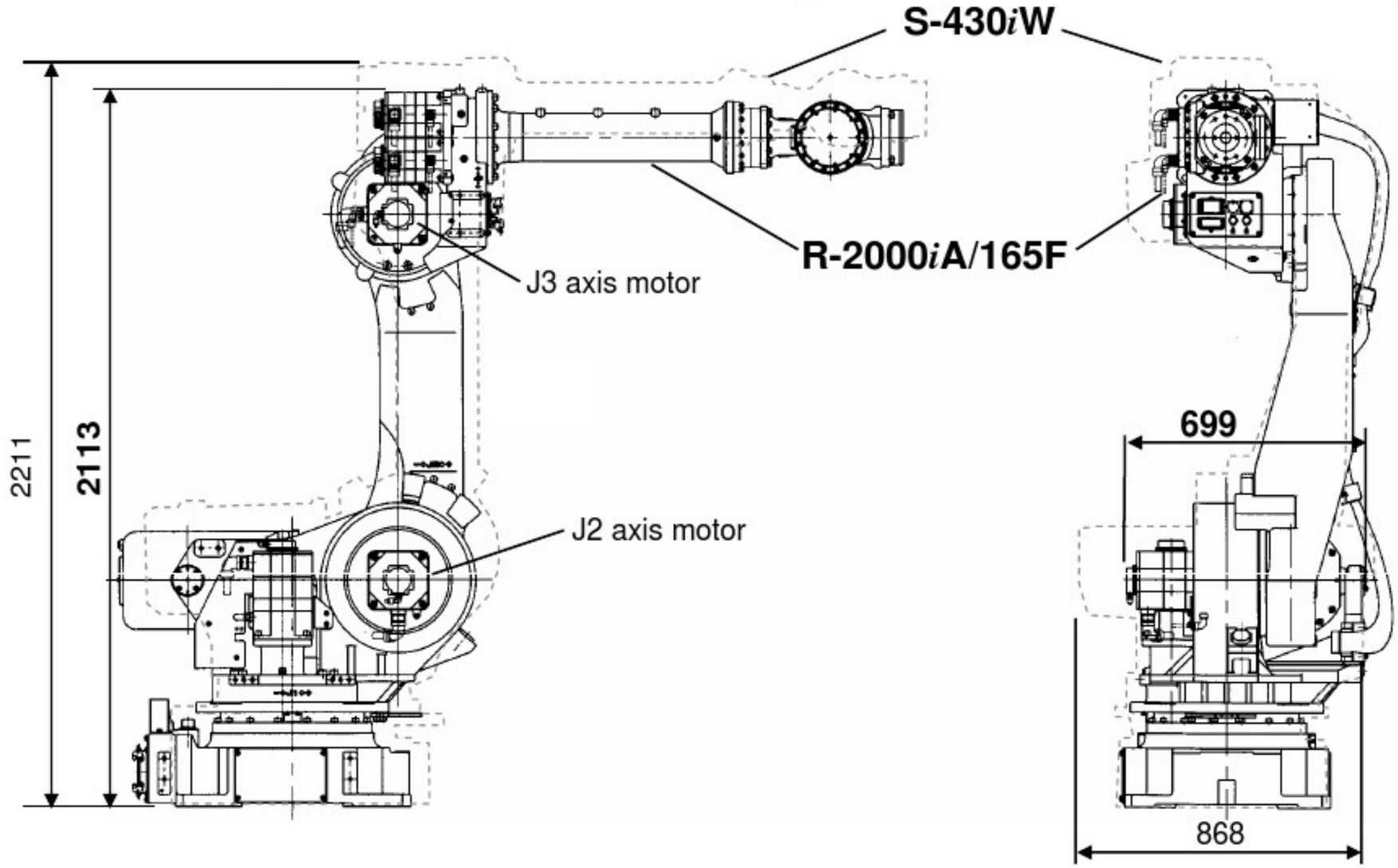


Payload at wrist		165 kg
Reach		2650mm
Maximum speed	J1	105 deg/sec
	J2	105 deg/sec
	J3	105 deg/sec
	J4	130 deg/sec
	J5	130 deg/sec
	J6	210 deg/sec
Allowable load moment at wrist	J4	921 Nm
	J5	921 Nm
	J6	461 Nm
Allowable load inertia at wrist	J4	78.4 kgm^2
	J5	78.4 kgm^2
	J6	40.2 kgm^2
Repeatability		±0.3mm

Note) All specifications are subject to change without notice.

Compact Mechanical Unit(1)

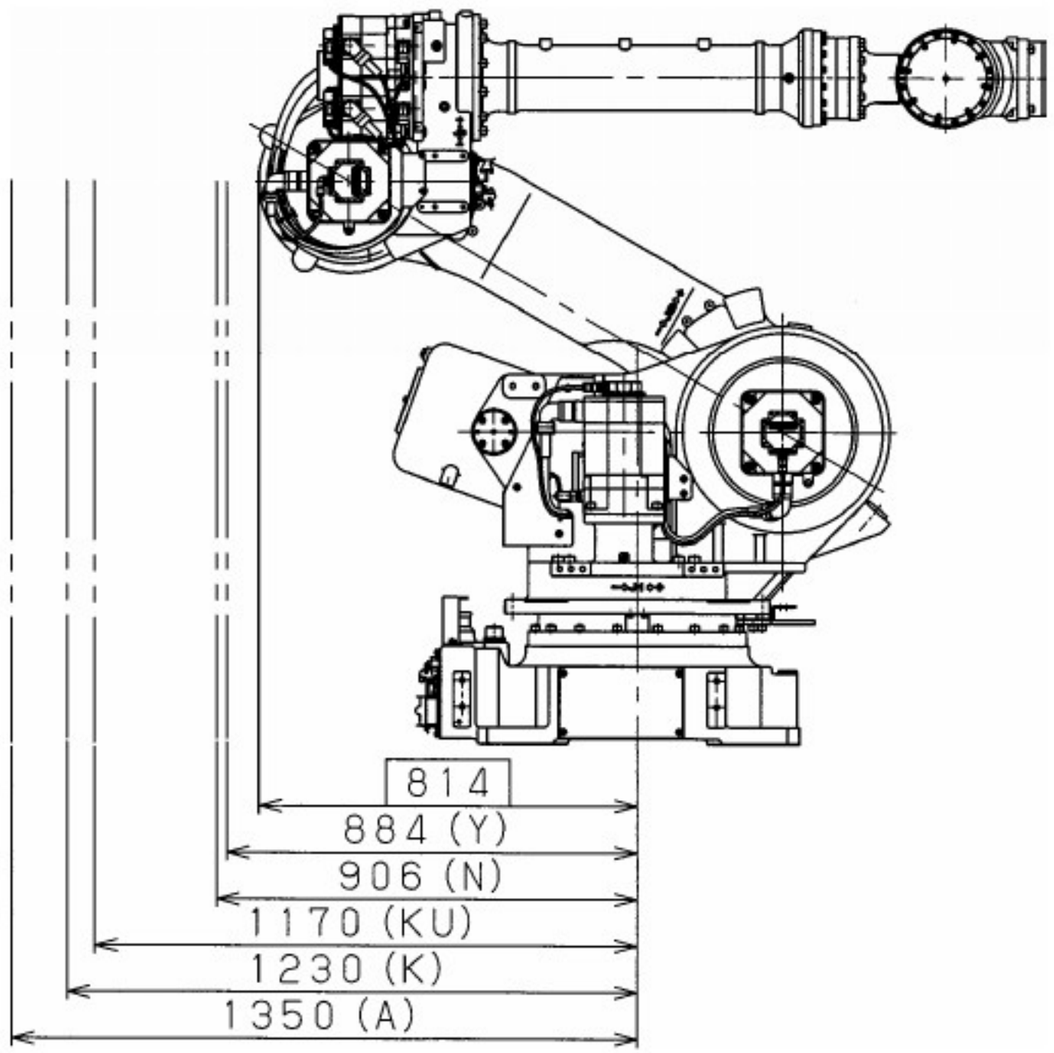
- Total height is reduced 98mm still maintaining a motion range equivalent to the S-430*i*. This reduction enables mounting in low ceiling places.
- Thanks to the newly developed small size motor, the projection of J2 and J3 axis motor is reduced, and then total width of the robot is reduced 158mm. This enables high density installation of the robots and peripherals.



Note) All specifications are subject to change without notice.

Compact Mechanical Unit(3)

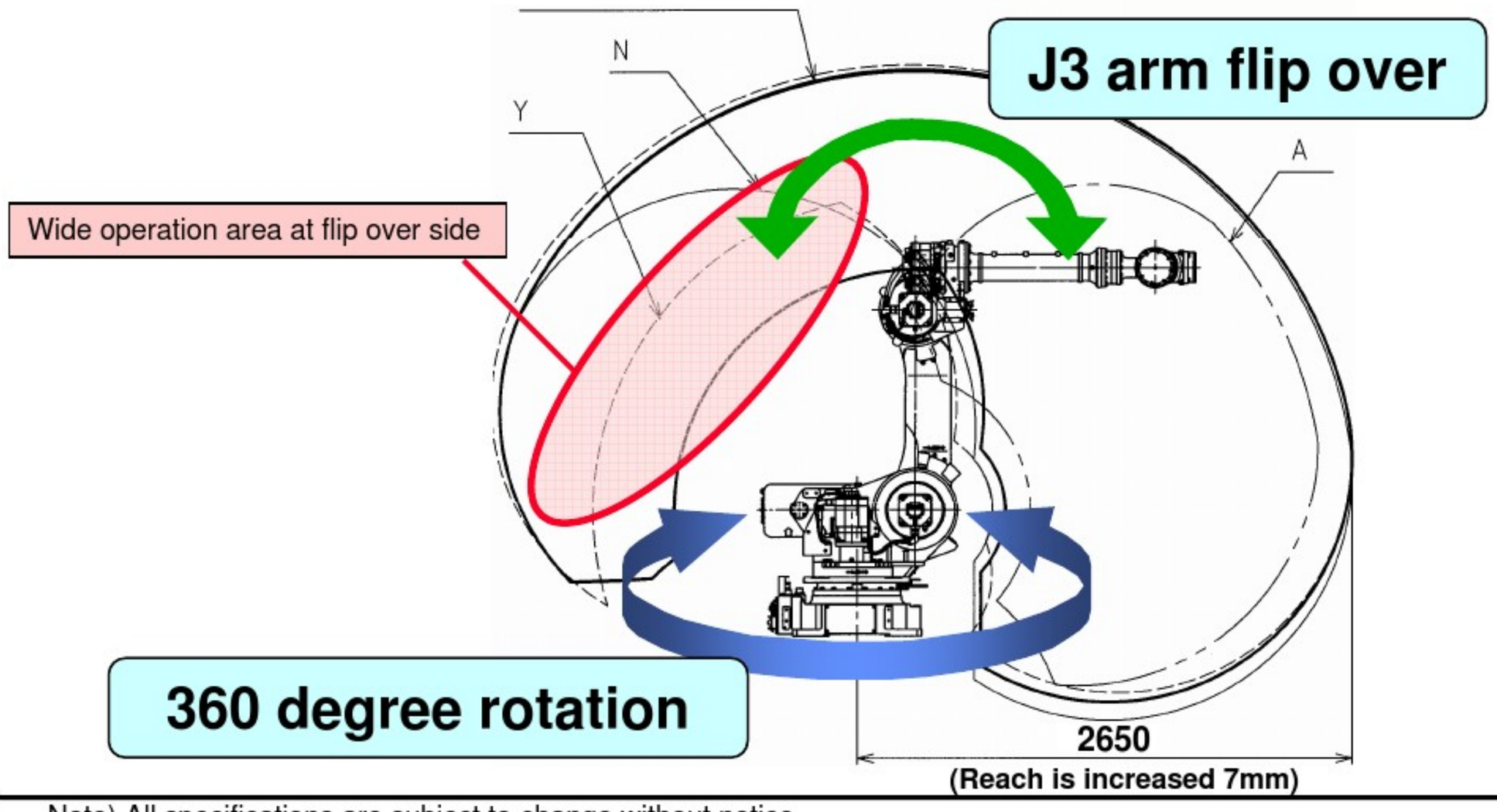
- Simple direct drive mechanism reduces rear side projection at robot escape position. Line width can be reduced and floor space is used effectively.



Excellent Performance and Function(1)

- As maximum reach is extended 7mm, wider operating area can be covered.
- Flip over mechanism as the standard and 360 degree rotation axis enables operation to all directions.

R-2000*i*A/165F

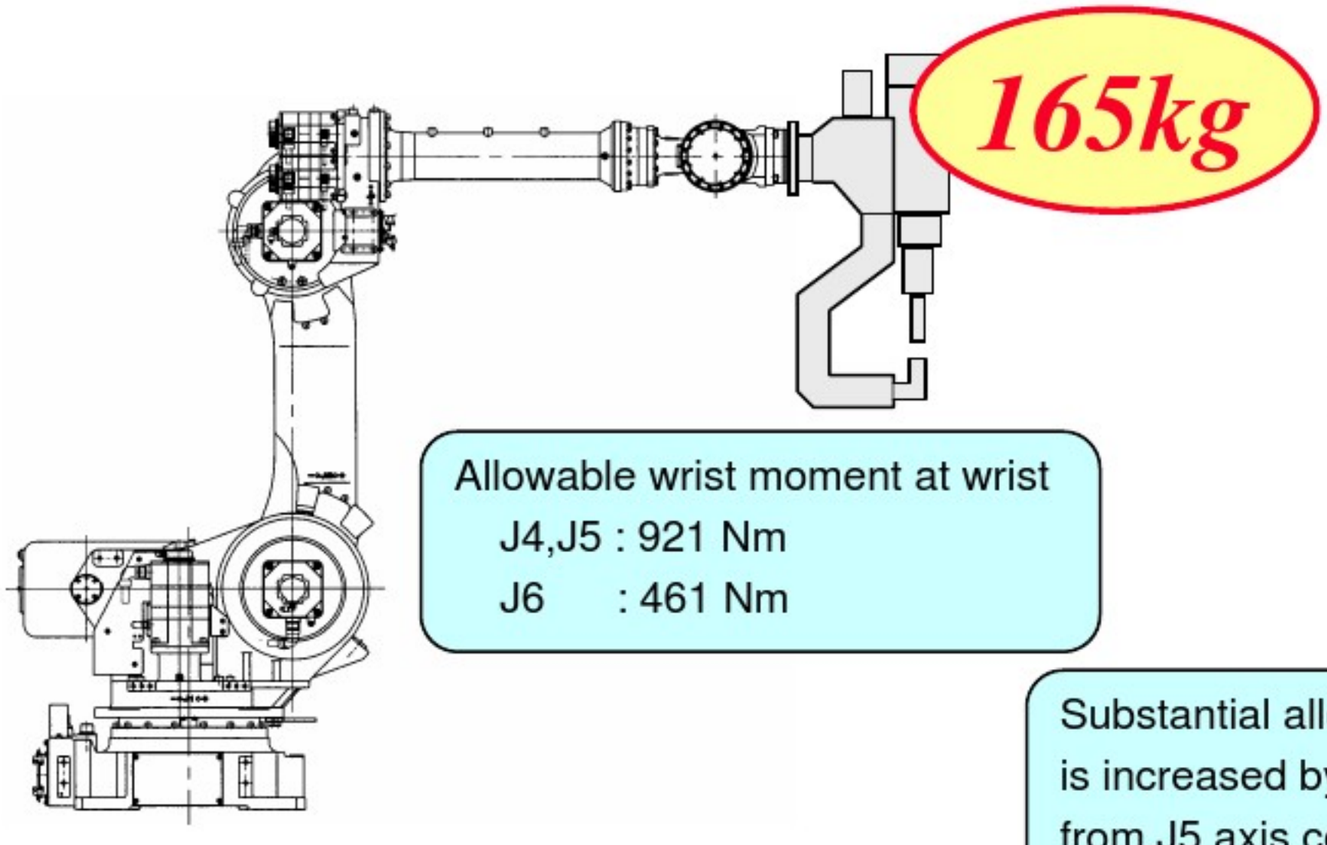


Note) All specifications are subject to change without notice.

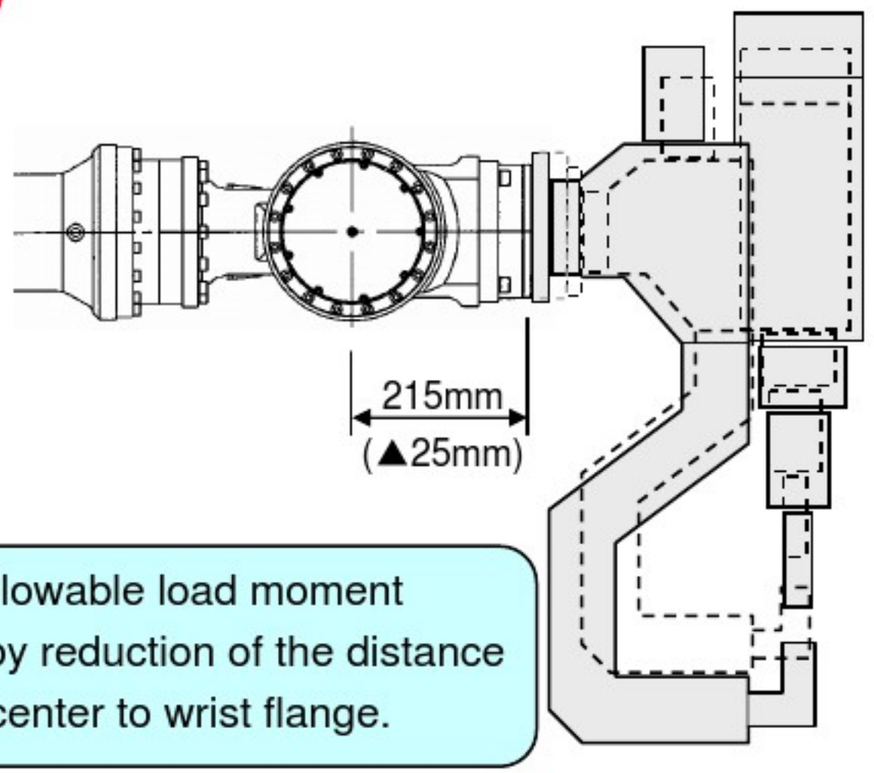
Excellent Performance and Function(2)

- Payload at wrist is 165kg as standard, and allowable load moment at wrist is increased. It is easily applied spot welding with large size gun or handling of heavy workpiece.
- The distance from J5 axis center to wrist flange is reduced 25mm.(ISO flange)

  This reduction increases the substantial allowable load moment at wrist.



Allowable wrist moment at wrist
J4,J5 : 921 Nm
J6 : 461 Nm



Substantial allowable load moment
is increased by reduction of the distance
from J5 axis center to wrist flange.

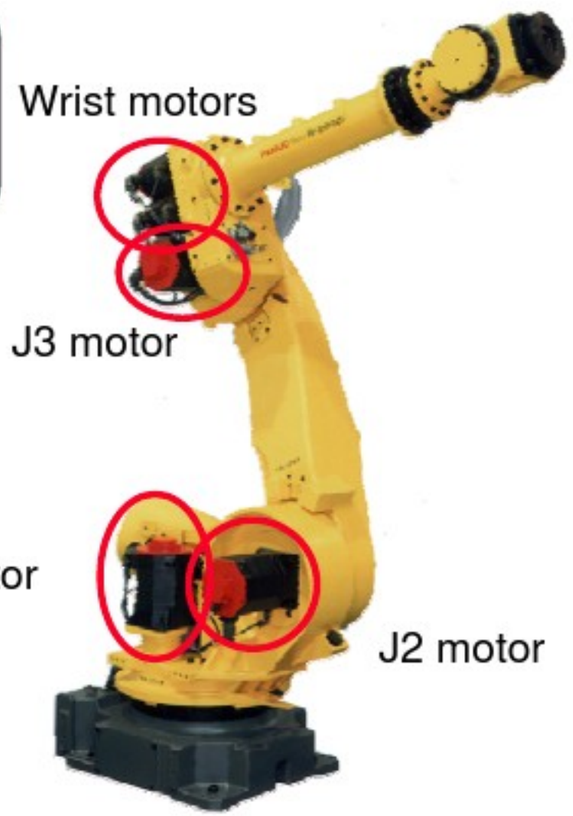
Improvement of Maintainability

- Every 6 months greasing points are eliminated and minimum maintenance period is extended to 1 year.
- As all motors and pulsecoders are faced to outside, replacement of these elements is easy.
- New pulsecoder mechanism enables automatic uniting with temperature detecting device which is wired so far. This can reduce replacing time of pulsecoder.
- As the mechanical unit cable is routed along with the outside of the J2 arm, it is easy to replace.

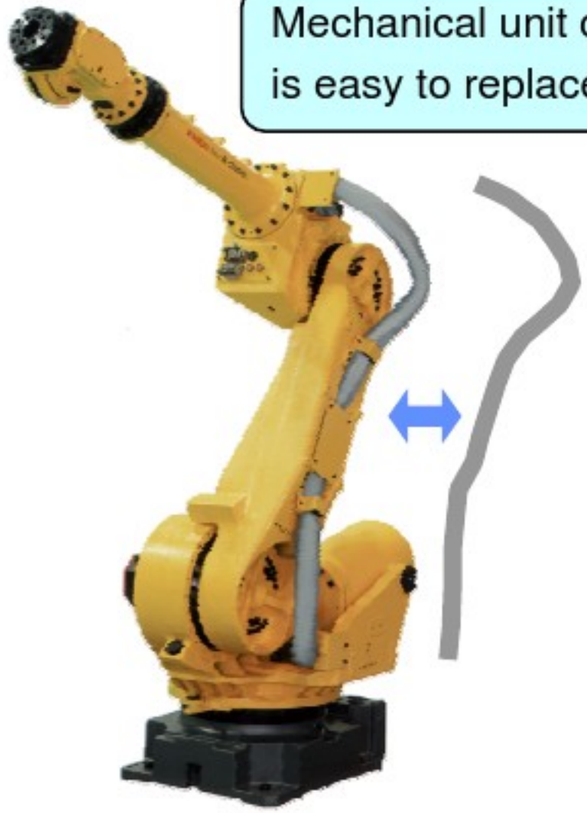
Minimum maintenance period

6 months → **1 year**

All motors and pulsecoders are faced to out side. Replacement of these elements is easy.



Mechanical unit cable is easy to replace

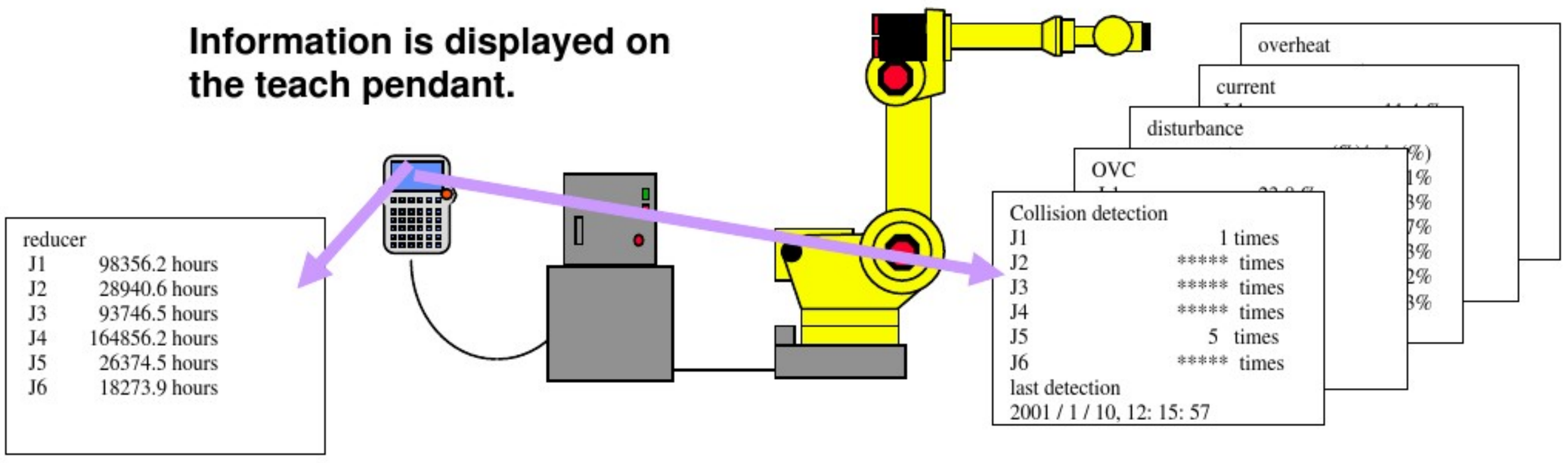


SERVO DIAGNOSIS

• SERVO DIAGNOSIS displays the information useful to maintain robots.

- It calculates the recommended reducer overhaul time
- It displays the percentage of margin of alarms(overheat, OVC etc.) with present duty useful to evaluate the propriety of the duty
- It keeps the history of collision detection useful to maintain the robot

Information is displayed on the teach pendant.



Reducer overhaul time calculated from torque and current

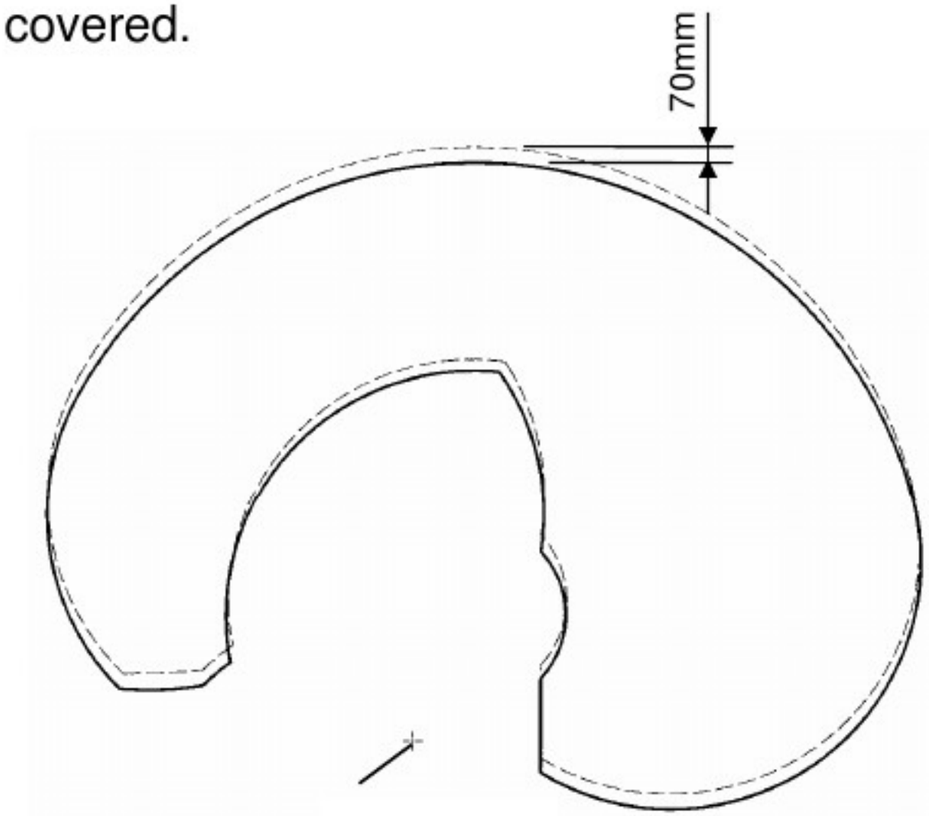
Margin of alarms
History of collision detection

Various Models and Options

- Various models are prepared. Customers can choose the most suitable model according to their use.
  - Floor mount 165kg payload type
  - Floor mount 200kg payload type
  - Long arm 125kg payload type
  - Rack mount 165kg payload type
  - Rack mount 200kg payload type
  - Compact 165kg payload type
- By using various options, robot will become more convenient and can be used for wider application.
  - Spot welding dressout package
  - Severe dust / liquid protection option
  - Mechanical unit option cable（signal,power,DeviceNet,etc.）
  - Servo weld gun cable（inside of the mechanical unit - J3 casing - servo weld gun）
  - Over travel switch（J1-J3 axis）
  - Stopper for motion range restriction
  - Insulated wrist flange(ISO）
  - Brake release unit

Replacement from S-430*i*

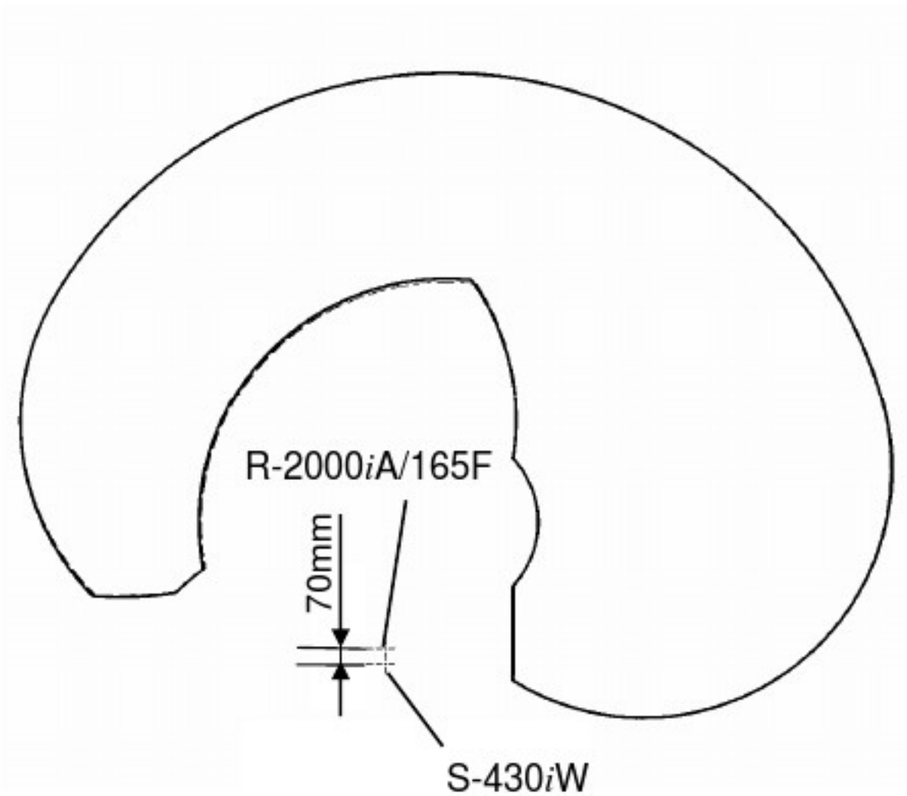
- In case of replacement from S-430*i*W to R-2000*i*A/165F , almost operation space can be covered even installed at the same position.
- Further more, if R-2000*i*A/165F is installed 70mm rise, almost entire operation space can be covered.



J1 axis rotation center(S-430*i*W, R-2000*i*A/165F)

Operation space(1)

In case of same position

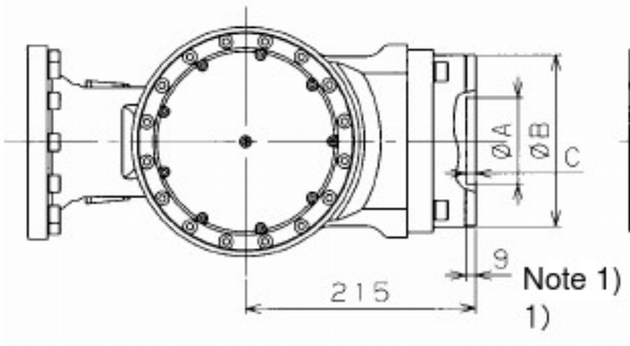


Operation space(2)

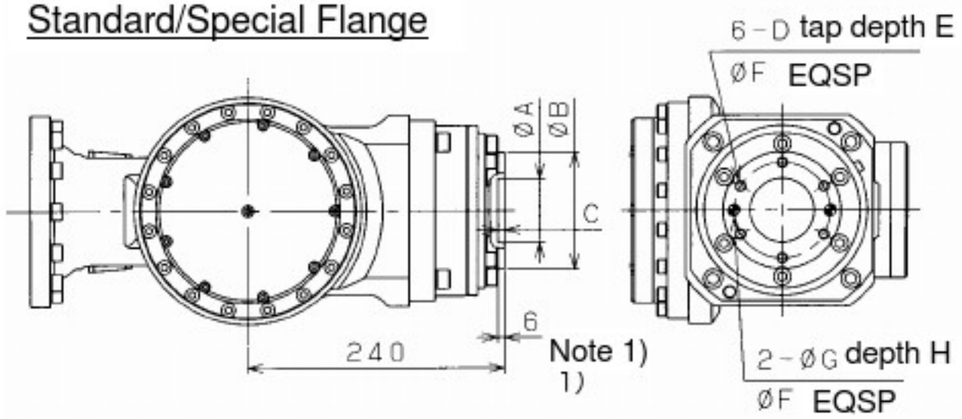
In case of 70mm rise

Wrist Flange Interface(R-2000*i*A/165F)

ISO Flange



Standard/Special Flange

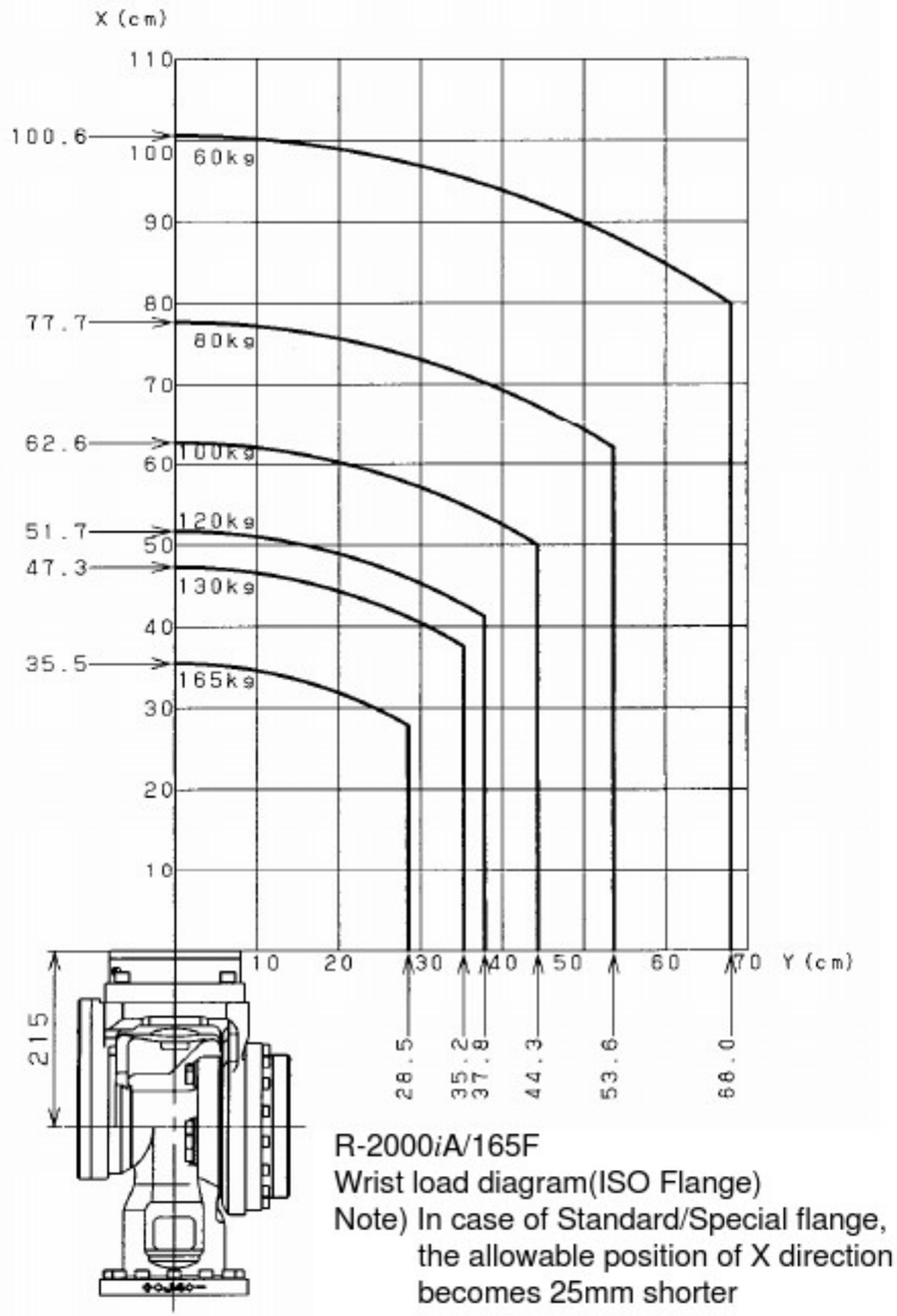


ISO Flange	Standard Flange	Special Flange
A Ø80H7 $^{+0.035}_{0}$	A Ø60H7 $^{+0.030}_{0}$	A Ø76G7 $^{+0.040}_{+0.010}$
B Ø160h8 $^{0}_{-0.063}$	B Ø110h7 $^{0}_{-0.035}$	B Ø108f8 $^{-0.036}_{-0.090}$
C 9	C 6	C 10
D M10	D M10	D M10
E DP16 Note 2)	E DP16 Note 2)	E DP16 Note 2)
F Ø125 2)	F Ø90 2)	F Ø92 2)
G Ø10H7 $^{+0.015}_{0}$	G Ø10H7 $^{+0.015}_{0}$	G Ø9H7 $^{+0.015}_{0}$
H DP12 Note 2)	H DP12 Note 2)	H DP12 Note 2)
(Based on ISO 9409-1-A125)	2)	2)

Note 1) The length of fitting(outside) is 1-4 mm shorter than S-430i.

Note 2) The depth of tap/pin holes is 4mm/8mm shallower than S-430i.

Wrist Load Diagram(R-2000*i*A/165F)

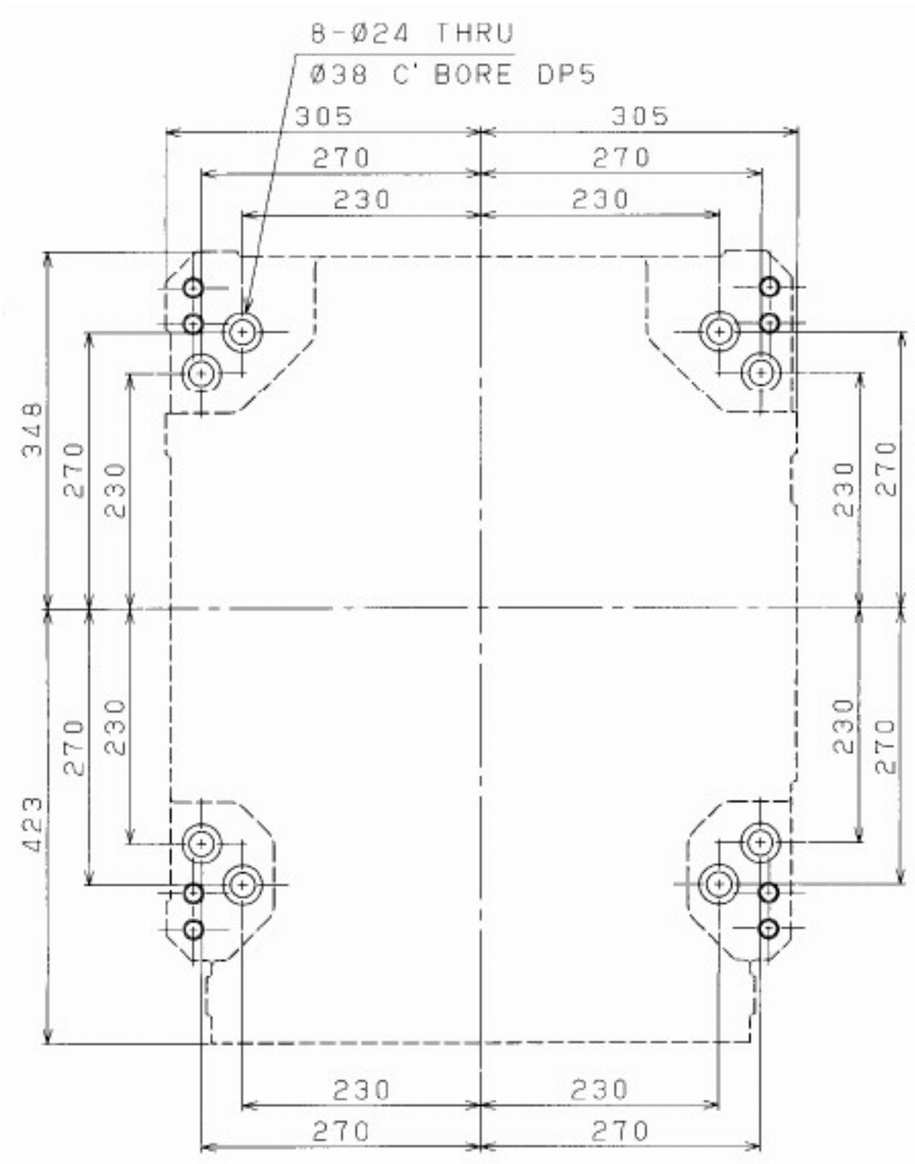


R-2000*i*A/165F
Wrist load diagram(ISO Flange)
Note) In case of Standard/Special flange, the allowable position of X direction becomes 25mm shorter

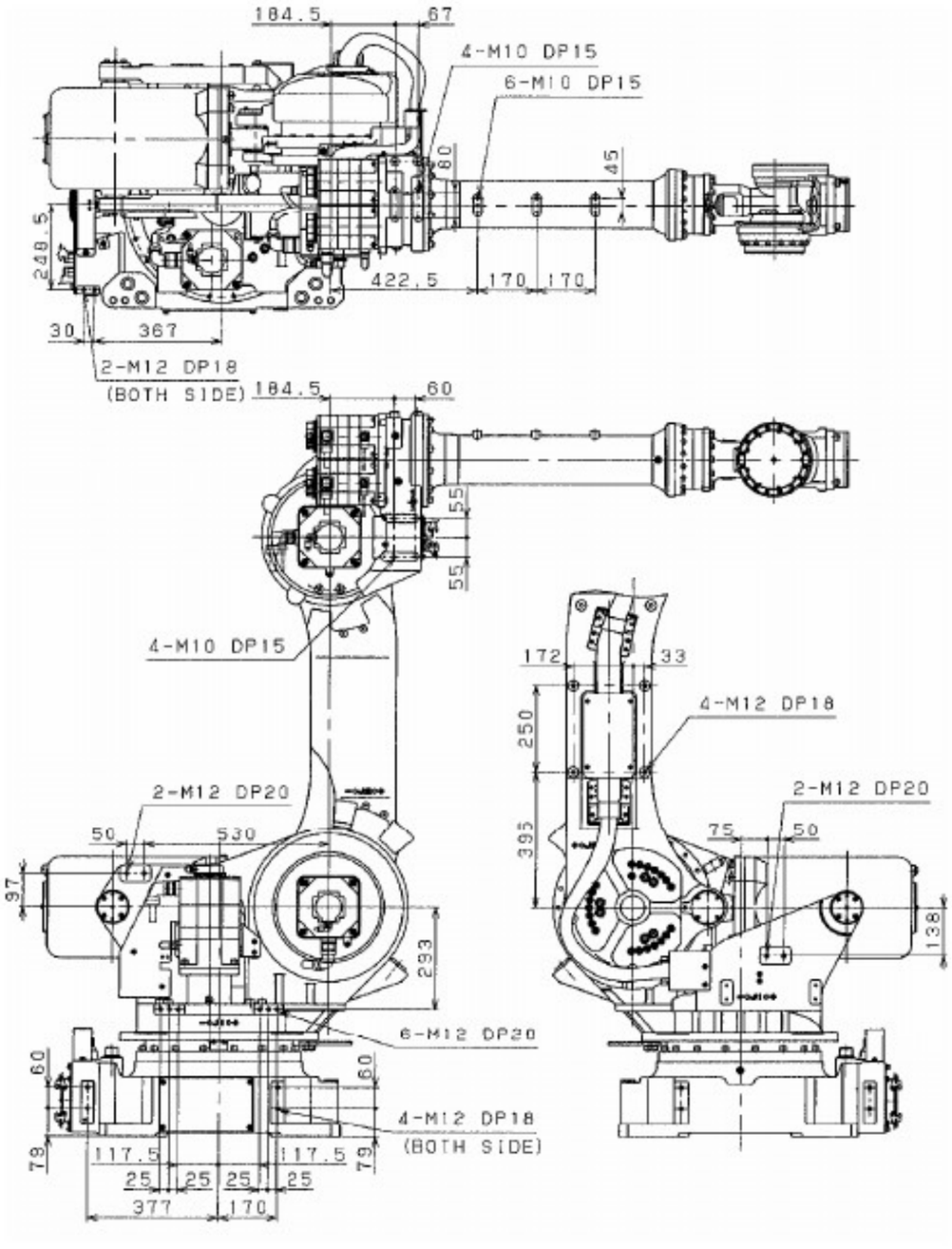
Note) All specifications are subject to change without notice.

Dimensions of the Robot Base

- Dimensions of the robot base is the same as S-430*i*

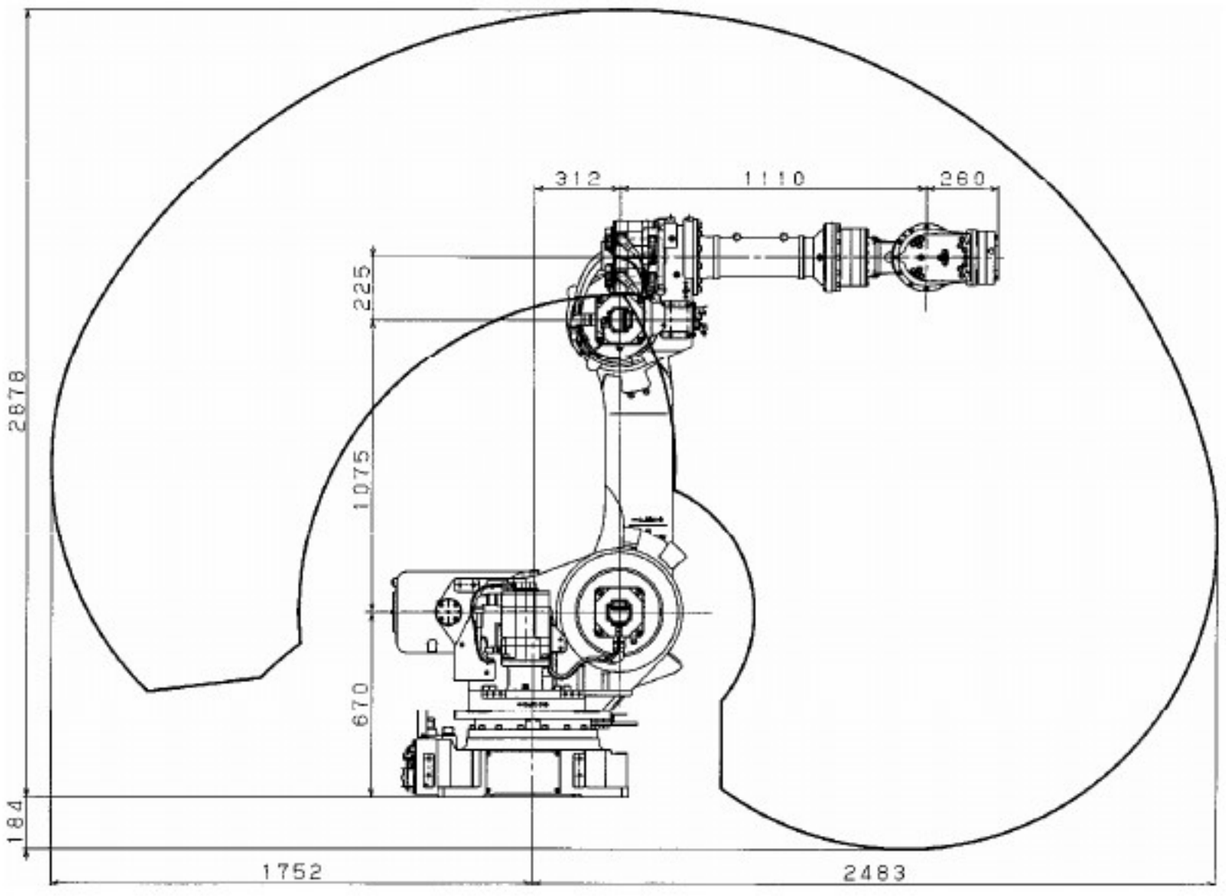


Equipment Mounting Surface(R-2000*i*A/165F)



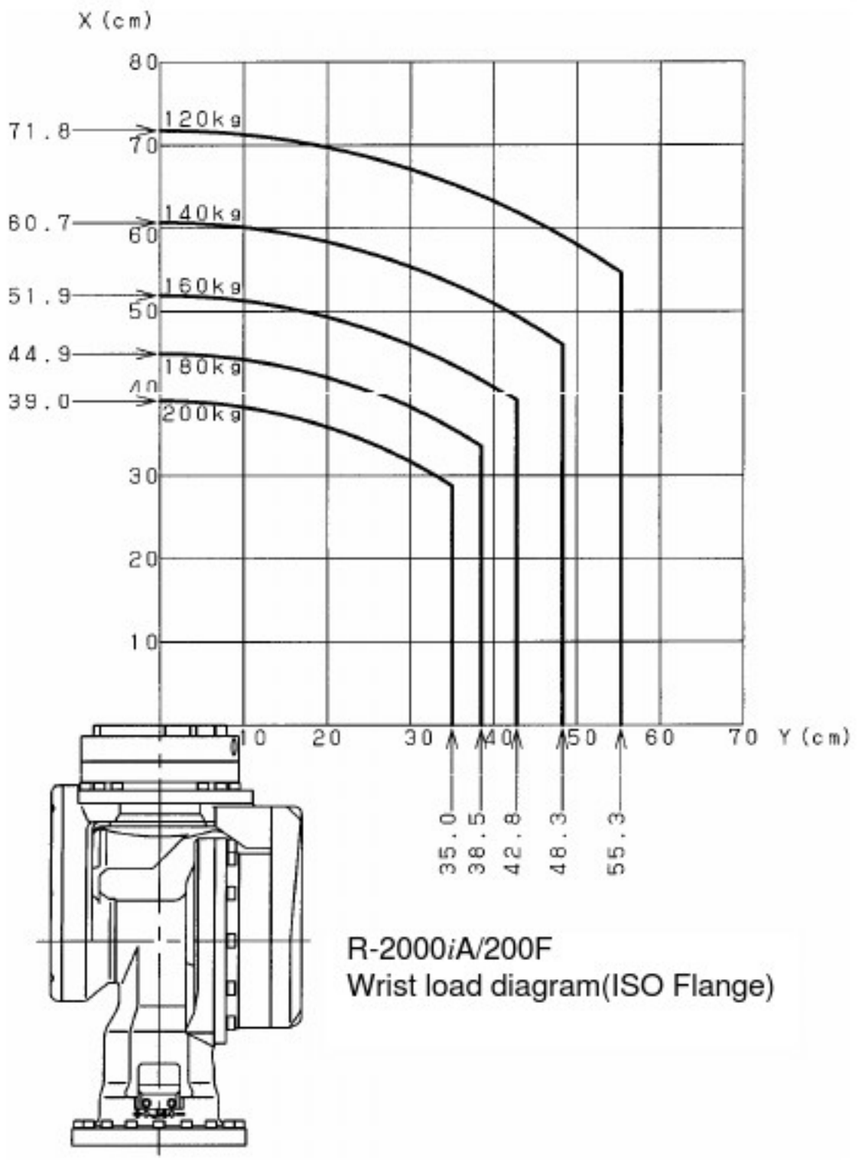
R-2000*i*A/200F specification

Maximum load capacity at wrist		200 kg
Maximum load capacity at J3 arm		25kg
Maximum load capacity at J2 base		550kg
Motion range (Maximum speed)	J1 axis	360 deg (90 deg/s)
	J2 axis	135 deg (85 deg/s)
	J3 axis	367.4 deg (90 deg/s)
	J4 axis	720 deg (110 deg/s)
	J5 axis	250 deg (110 deg/s)
	J6 axis	720 deg (155 deg/s)
Allowable load moment at wrist	J4 axis	1274 Nm
	J5 axis	1274 Nm
	J6 axis	686 Nm
Allowable load inertia at wrist	J4 axis	117.6 kgm^2
	J5 axis	117.6 kgm^2
	J6 axis	58.8 kgm^2
Repeatability		+/-0.3 mm
Mass		1,240 kg



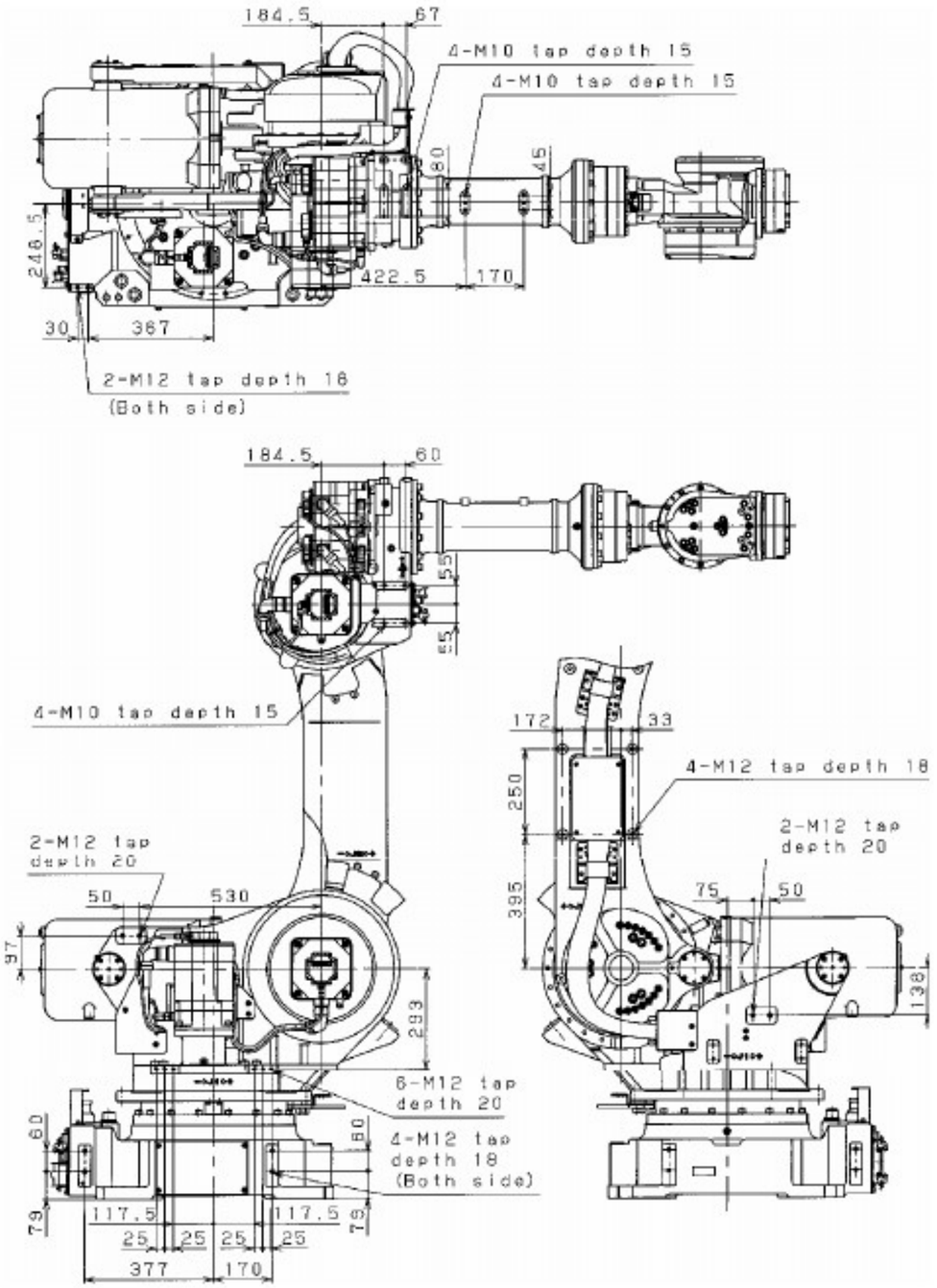
Note) All specifications are subject to change without notice.

R-2000*i*A/200F wrist load conditions



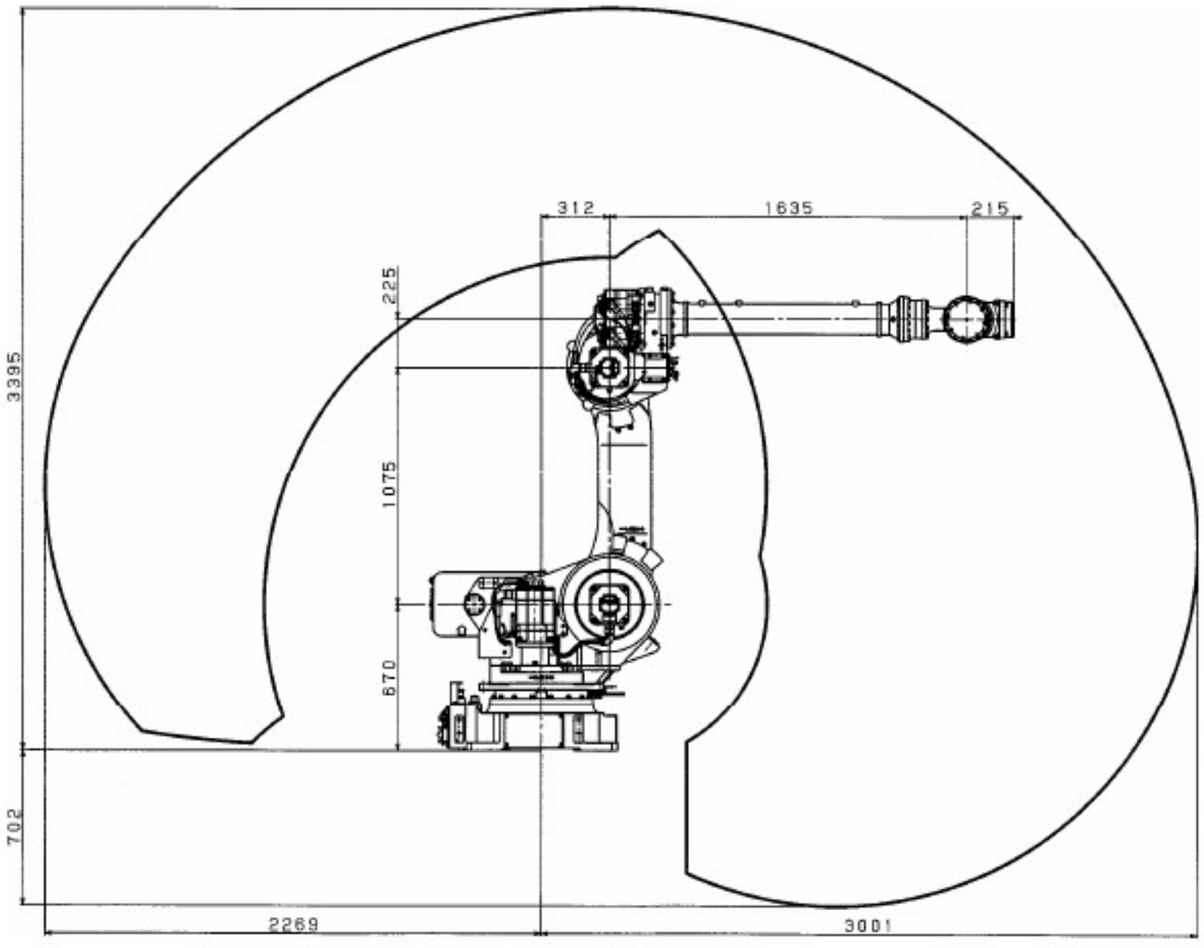
R-2000*i*A/200F
Wrist load diagram(ISO Flange)

R-2000*i*A/200F equipment mounting surfaces



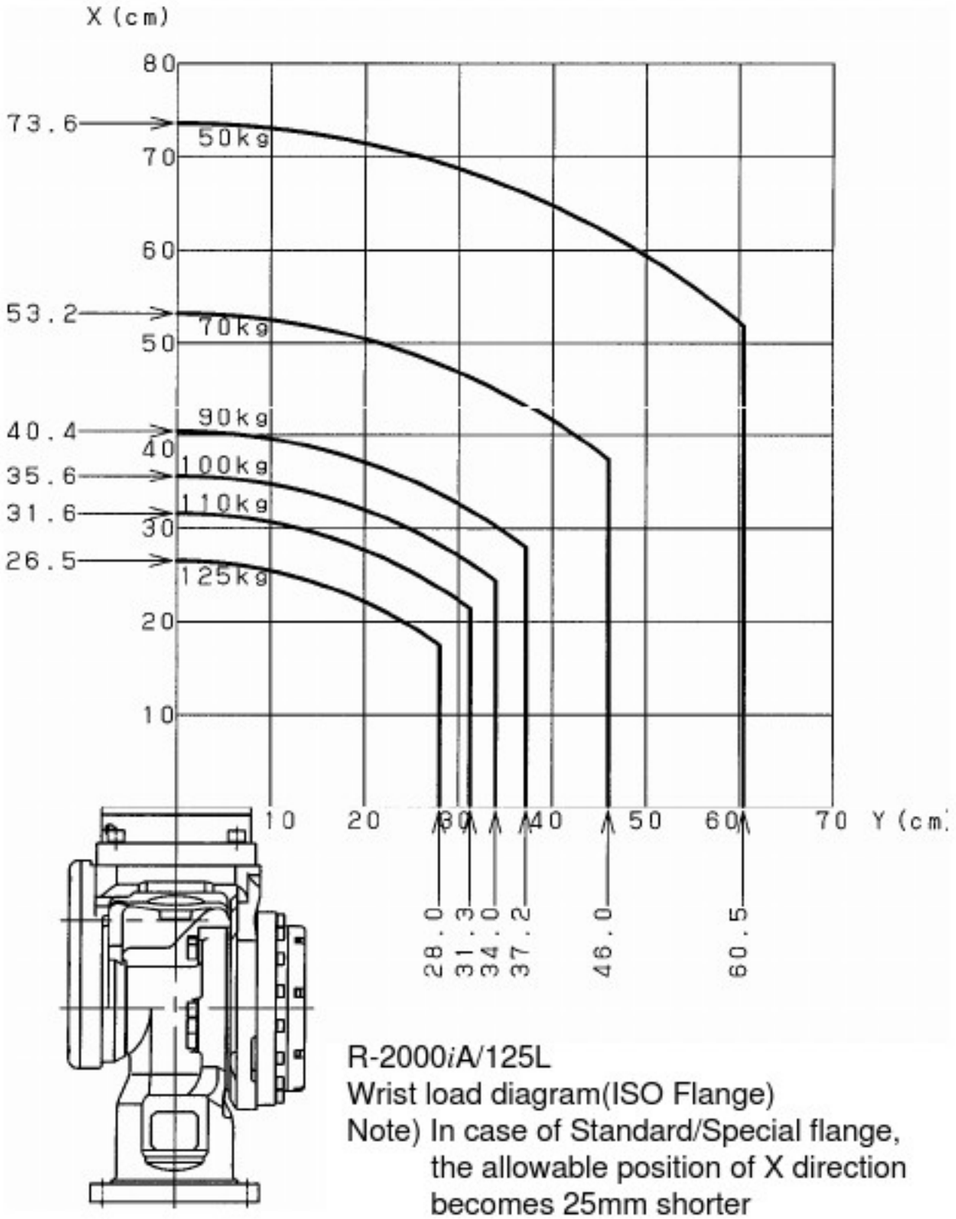
R-2000*i*A/125L specification

Maximum load capacity at wrist		125 kg
Maximum load capacity at J3 arm		20 kg
Maximum load capacity at J2 base		550 kg
Motion range (Maximum speed)	J1 axis	360 deg (105 deg/s)
	J2 axis	135 deg (105 deg/s)
	J3 axis	352.4 deg (105 deg/s)
	J4 axis	720 deg (170 deg/s)
	J5 axis	250 deg (170 deg/s)
	J6 axis	720 deg (260 deg/s)
Allowable load moment at wrist	J4 axis	588 Nm
	J5 axis	588 Nm
	J6 axis	343 Nm
Allowable load inertia at wrist	J4 axis	58.8 kgm^2
	J5 axis	58.8 kgm^2
	J6 axis	22.5 kgm^2
Repeatability		+/-0.3 mm
Mass		1,230 kg



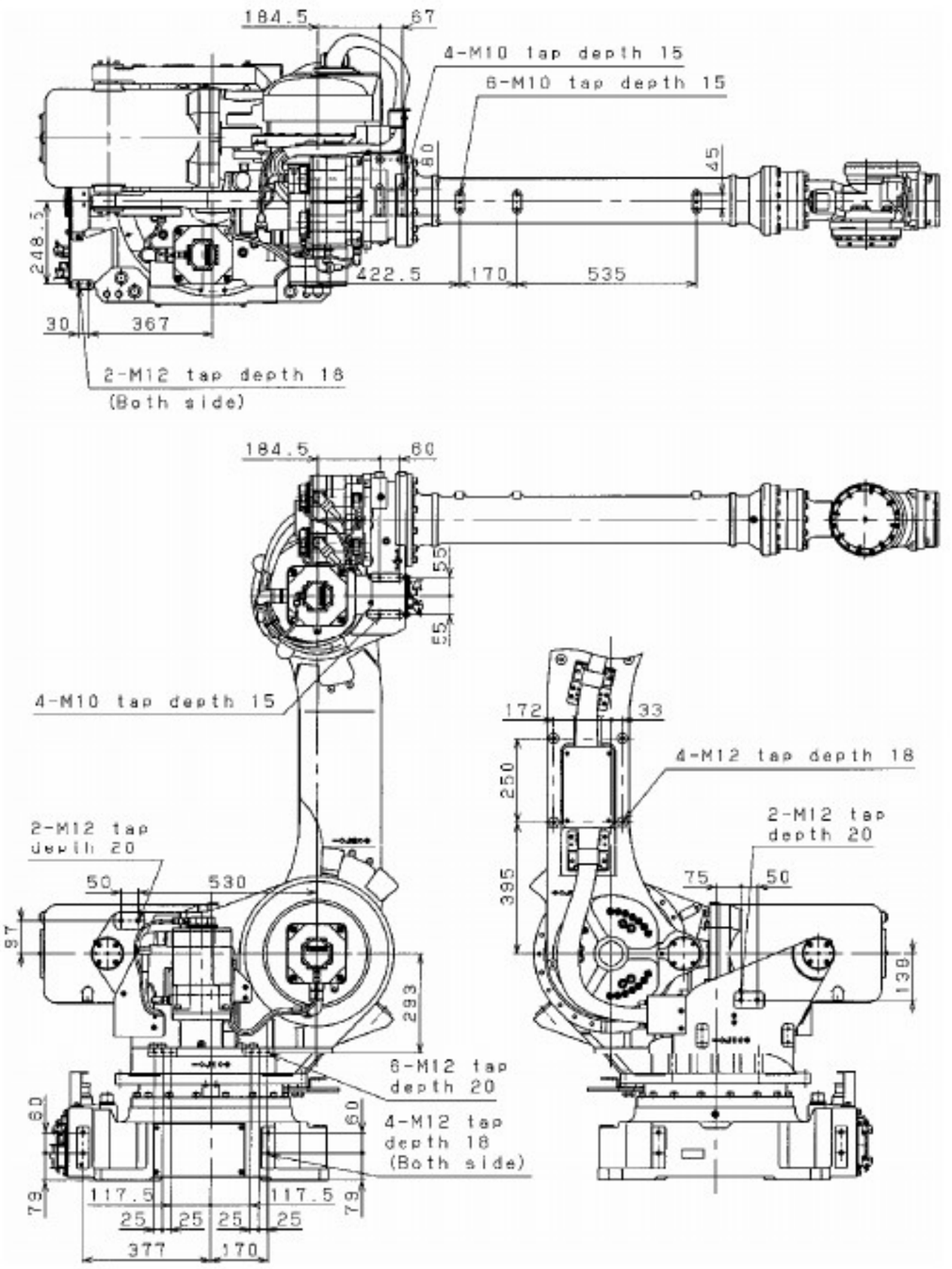
Note) All specifications are subject to change without notice.

R-2000*i*A/125L wrist load conditions



R-2000*i*A/125L
Wrist load diagram(ISO Flange)
Note) In case of Standard/Special flange,
the allowable position of X direction
becomes 25mm shorter

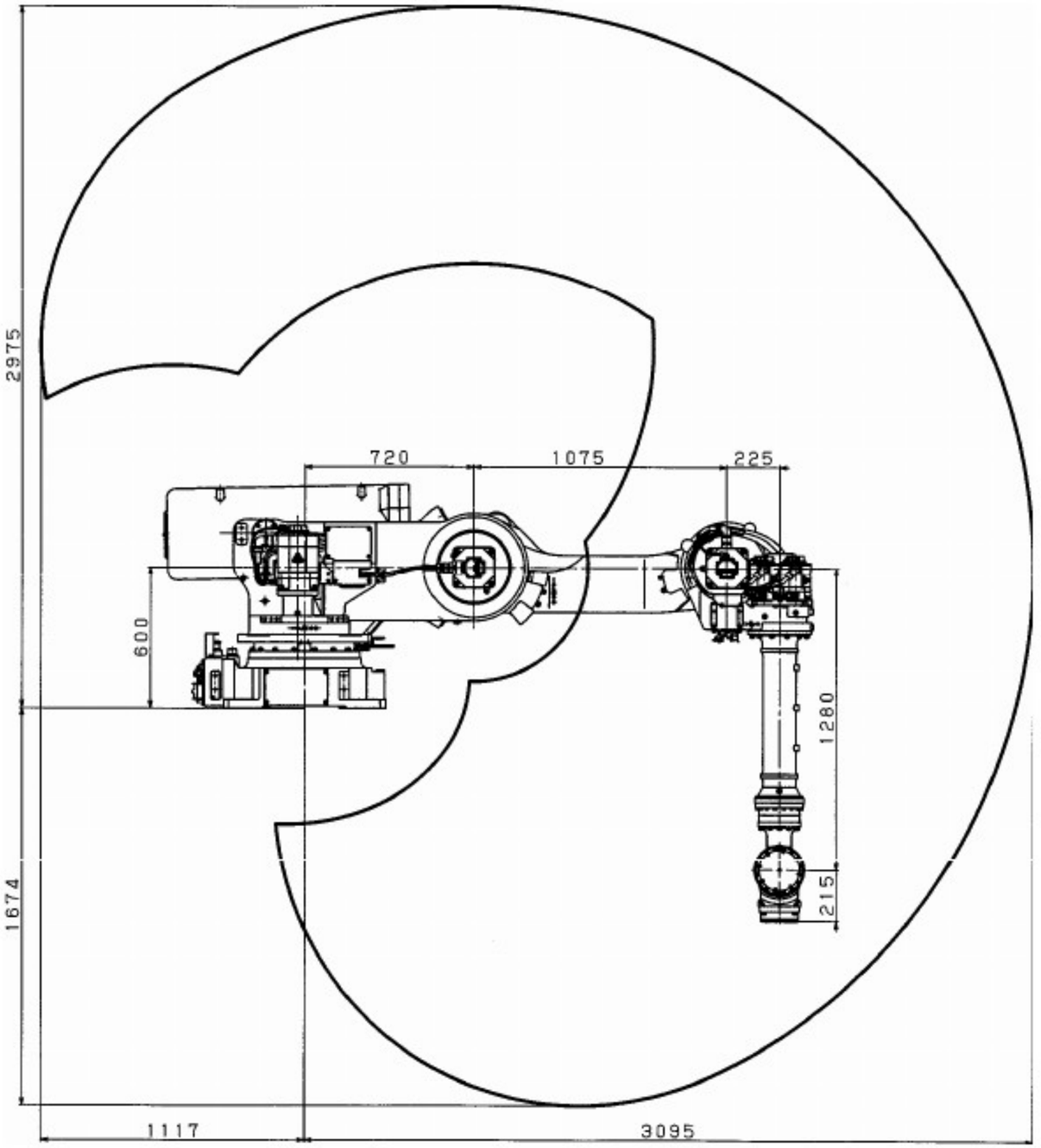
R-2000*i*A/125L equipment mounting surfaces



Note) All specifications are subject to change without notice.

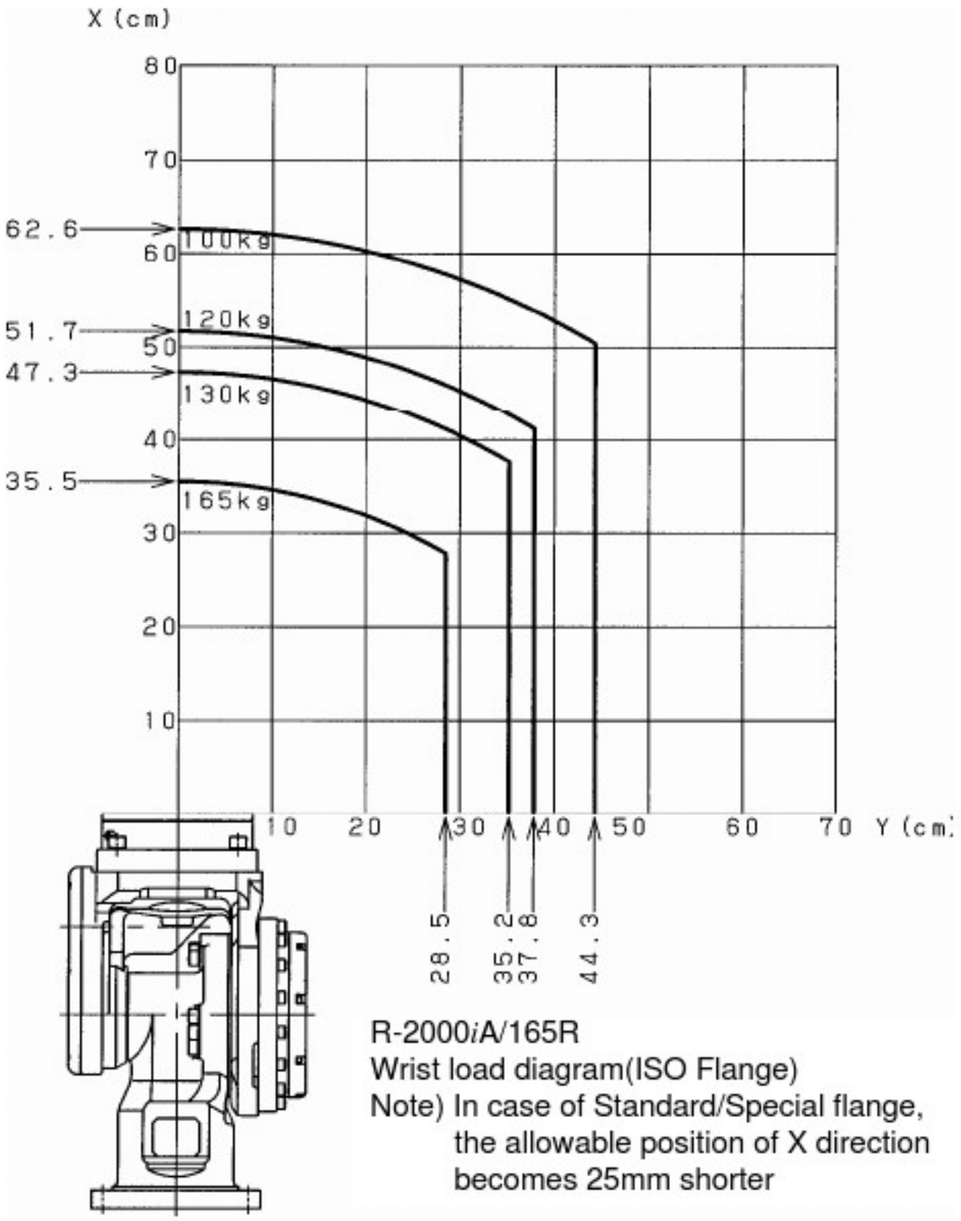
R-2000*i*A/165R specification

Maximum load capacity at wrist		165 kg
Maximum load capacity at J3 arm		25 kg
Maximum load capacity at J2 base		550 kg
Motion range (Maximum speed)	J1 axis	360 deg (105 deg/s)
	J2 axis	185 deg (90 deg/s)
	J3 axis	365 deg (105 deg/s)
	J4 axis	720 deg (130 deg/s)
	J5 axis	250 deg (130 deg/s)
	J6 axis	720 deg (210 deg/s)
Allowable load moment at wrist	J4 axis	921 Nm
	J5 axis	921 Nm
	J6 axis	461 Nm
Allowable load inertia at wrist	J4 axis	78.4 kgm^2
	J5 axis	78.4 kgm^2
	J6 axis	40.2 kgm^2
Repeatability		+/-0.3 mm
Mass		1,540 kg



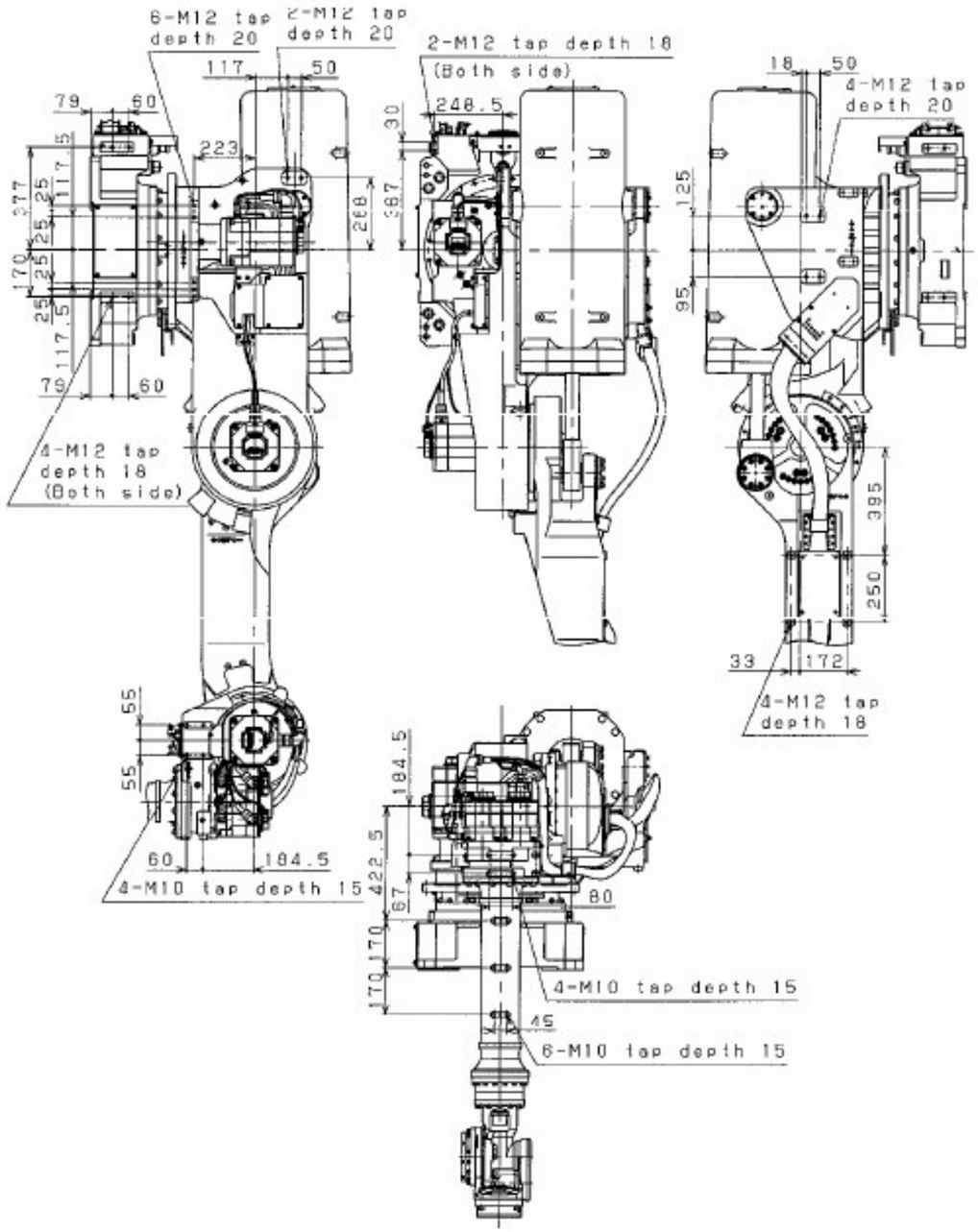
Note) All specifications are subject to change without notice.

R-2000*i*A/165R wrist load conditions



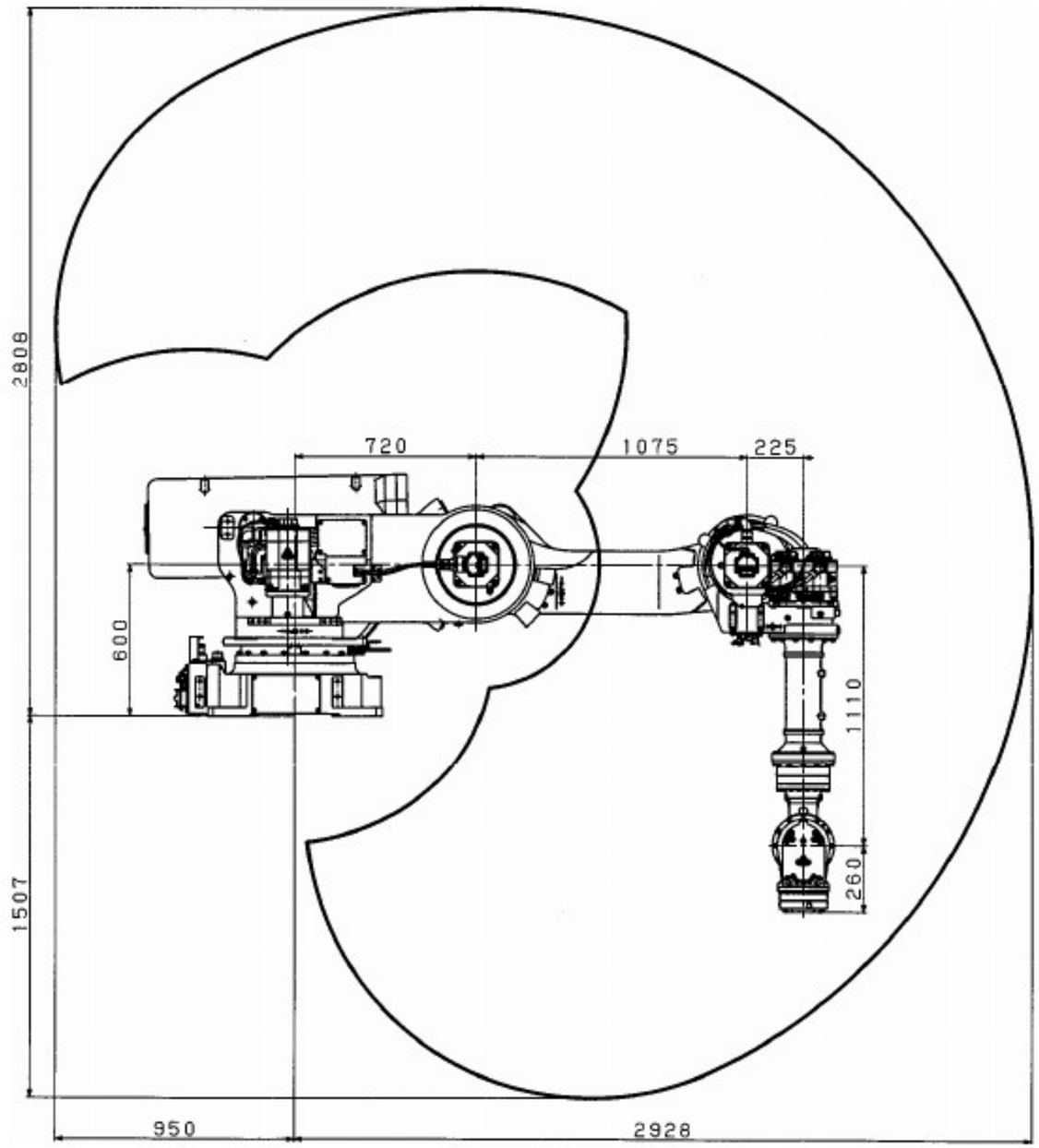
R-2000*i*A/165R
Wrist load diagram(ISO Flange)
Note) In case of Standard/Special flange, the allowable position of X direction becomes 25mm shorter

R-2000*i*A/165R equipment mounting surfaces



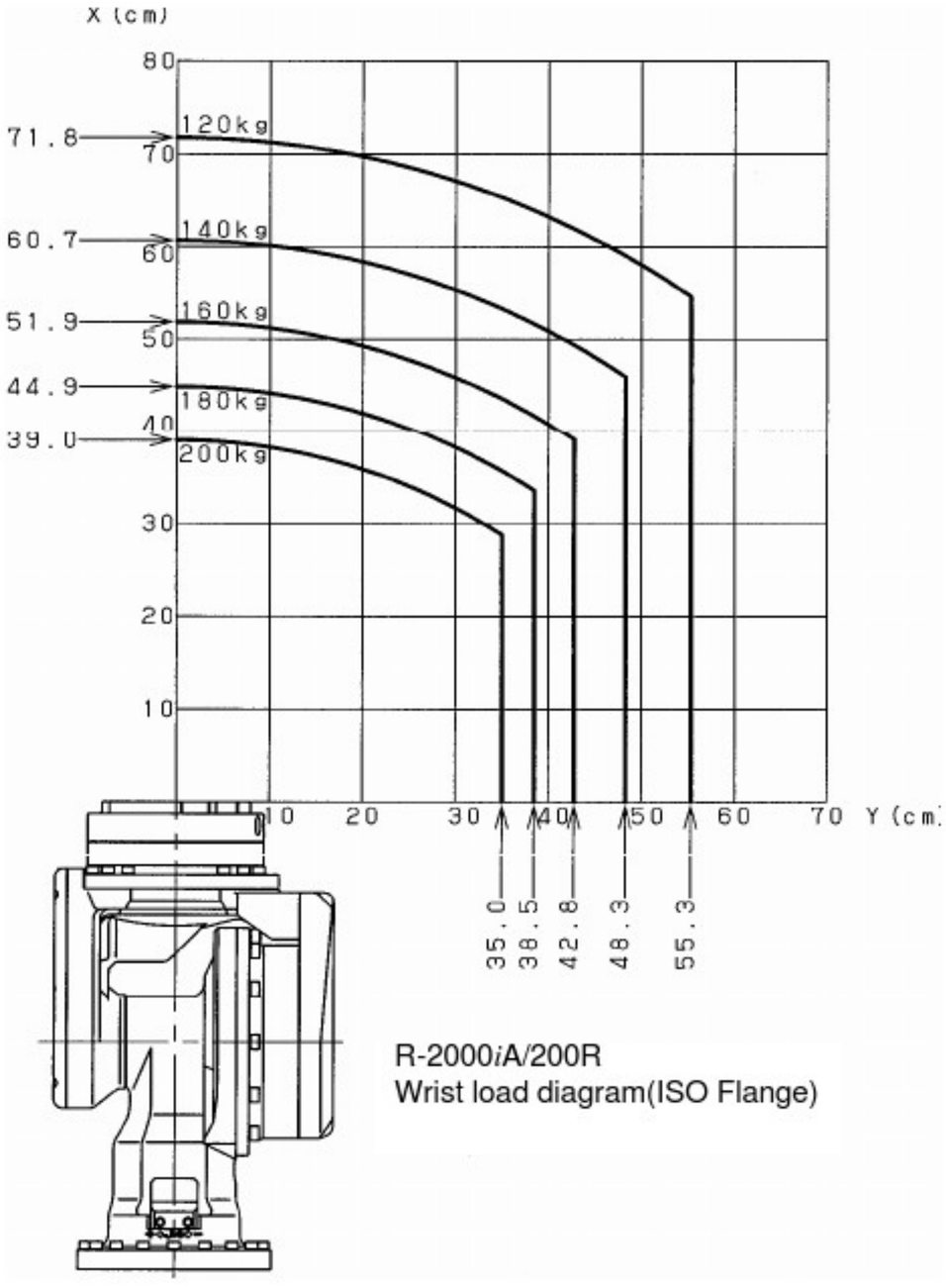
R-2000*i*A/200R specification

Maximum load capacity at wrist		200 kg
Maximum load capacity at J3 arm		0 kg
Maximum load capacity at J2 base		550 kg
Motion range (Maximum speed)	J1 axis	360 deg (90 deg/s)
	J2 axis	185 deg (85 deg/s)
	J3 axis	365 deg (90 deg/s)
	J4 axis	720 deg (110 deg/s)
	J5 axis	250 deg (110 deg/s)
	J6 axis	720 deg (155 deg/s)
Allowable load moment at wrist	J4 axis	1274 Nm
	J5 axis	1274 Nm
	J6 axis	686 Nm
Allowable load inertia at wrist	J4 axis	117.6 kgm^2
	J5 axis	117.6 kgm^2
	J6 axis	58.8 kgm^2
Repeatability		+/-0.3 mm
Mass		1,570 kg



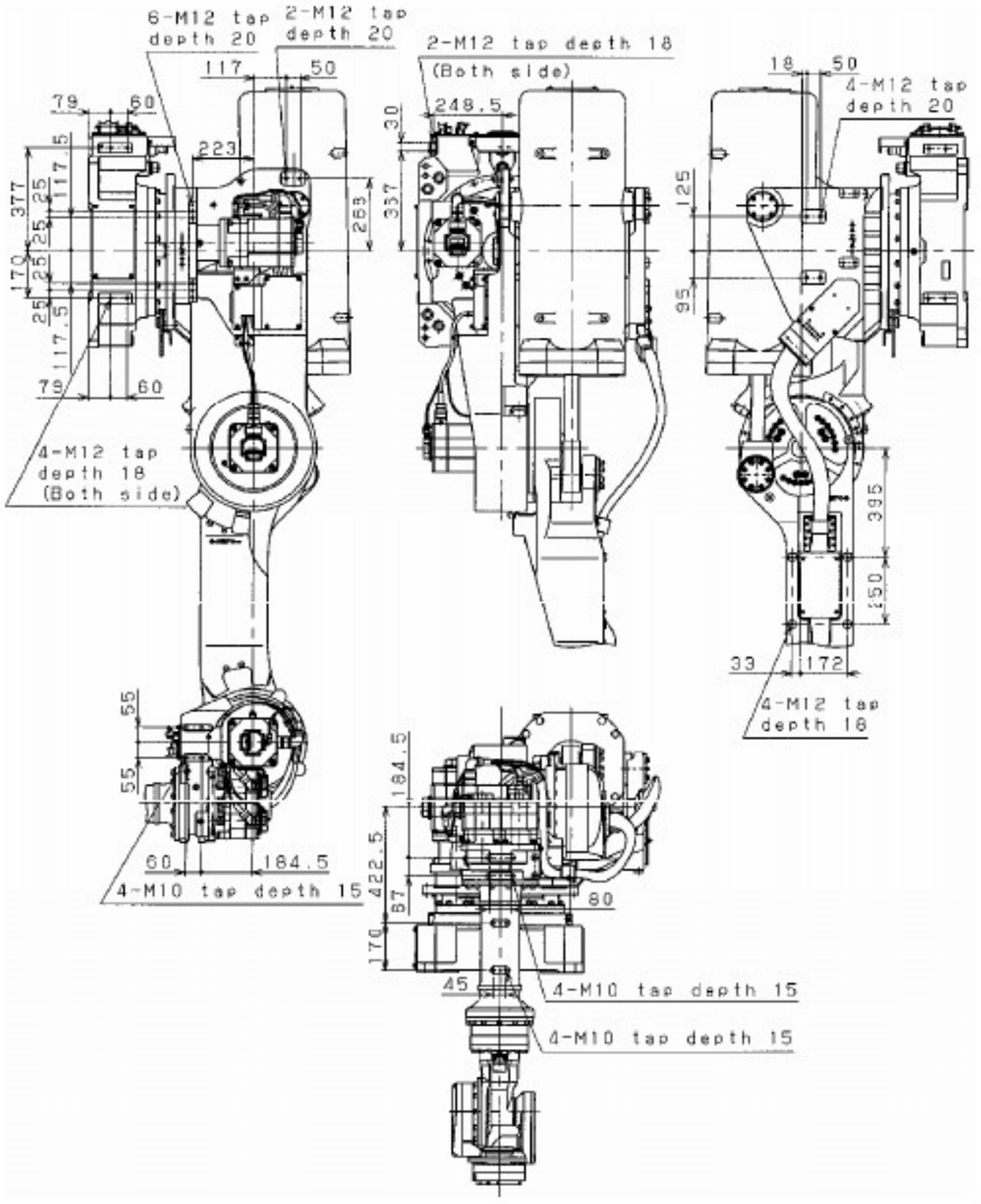
Note) All specifications are subject to change without notice.

R-2000*i*A/200R wrist load conditions



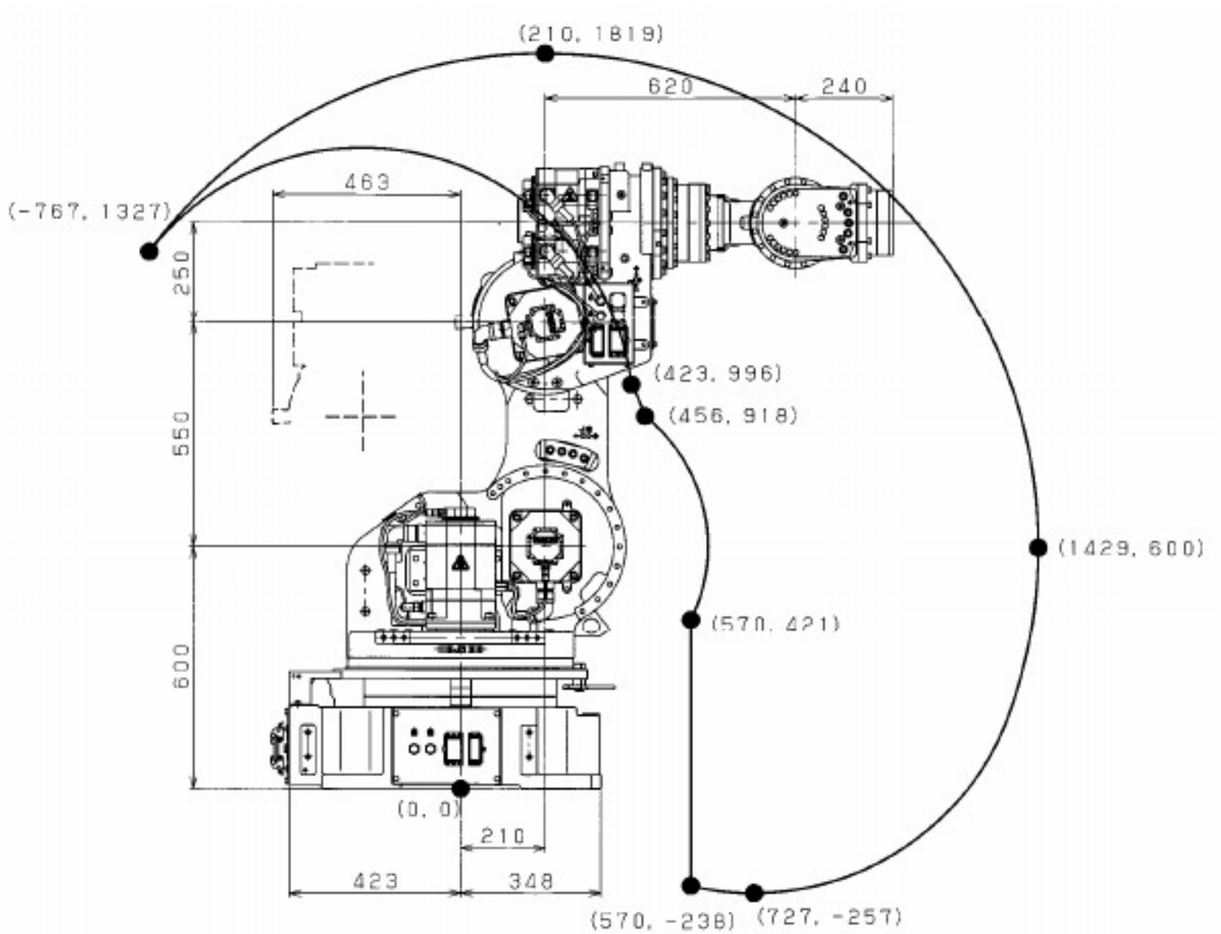
R-2000*i*A/200R
Wrist load diagram(ISO Flange)

R-2000*i*A/200R equipment mounting surfaces



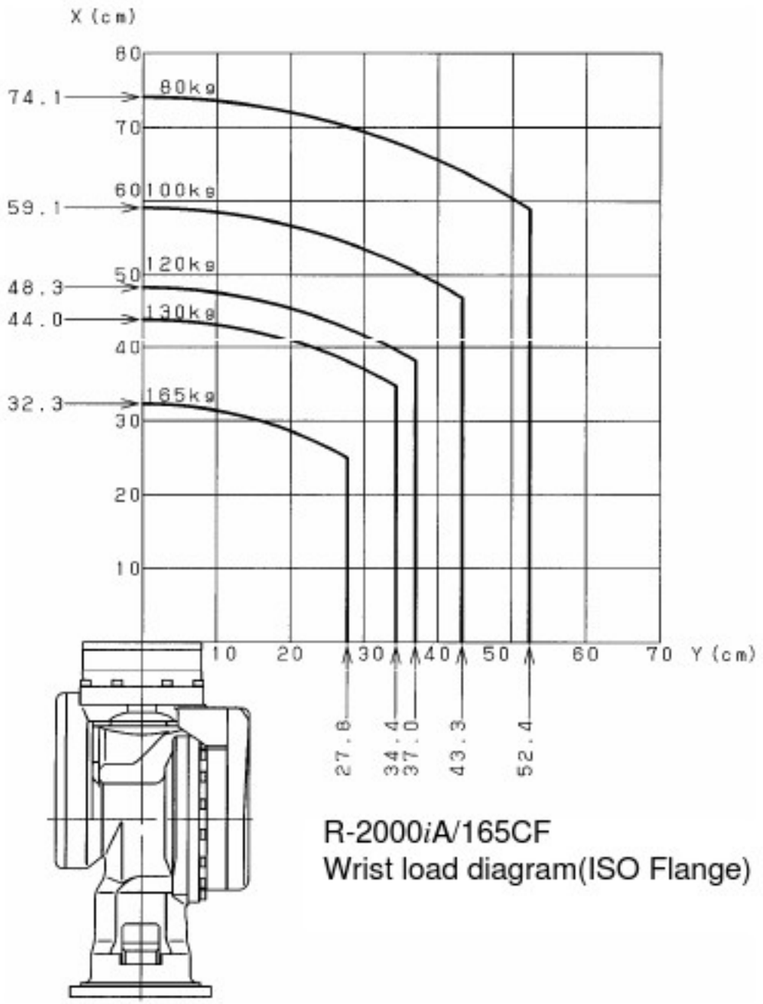
R-2000*i*A/165CF specification

Maximum load capacity at wrist		165 kg
Maximum load capacity at J3 arm		25kg
Maximum load capacity at J2 base		550kg
Motion range (Maximum speed)	J1 axis	360 deg (110 deg/s)
	J2 axis	165 deg (90 deg/s)
	J3 axis	250 deg (100 deg/s)
	J4 axis	720 deg (130 deg/s)
	J5 axis	250 deg (130 deg/s)
	J6 axis	720 deg (210 deg/s)
Allowable load moment at wrist	J4 axis	911 Nm
	J5 axis	911 Nm
	J6 axis	451 Nm
Allowable load inertia at wrist	J4 axis	88.2 kgm^2
	J5 axis	88.2 kgm^2
	J6 axis	44.1 kgm^2
Repeatability		+/-0.3 mm
Mass		1,050 kg



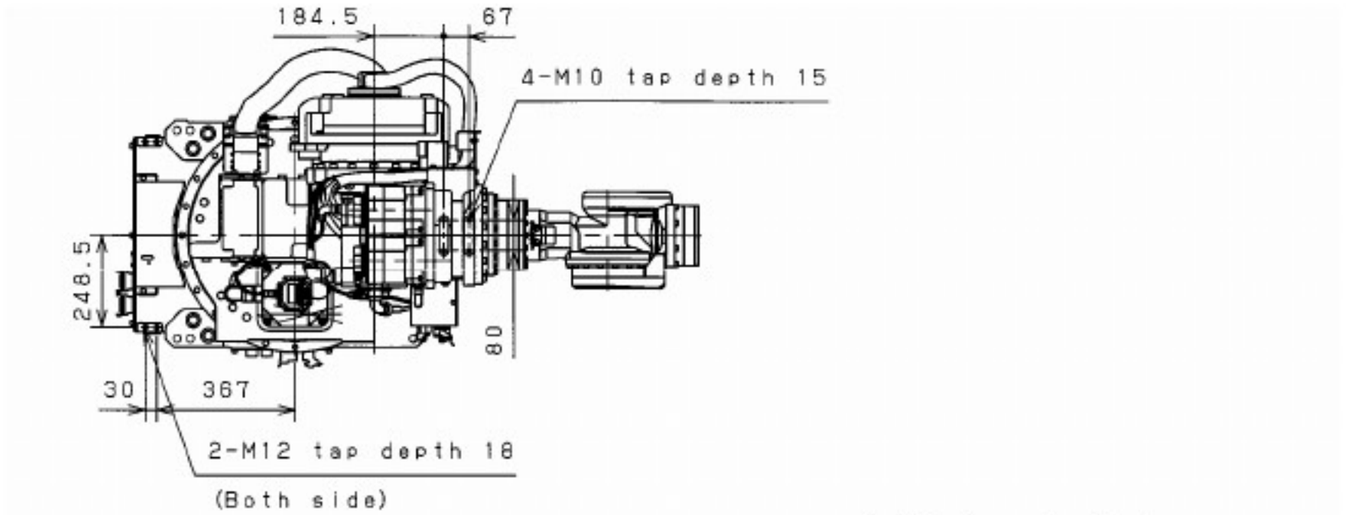
Note) All specifications are subject to change without notice.

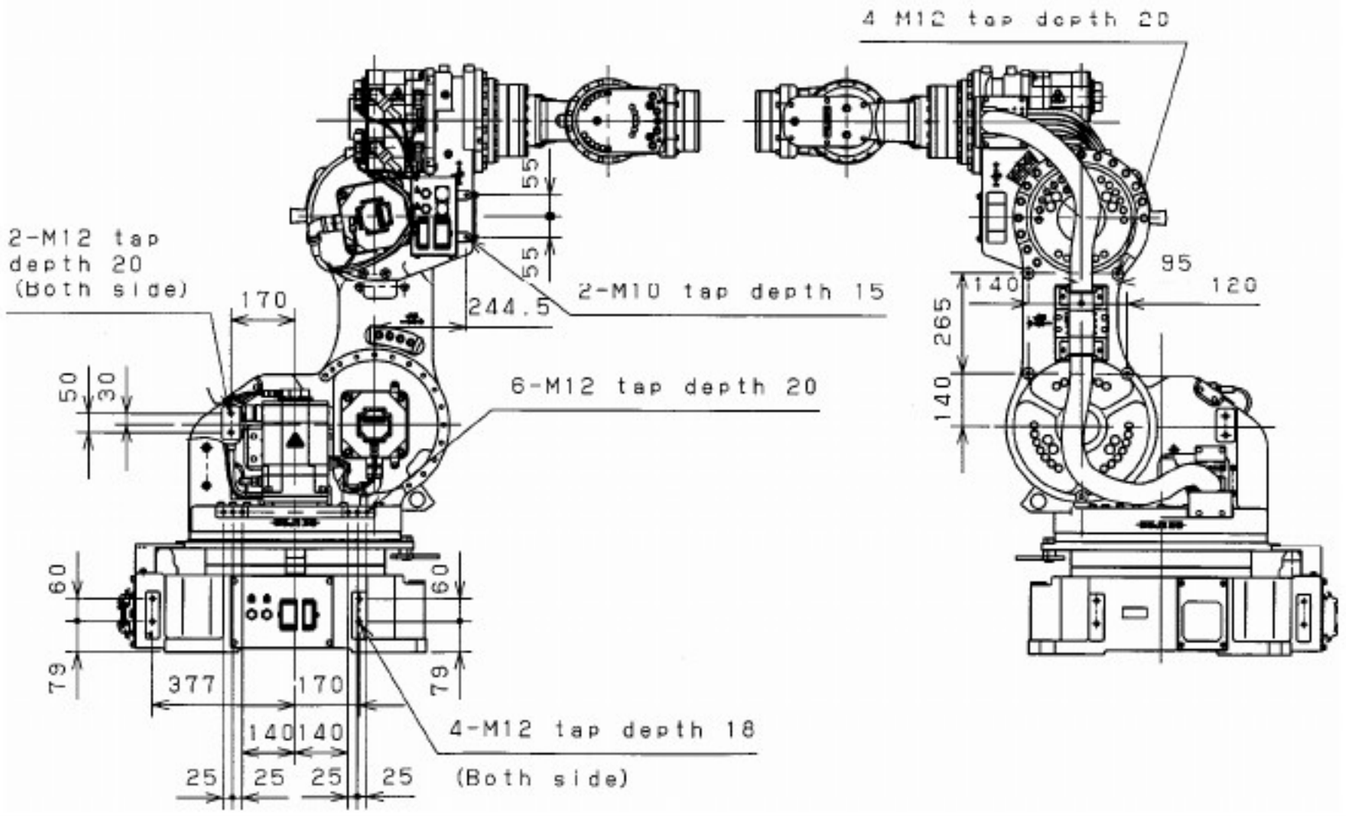
R-2000*i*A/165CF wrist load conditions



R-2000*i*A/165CF
Wrist load diagram(ISO Flange)

R-2000*i*A/165CF equipment mounting surfaces

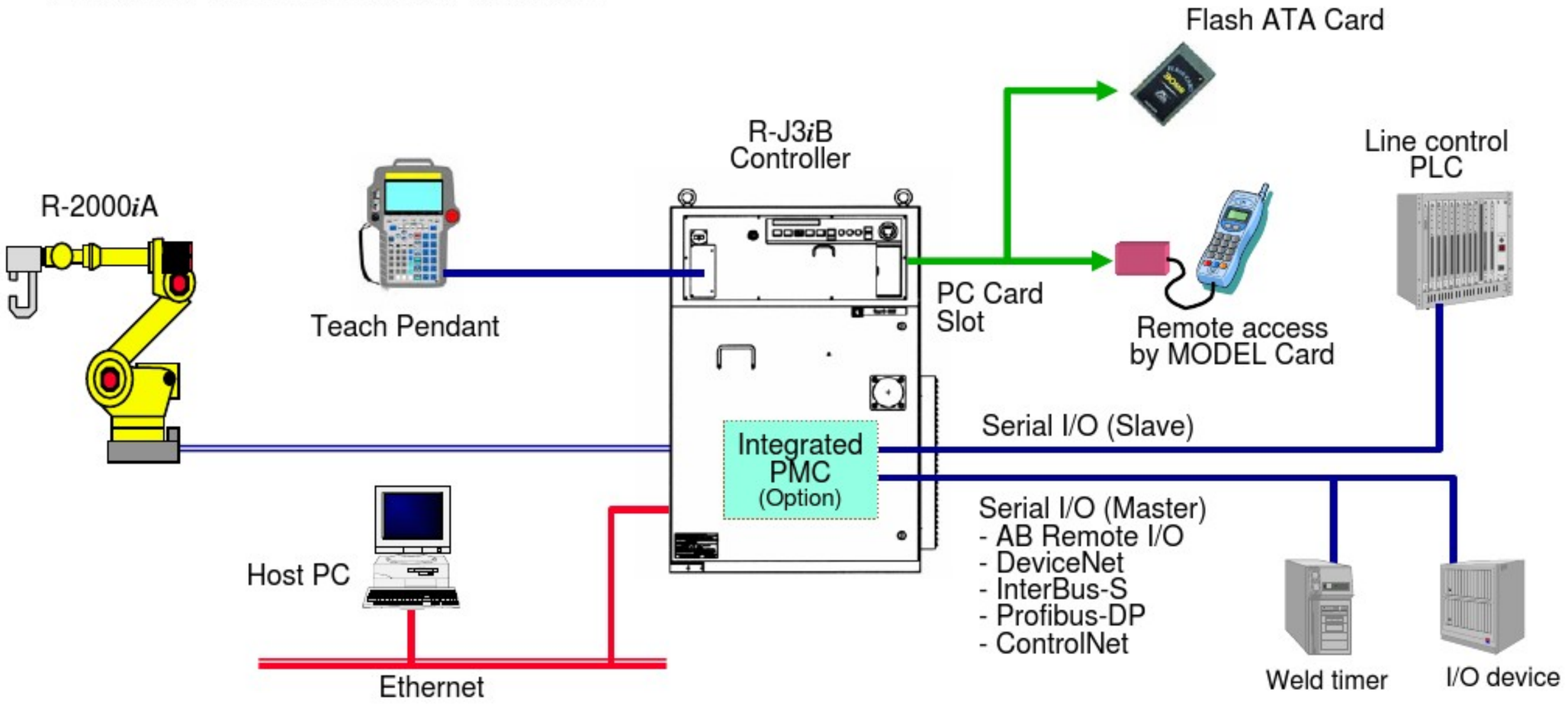




Note) All specifications are subject to change without notice.

R-2000*i*A Controller Configuration
(R-J3*i*B)

- Special controller designed for R-2000*i*A robot
- Based on current R-J3 and increase performance with keeping reliability
- Enhance communication function

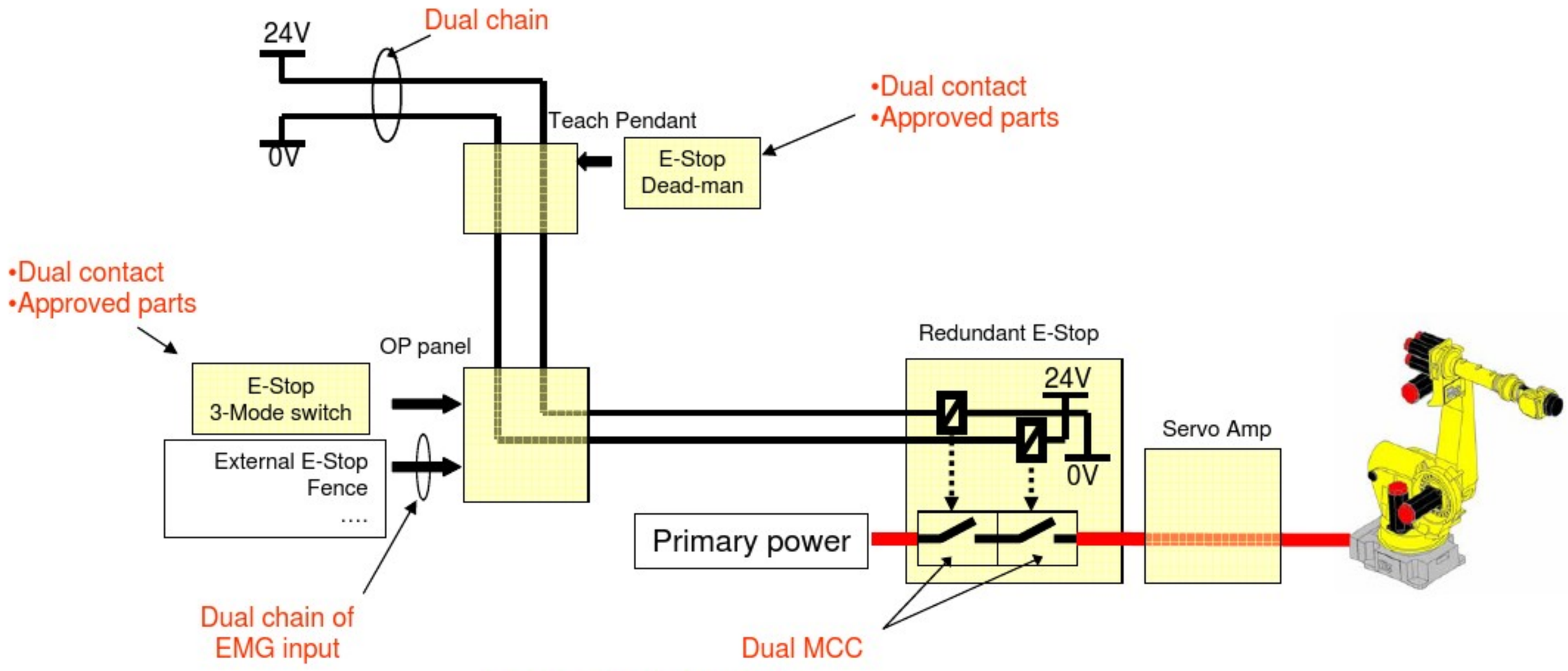


Controller (Hardware)

- **Providing Main CPU and communication CPU as dual processor system**
  - **64 bit RISC processor for Main CPU**
  - **Enhancement of communication processor to realize 100 BaseT Ethernet**
- **Expanding Flash memory from 4-16MB to 16,32MB**
- **Adopting ECC for battery-backed up SRAM for high reliability**
- **Enhancement servo DSP**
  - **Two times faster than R-J3**

Controller(Hardware)

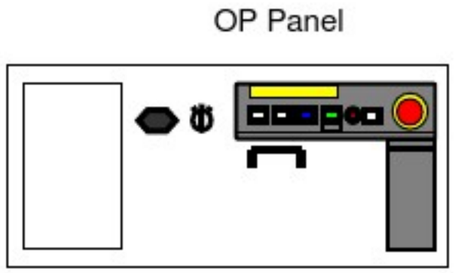
•For CE mark and RIA standard, to provide category-4 safety level of IEC standard and control reliable of RIA standard.

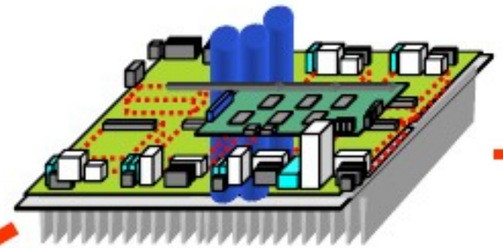


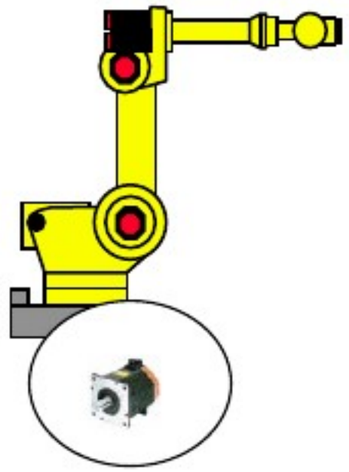
Dual chain Circuit

Controller(Hardware)

•Two expandable high speed reliable serial buses are provided







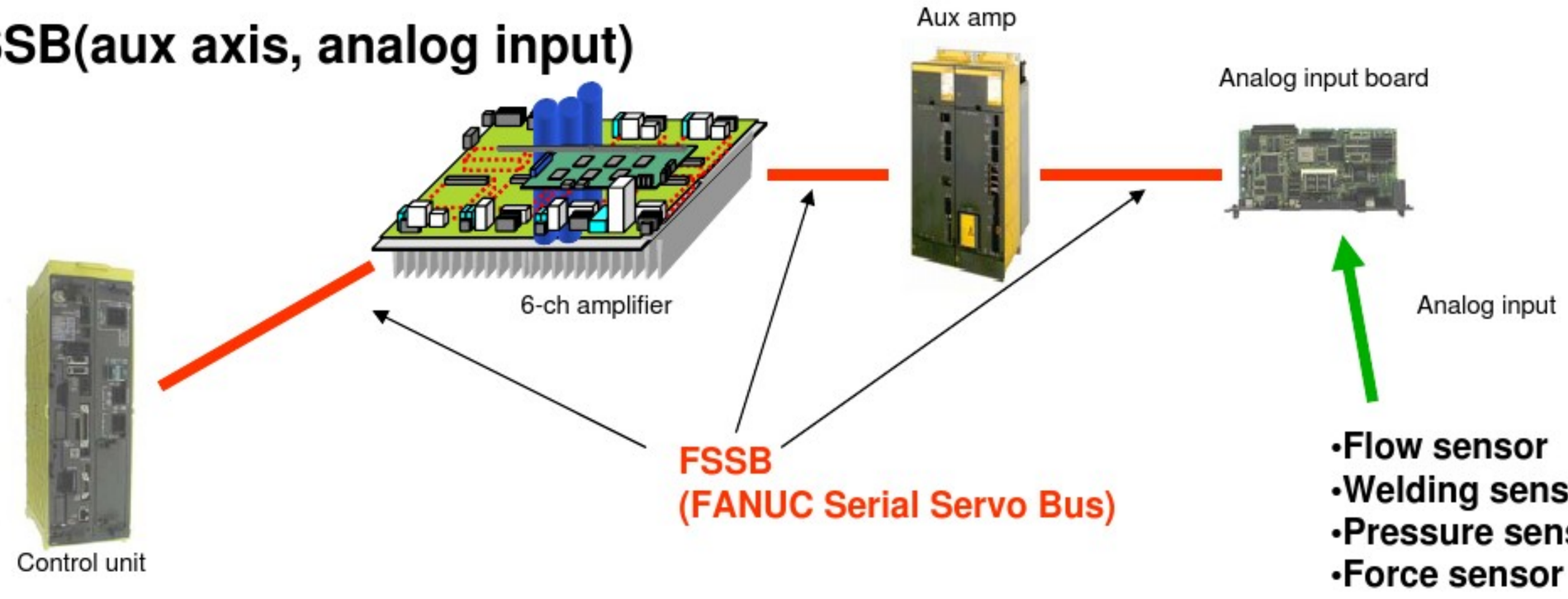
HSSB
(High Speed Serial Bus)
- Serial bus to OP panel
- Providing PCMCIA port at OP panel
- Switch/LED control
- Status of E-Stop signal

FSSB
(FANUC Serial Servo Bus)
- 50 Mbps optical fiber communication
- High reliable ECC function
- Various data transfer except motor control signal
- High speed Communication directly to/from servo DSP

Motor power
Pulsecoder signal
ROT/HBK
RDI/RDO

Controller(hardware)

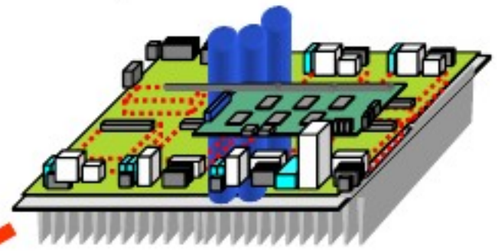
•FSSB(aux axis, analog input)



- Providing high speed serial communication between servo DSP and aux axis amplifier/analog input board by FSSB
- Realizing real time control based on the data from sensors

Controller(Hardware)

•FSSB(Servo amplifier)



6-ch amplifier

Control unit

FSSB
(FANUC Serial Servo Bus)

Various data transfer directly to servo DSP

•Voltage information

•Discharge current

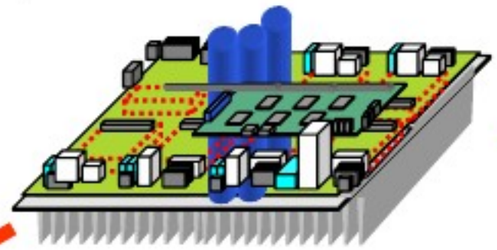
•Detail alarm status

•Improvement of servo control by use of voltage information.

•Providing good maintenance information based on various data from servo amplifier

Controller(Hardware)

•FSSB(Pulse coder)



6-ch amplifier

Pulsecoder

Serial communication

Control unit

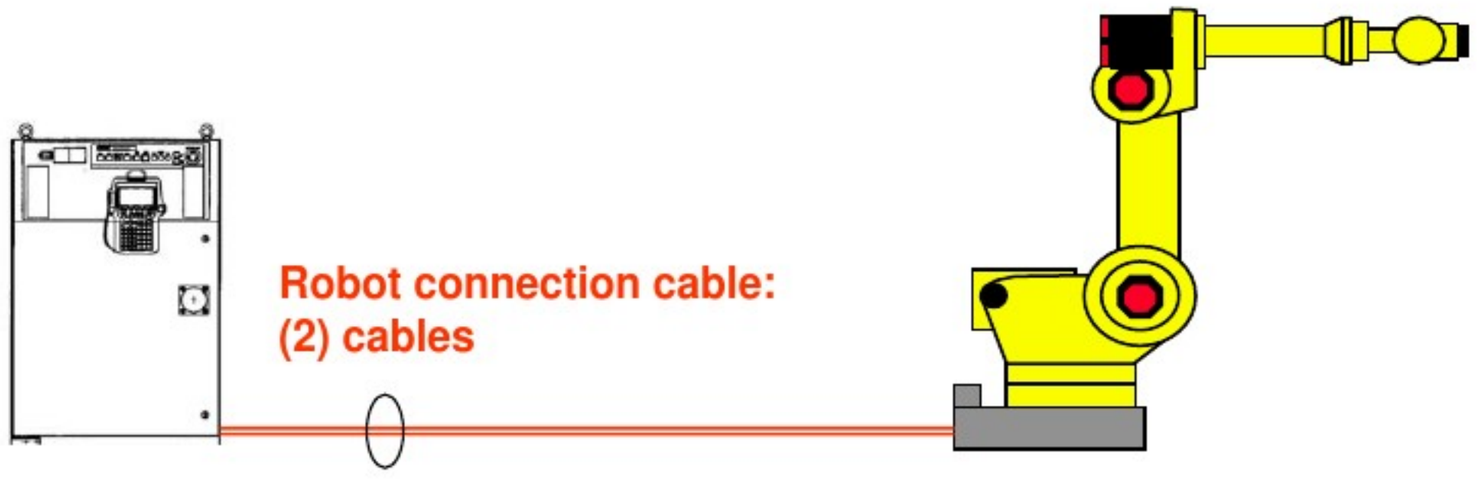
FSSB
(FANUC Serial Servo Bus)

- High speed serial communication of absolute position data
- Because of absolute data, higher reliability than pulse transfer
- Detecting alarms at pulsecoder and transfer them to control unit for better maintenance

Controller(Hardware)

•Reducing transformer size and Robot connection cable

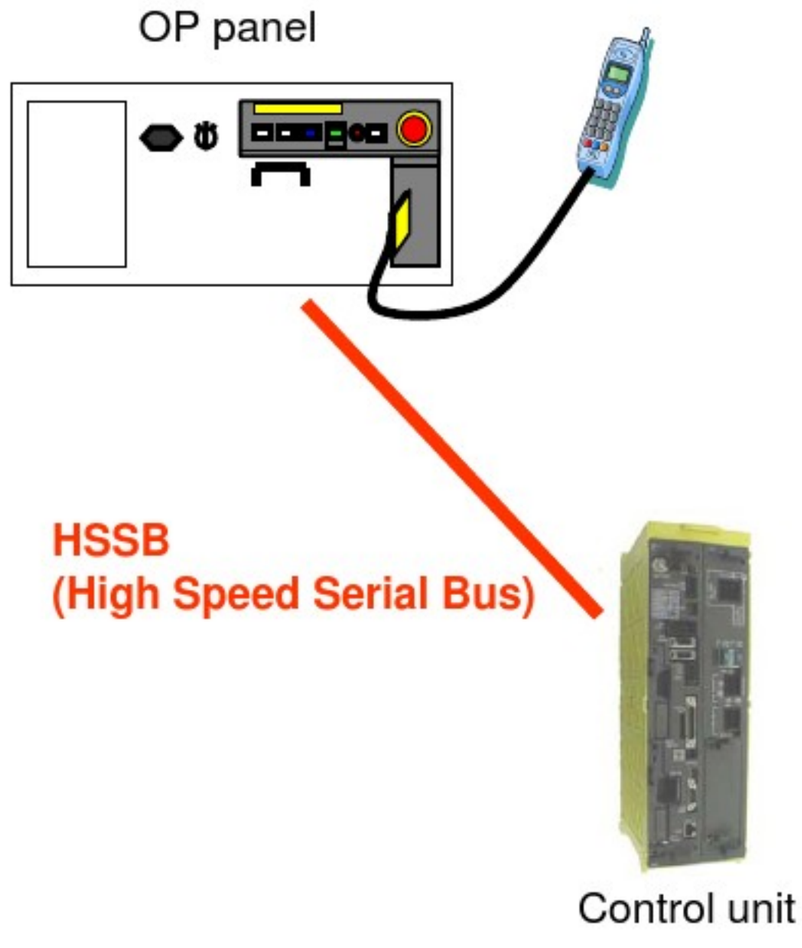
•Transformer	S-430*i*W : 10.5KVA	R-2000*i*A : 7.5KVA
•Connection cable	S-430*i*W : (4) cables S-430*i*F : (3) cables	R-2000*i*A : (2) cables



Controller(Hardware)

•Providing PCMCIA port at OP panel

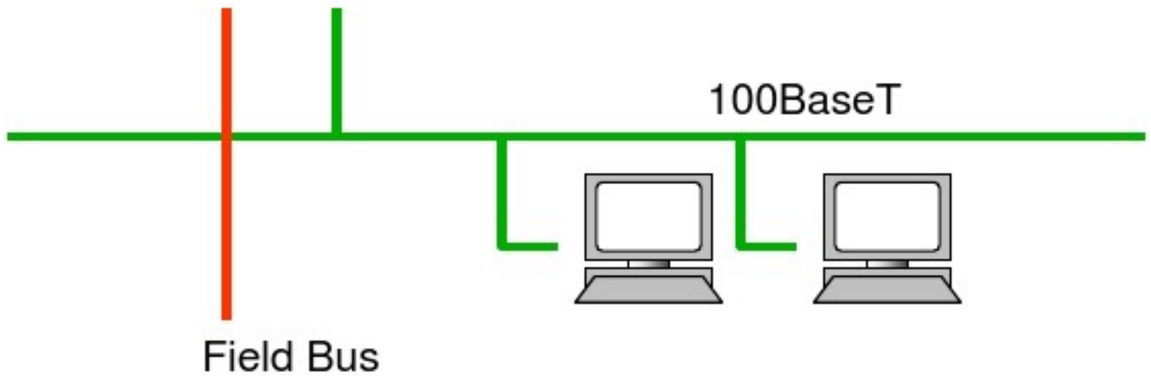
- **•Expanding PCMCIA bus to OP panel by HSSB**
- **•Easy to access PCMCIA port for Data back-up or modem connection**
- **•Available to use large size ATA flash memory card**
- **•Easy to back-up to/from PC through memory card**



Controller(Hardware)

•Enhancement of network

Control unit



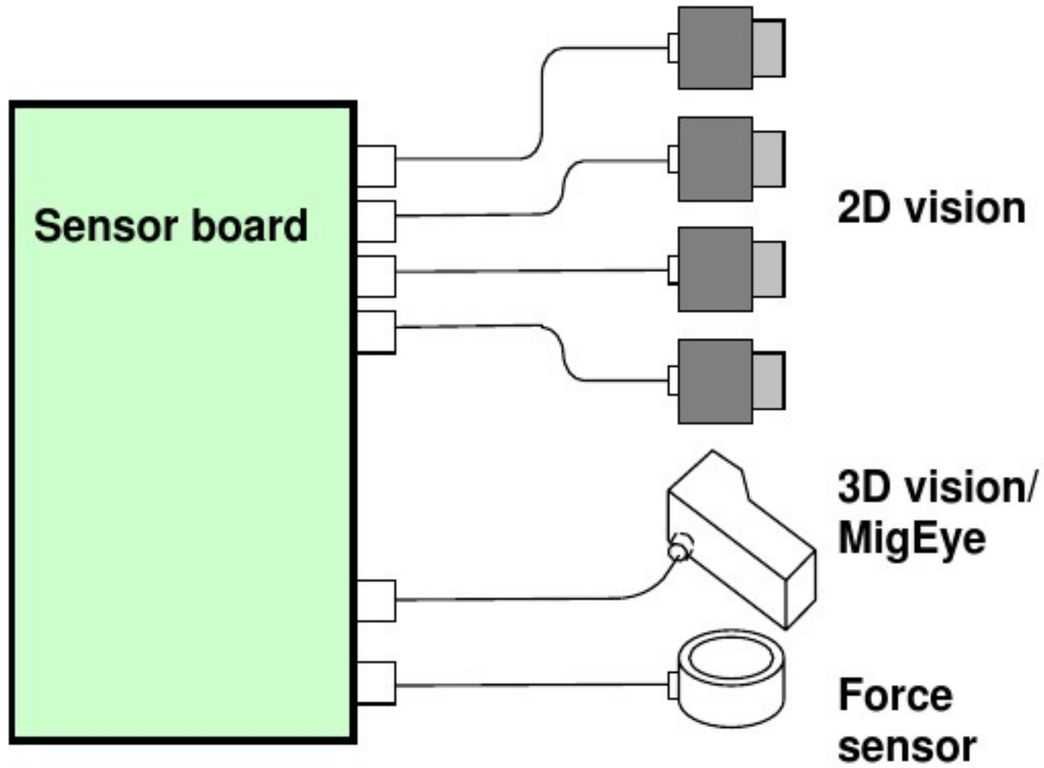
•Providing 100BaseT Ethernet by enhancement of communication processor

•Field Bus option
- -Device Net
- -Control Net
- -FL Net
- -Profi Bus
- -InterBus S

Controller(Hardware)

•Sensor Board

Full size option

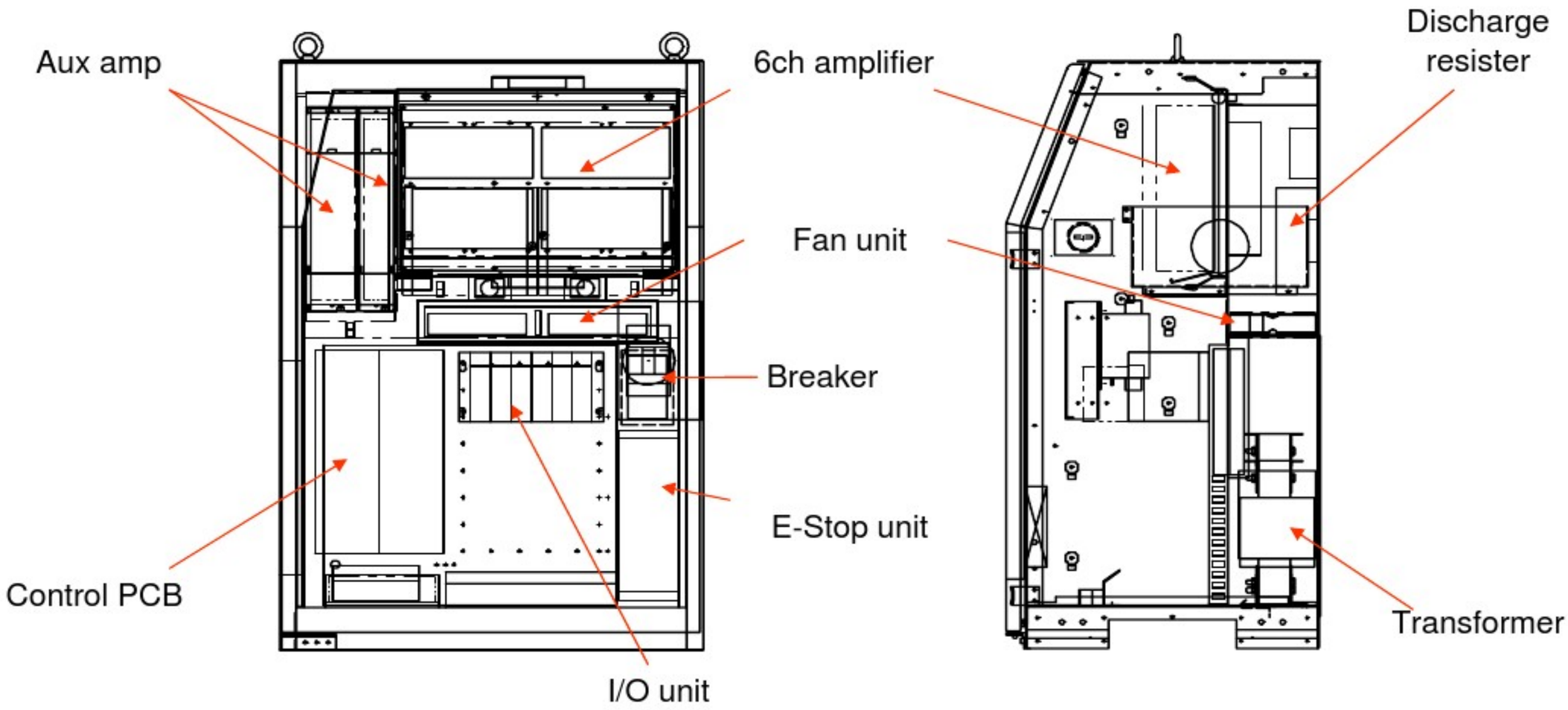


•Having all sensor I/F at one board(sensor board)

•Possible to provide various sensors to robot system easily

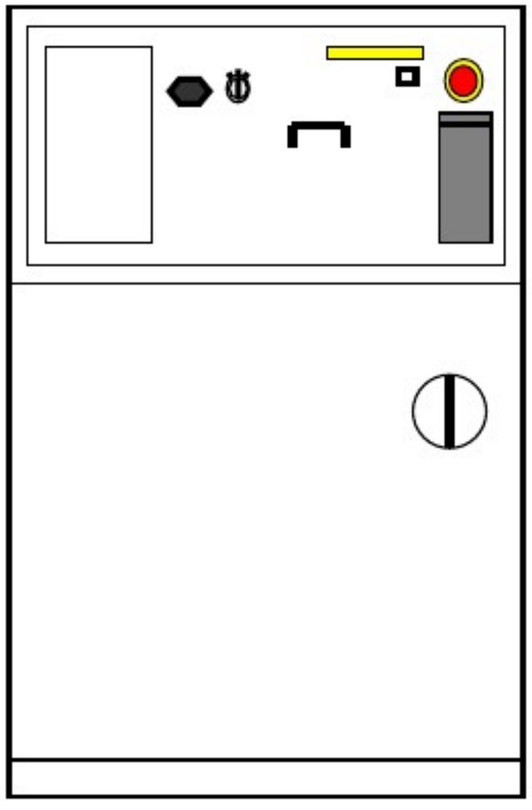
Controller(Configuration)

- Inside of cabinet



Controller(Configuration)

•OP panel

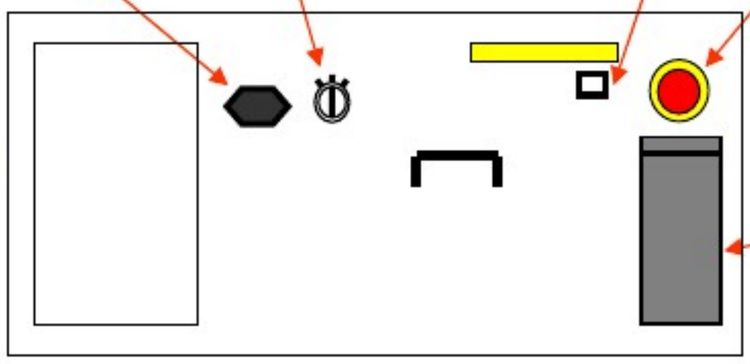


Mode switch(key switch)
IEC-947-5-1(force opening)
AUTO : Running
T1 : Teach(safety speed)
T2 : Teach(100% speed)

Hour meter (option)

ON/OFF (alternate)

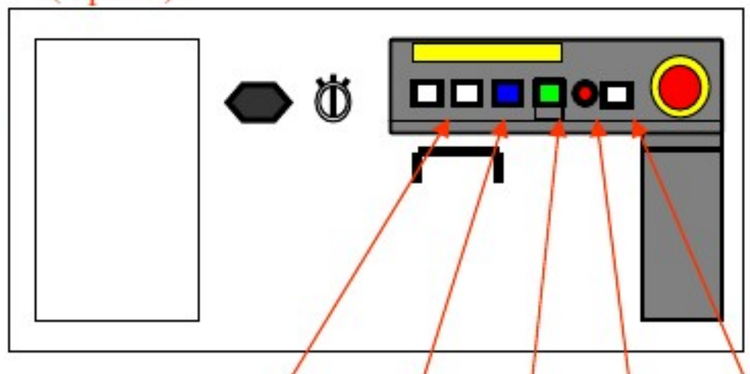
E-Stop switch
IEC-947-5-1(force opening)



PCMCIA
RS-232-C
Ethernet(option)

Optional panel with Alarm LED,
Start switch, Reset switch and
User #1, #2 switch is available.

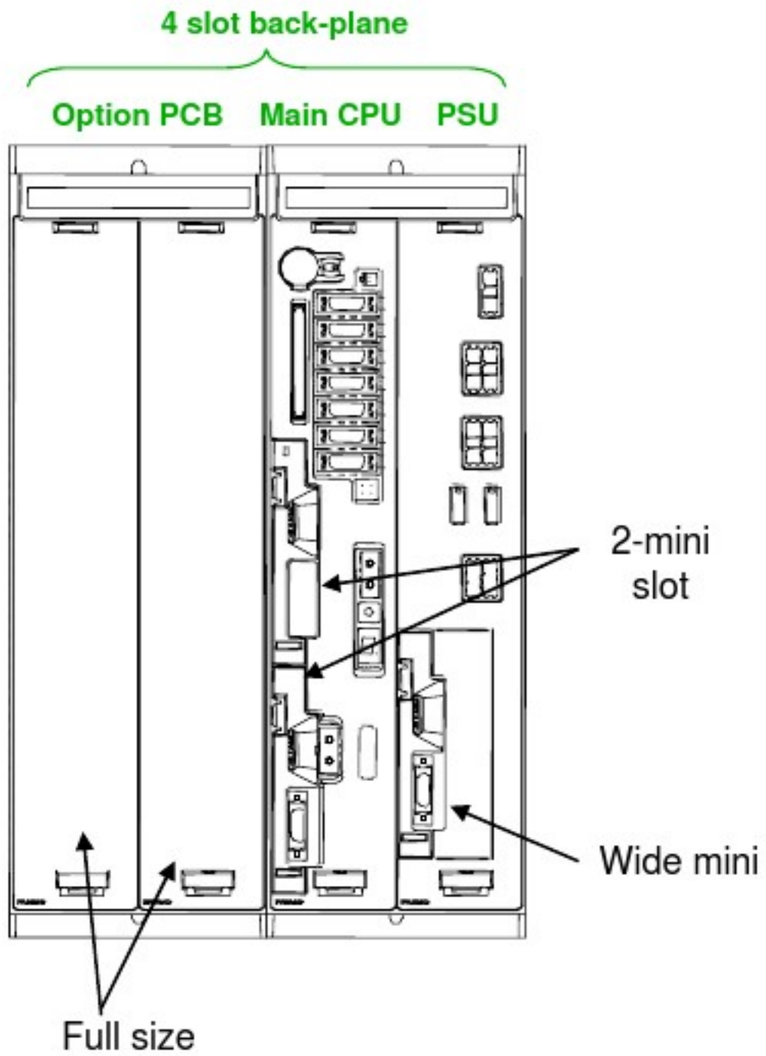
(Option)



User #1,#2
Reset switch
Start switch(with cover)
Alarm LED
ON/OFF (alternate)

Controller(Configuration)

•Option PCB



Mini slot

- **Profibus**
- **DeviceNet**
- **FL Net**
- **Aux axis**

Wide mini slot

- **Line Tracking**
- **Interbus-S(PC104)**
- **ControlNet(PC104)**

Full size slot

- **DeviceNet(PC104)**
- **Interbus-S(PC104)**
- **ControlNet(PC104)**
- **Process I/O**
- **Sensor Board**

Controller(Configuration)

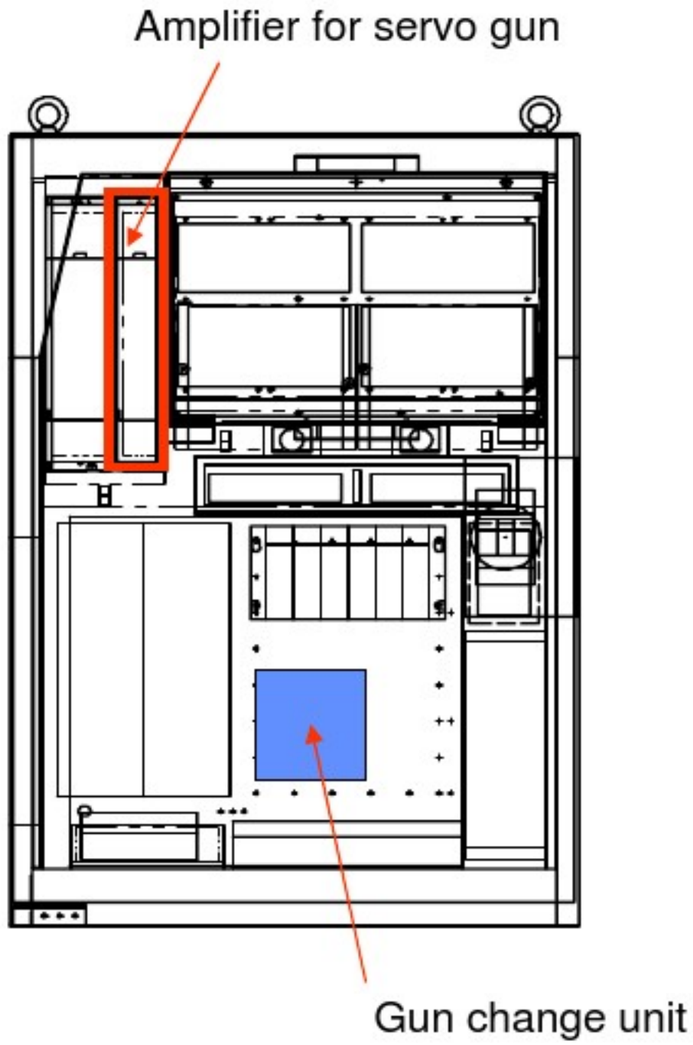
•Servo Gun

•**Add servo amplifier and cables to realize servo gun**

Brake power is provided from 6 ch amplifier

DC link is also provided from 6 ch amplifier

•**Add gun change unit to realize gun change**



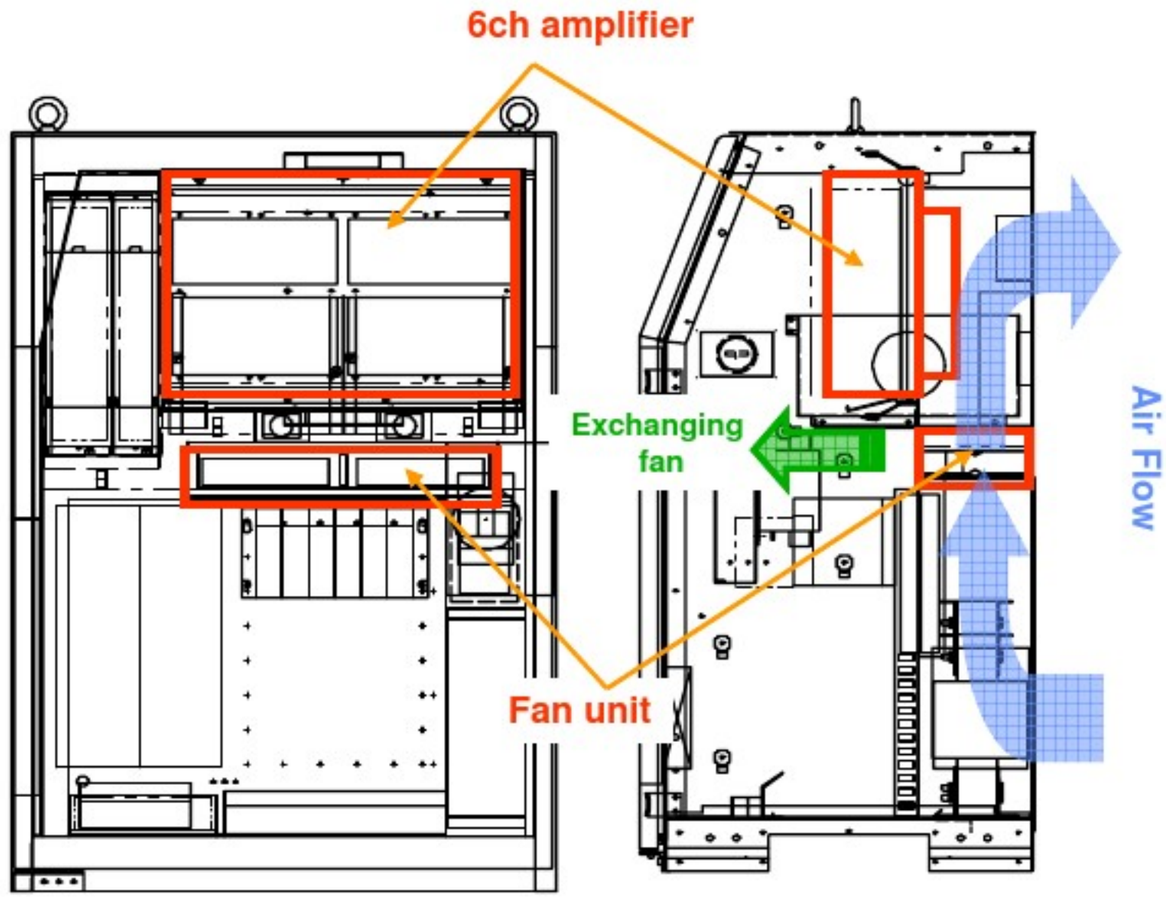
Controller(Maintenance)

•Servo amplifier

- •Connector for all connection
- •Reduce 18% weight as R-J3
- •Exchanging within 5 minutes

•Fan unit

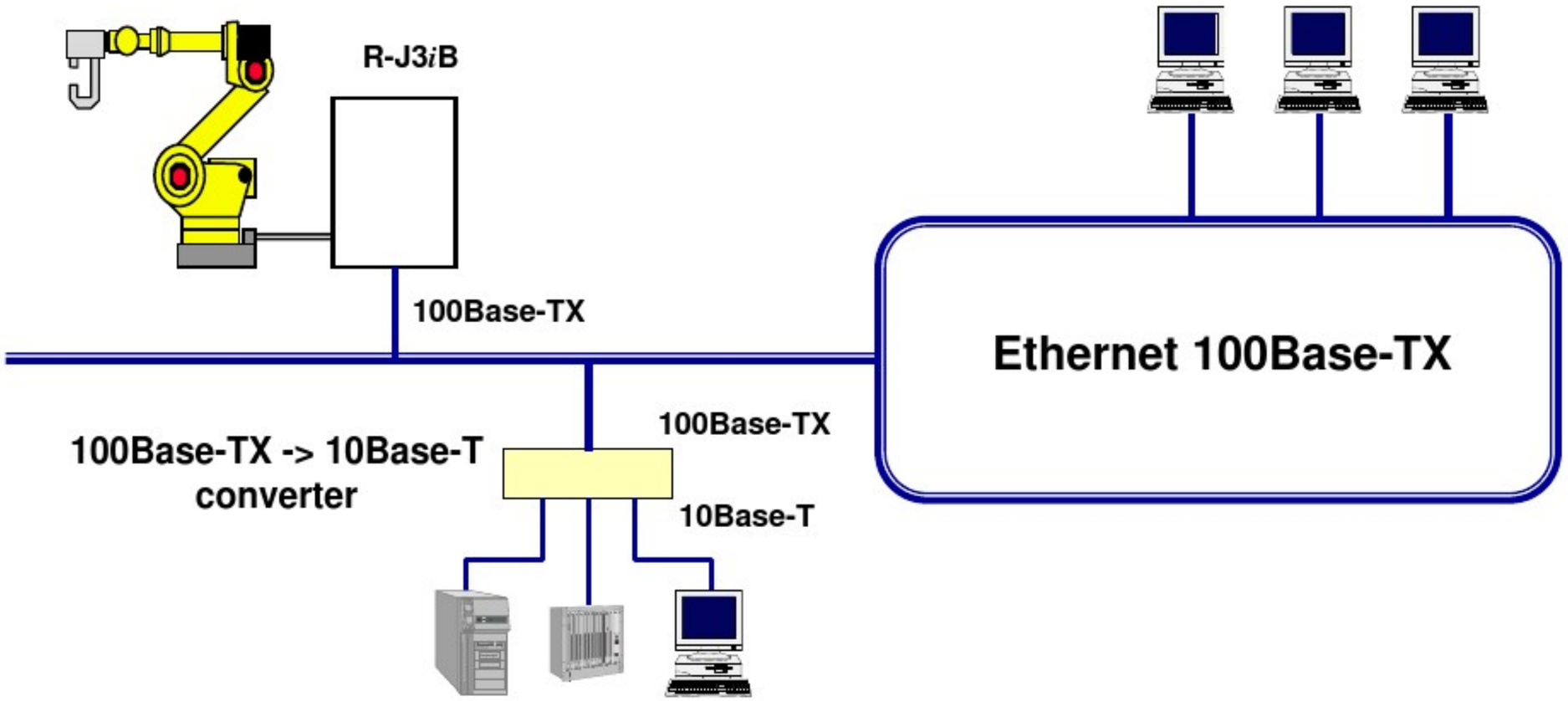
- •Rear-to-rear air flow
- •No maintenance space at side of cabinet
- •Exchanging fan unit from front side



R-J3*i*B Software

Ethernet 100Base-TX

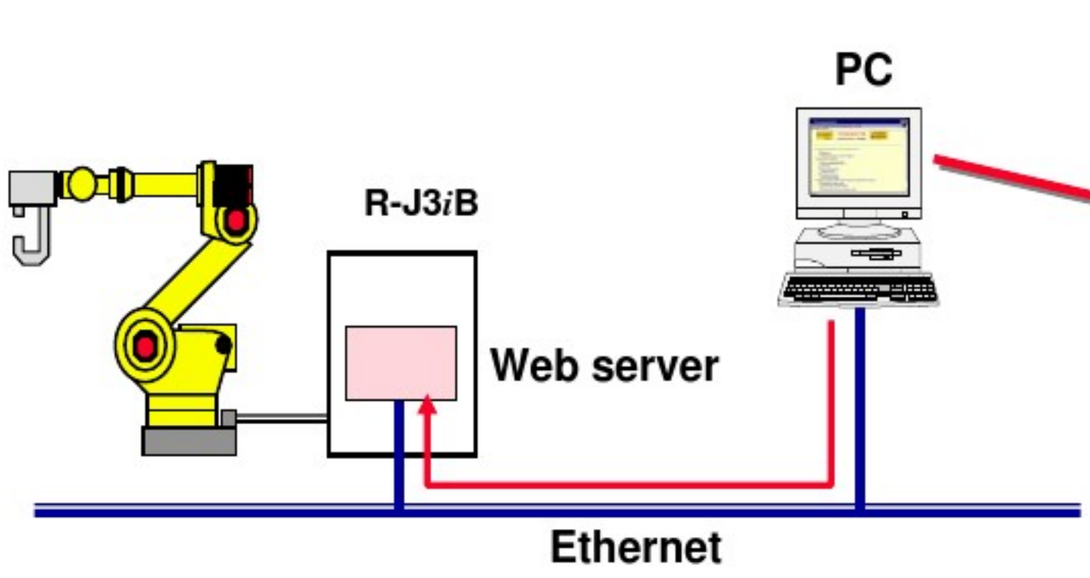
- 100Base-TX Ethernet is supported
- Higher data transfer is available than current 10Base-T
- Robot can connect 100Base-TX Ethernet directly in factory without any converter

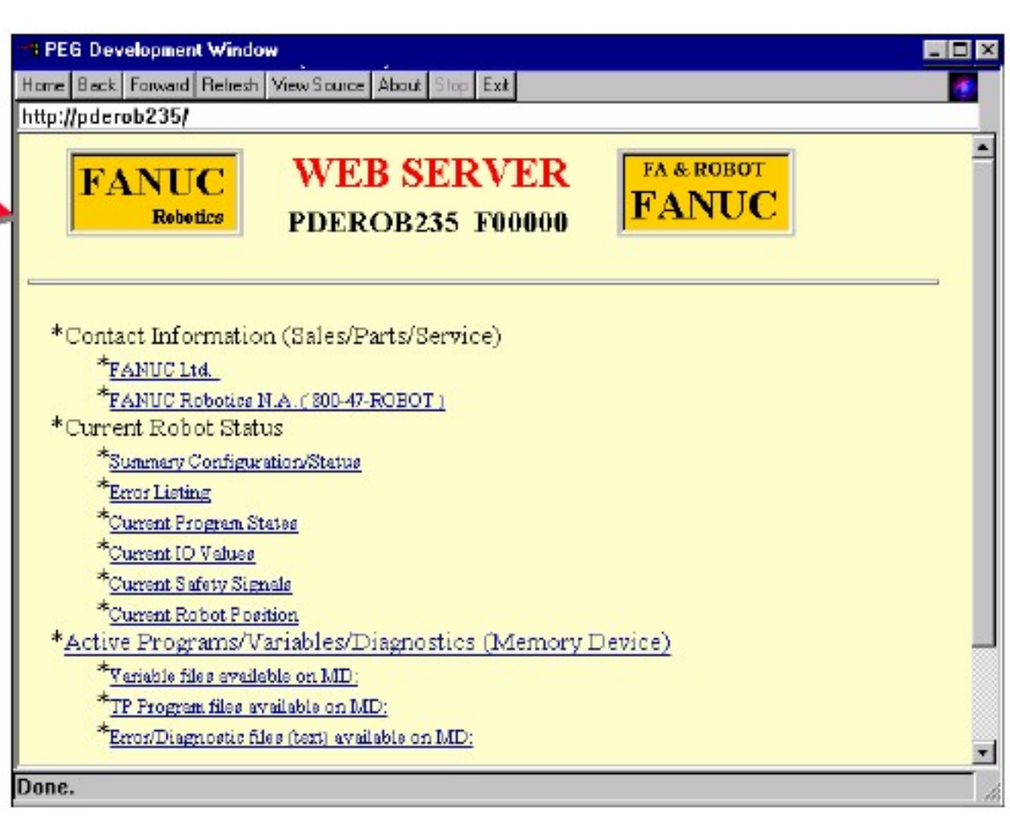


R-J3*i*B Software

Web Server

- HTTP interface is supported
- Access robot data through Internet or Intranet
- Access robot data through Internet Explorer on PC. Special software is not needed on PC
- Customer can look/modify/save robot data as same manner of Internet Home Page

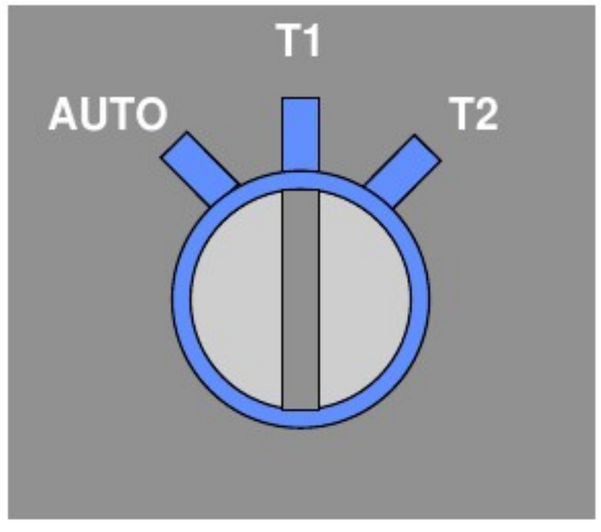




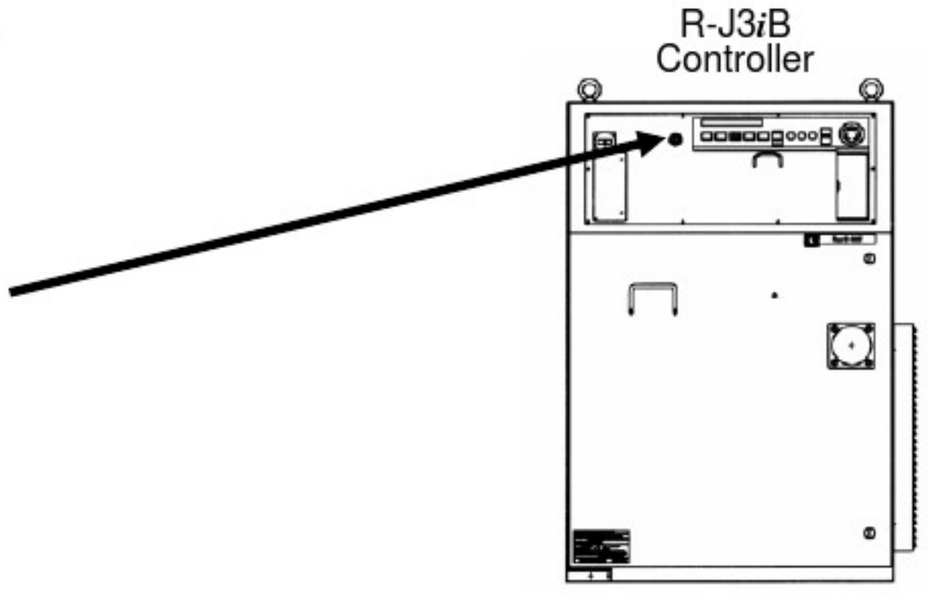
R-J3*i*B Software

3 Mode Switch

- 3 mode switch (AUTO, T1, T2) is provided as standard. Previously, only CE/RIA controller provides 3 mode switch.
- In T1 mode, robot speed is limited under 250mm/sec. Teaching operation becomes safe.
- In T1 and T2 mode, robot is energize only when Dead-man switch of TP is held
- Mode can be fixed by key-lock. Prevent to change mode unexpectedly



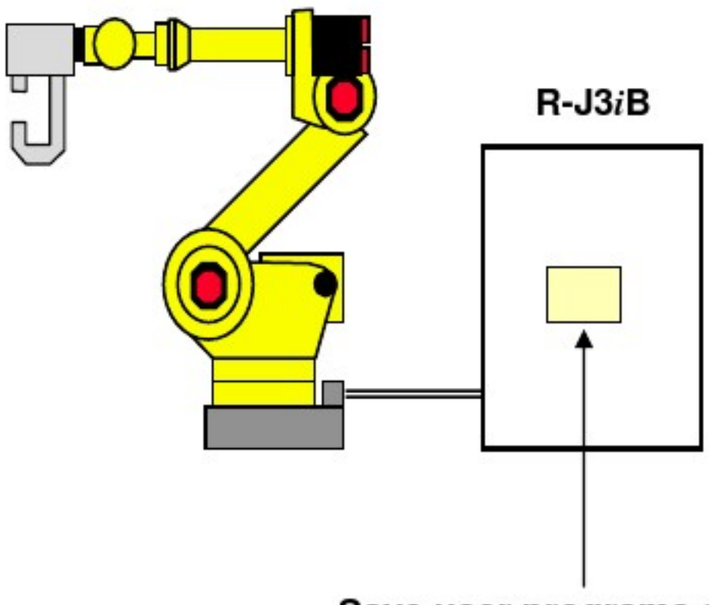
3 Mode Switch



R-J3*i*B Software

Automatic Backup Function

- User programs and other system setup are saved in system automatically
- Reduce effort to data backup when program is changed and prevent to forget to save modified program
- When user programs and/or system setup are lost in unexpected reason, easy to recover system with minimum effort and time

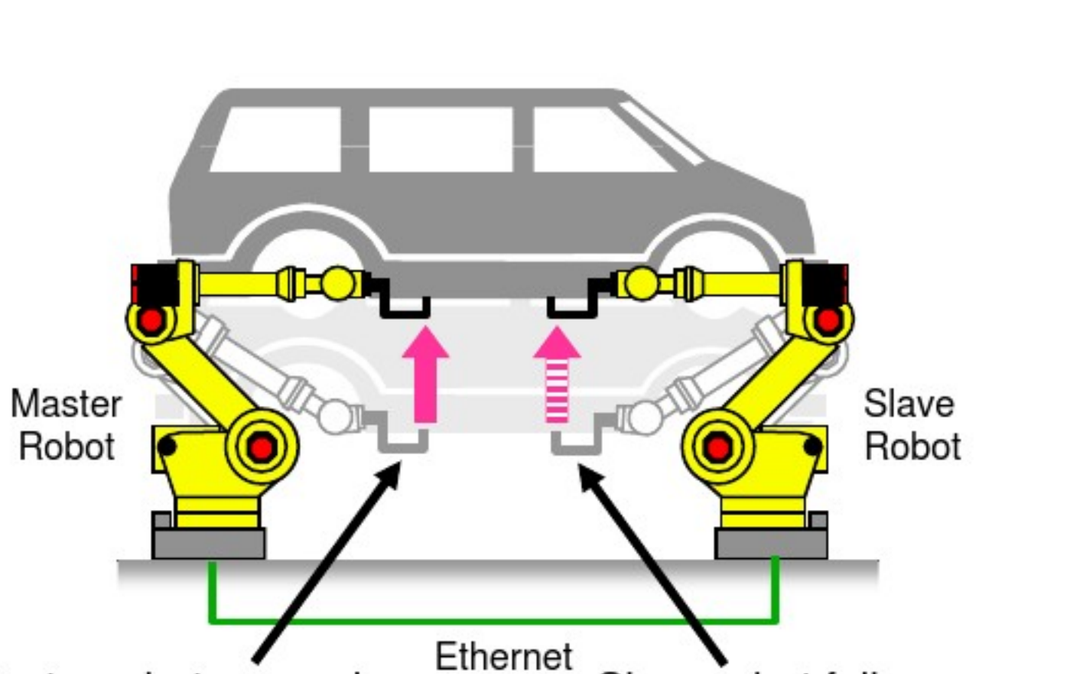


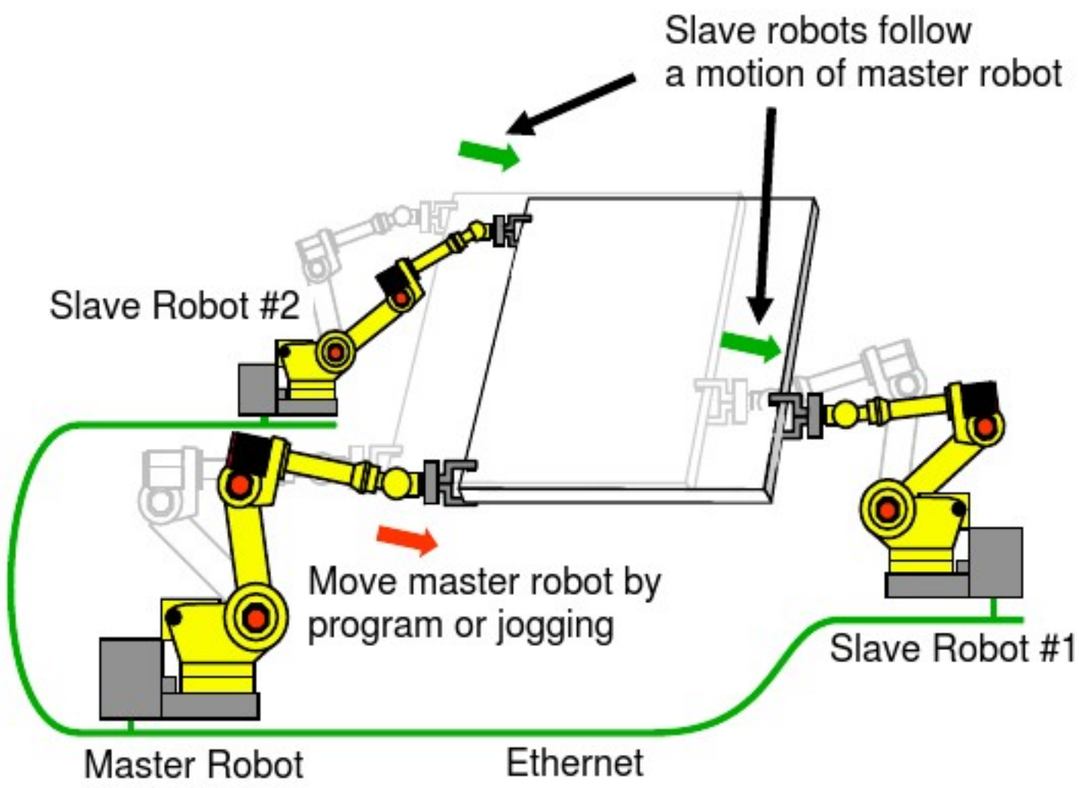
- Backup is automatic done at following timing
  - Specified time (5 times per day)
  - Specified digital input signal turning on
  - Power on
- Multiple backups are available. If wrong program and setup is saved, previous another backup can be loaded

R-J3*i*B Software

Robot Link Simultaneous Motion

- Handling for heavy / large workpiece by multiple robots
- By handling with multiple robots, robot hand can be simple and small
- Does not need special hardware
- When one robot is stopped, other robots are also stopped automatically.





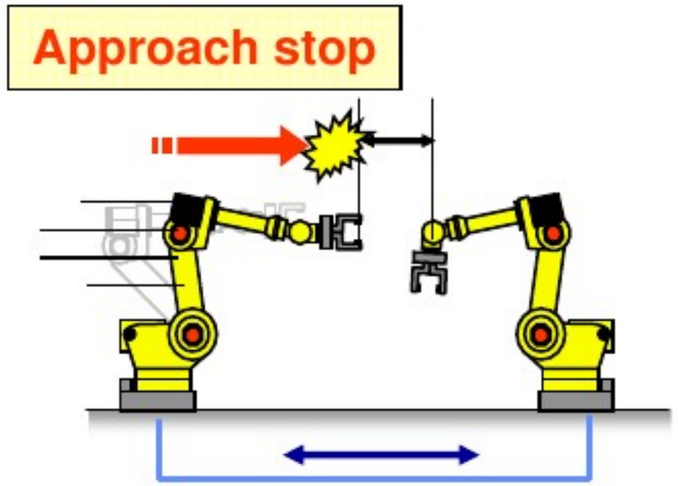
R-J3*i*B Software

Robot Link Approach Deterrence

- **Approach stop function**

  Feature: This function detects near-miss between a robot and another one/fixed object. This function decelerates and stops robots before collision.If deceleration is not in time, robots are E-stopped.

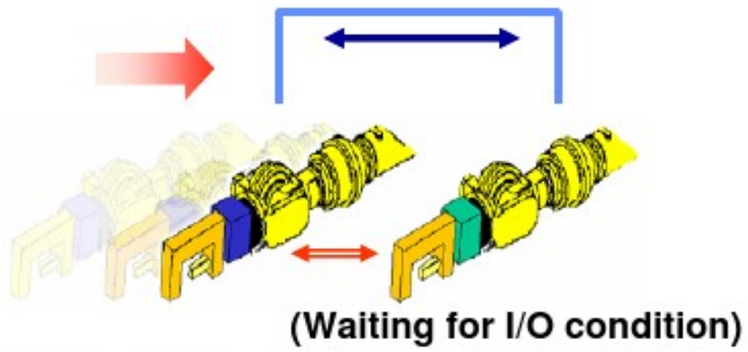
  Usage : This function prevents interference by operation error.



- **Approach wait function**

  Feature: If distance between a robot and another one/fixed object is less than approach wait distance, this function decelerates former robot to stop. According to situation,motion of stopped robot can be restarted automatically.

  Usage : This function is used when robots move in close range to each other.



R-J3*i*B Software

ROBOGUIDE

- Connect PC to robot controller and execute high accurate simulation is available on PC
  - Robot motion
  - TCP path trajectory
  - Cycle time
  - I/O Interlock
- Easy to switch simulation to actual robot. After simulating a robot program, execute this program and move actual robot.
- 3D animation on PC is available for create/edit robot program, teach/modify taught robot position
- Multiple robots animation is available