

# Product Specification

*IRB 6400PE*

3HAC 9120-1 / M2000



**ABB Flexible Automation**



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ABB Robotics AB  
S-721 68 Västerås  
Sweden

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# 1 Description

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## 1.1 Structure

IRB 6400PE is a 6-axis industrial robot, designed specifically for poke welding at manufacturing industries that use flexible robot-based automation. The robot has an open structure that is specially adapted for flexible use, and can communicate extensively with external systems.

The robot is equipped with the operating system BaseWare OS. BaseWare OS controls every aspect of the robot, like motion control, development and execution of application programs communication etc. See Product Specification S4Cplus.

For additional functionality, the robot can be equipped with optional software for application support - for example gluing and arc welding, communication features - network communication - and advanced functions such as multitasking, sensor control etc. For a complete description on optional software, see the Product Specification RobotWare Options.

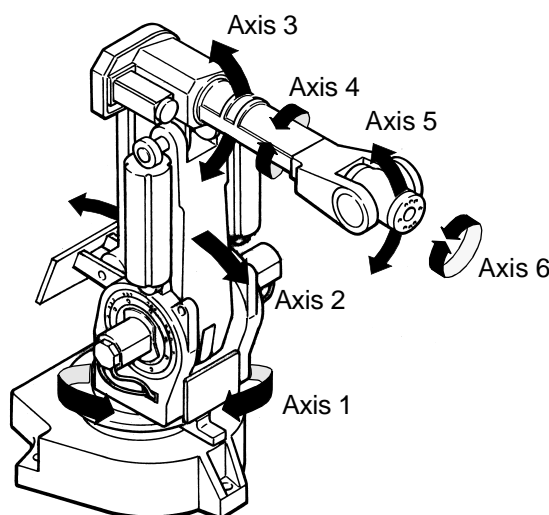


Figure 1 The IRB 6400PE manipulator has 6 axes.

Manipulator weight    1590 kg

Airborne noise level:

The sound pressure level outside  
the working space

< 70 dB (A) Leq (acc. to  
Machinery directive 89/392 EEC)

*Description*

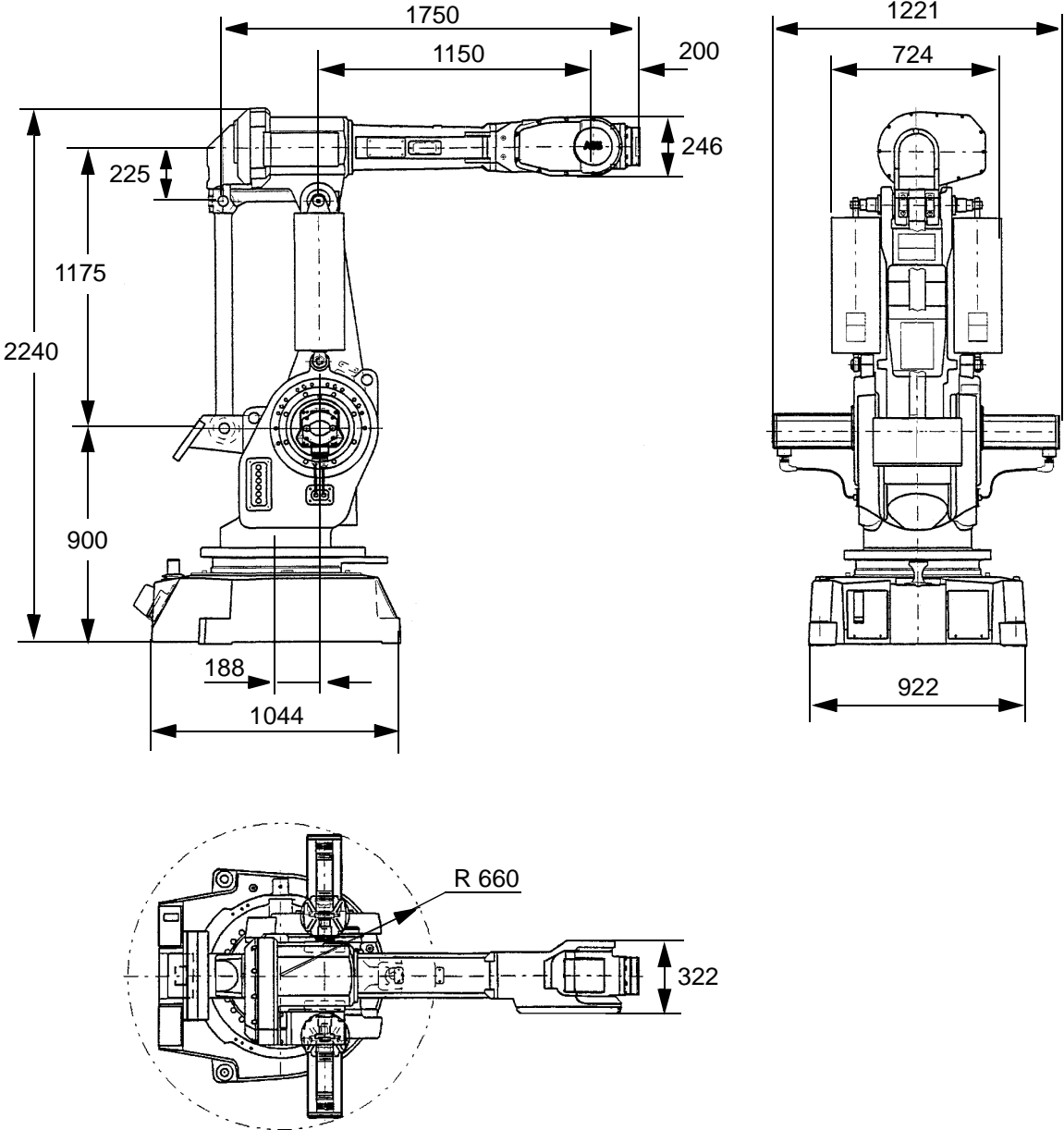


Figure 2 View of the manipulator from the side, rear and above (dimensions in mm).

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## 1.2 Safety/Standards

The robot conforms to the following standards:

EN 292-1	Safety of machinery, terminology
EN 292-2	Safety of machinery, technical specifications
EN 954-1	Safety of machinery, safety related parts of control systems
EN 60204	Electrical equipment of industrial machines
IEC 204-1	Electrical equipment of industrial machines
ISO 10218, EN 775	Manipulating industrial robots, safety
ANSI/RIA 15.06/1999	Industrial robots, safety requirements
ISO 9409-1	Manipulating industrial robots, mechanical interface
ISO 9787	Manipulating industrial robots, coordinate systems and motions
IEC 529	Degrees of protection provided by enclosures
EN 50081-2	EMC, Generic emission
EN 50082-2	EMC, Generic immunity
ANSI/UL 1740-1996 (option)	Standard for Industrial Robots and Robotic Equipment
CAN/CSA Z 434-94 (option)	Industrial Robots and Robot Systems - General Safety Requirements

The robot complies fully with the health and safety standards specified in the EEC's Machinery Directives.

The robot is designed with absolute safety in mind. It has a dedicated safety system based on a two-channel circuit which is monitored continuously. If any component fails, the electrical power supplied to the motors shuts off and the brakes engage.

### **Safety category 3**

Malfunction of a single component, such as a sticking relay, will be detected at the next MOTOR OFF/MOTOR ON operation. MOTOR ON is then prevented and the faulty section is indicated. This complies with category 3 of EN 954-1, Safety of machinery - safety related parts of control systems - Part 1.

### **Selecting the operating mode**

The robot can be operated either manually or automatically. In manual mode, the robot can only be operated via the teach pendant, i.e. not by any external equipment.

### **Reduced speed**

In manual mode, the speed is limited to a maximum of 250 mm/s (600 inch/min.). The speed limitation applies not only to the TCP (Tool Centre point), but to all parts of the robot. It is also possible to monitor the speed of equipment mounted on the robot.

### **Three position enabling device**

The enabling device on the teach pendant must be used to move the robot when in manual mode. The enabling device consists of a switch with three positions, meaning

## *Description*

that all robot movements stop when either the enabling device is pushed fully in, or when it is released completely. This makes the robot safer to operate.

### **Safe manual movement**

The robot is moved using a joystick instead of the operator having to look at the teach pendant to find the right key.

### **Over-speed protection**

The speed of the robot is monitored by two independent computers.

### **Emergency stop**

There is one emergency stop push button on the controller and another on the teach pendant. Additional emergency stop buttons can be connected to the robot's safety chain circuit.

### **Safeguarded space stop**

The robot has a number of electrical inputs which can be used to connect external safety equipment, such as safety gates and light curtains. This allows the robot's safety functions to be activated both by peripheral equipment and by the robot itself.

### **Delayed safeguarded space stop**

A delayed stop gives a smooth stop. The robot stops in the same way as at a normal program stop with no deviation from the programmed path. After approx. 1 second the power supplied to the motors shuts off.

### **Collision detection (option)**

In case an unexpected mechanical disturbance like a collision, electrode stick etc appears, the robot will stop and slightly back off from its stop position.

### **Restricting the working space**

The movement of each axis can be restricted using software limits.

There are safeguarded space stops for connection of limit switches to restrict the working space.

Axes 1-3 can also be restricted (option).

### **Hold-to-run control**

"Hold-to-run" means that you must depress the start button in order to move the robot. When the button is released the robot will stop. The hold-to-run function makes program testing safer.

### **Fire safety**

Both the manipulator and control system comply with UL's (Underwriters Laboratory) tough requirements for fire safety.

### **Safety lamp (option)**

As an option, the robot can be equipped with a safety lamp mounted on the manipulator. This is activated when the motors are in the MOTORS ON state.



### 1.3 Installation

The IRB 6400PE is designed for floor mounting. An end effector of max. weight 75 kg, including payload, can be mounted on the mounting flange (axis 6). Load diagram, see page 8.

Extra loads (valve packages, transformers) can be mounted on the upper arm. An extra load can also be mounted on the frame of axis 1. Holes for extra equipment see page 11.

The working range of axes 1-3 can be limited by mechanical stops. Position switches can be supplied on axis 1 and axis 2 for position indication of the manipulator.

#### Operating requirements

<b>Protection standards</b>	IEC529
Manipulator	IP54
Wrist	IP55

#### Explosive environments

The robot must not be located or operated in an explosive environment.

#### Ambient temperature

Manipulator during operation	+5°C (41°F) to +45°C (117°F)
Complete robot during transportation and storage, for short periods (not exceeding 24 hours)	-25°C (13°F) to +55°C (131°F) up to +70°C (158°F)

#### Relative humidity

Complete robot during transportation and storage	Max. 95% at constant temperature
Complete robot during operation	Max. 95% at constant temperature

#### Mounting the manipulator

Maximum load in relation to the base coordinate system.

	Endurance load in operation	Max. load at emergency stop
Force xy	± 12000 N	± 18000 N
Force z	21000 ± 5500 N	21000 ± 10000 N
Torque xy	± 32000 Nm	± 39000 Nm
Torque z	± 12000 Nm	± 13000 Nm

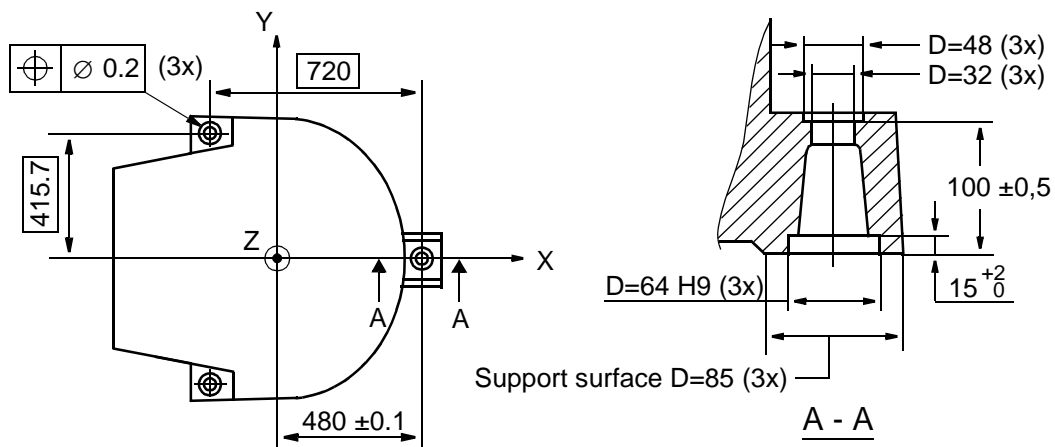
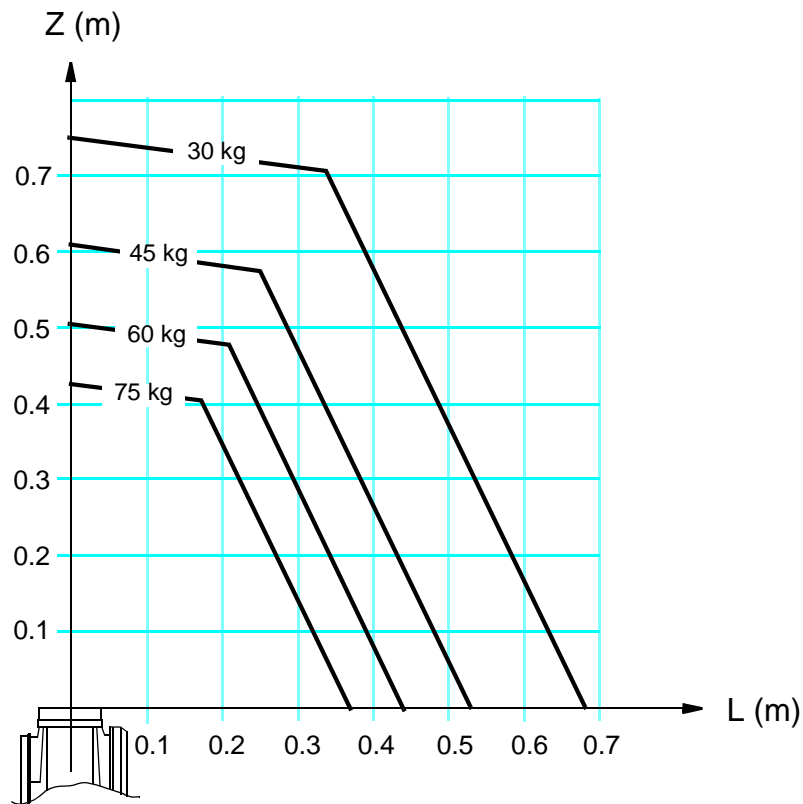


Figure 3 Hole configuration (dimensions in mm).

# Description

## Load diagram

Load diagram for **IRB 6400PE**



The load diagram is valid for  $J_0 \leq 10 \text{ kgm}^2$ .

$J_0$  = the maximum component ( $J_{X0}$ ,  $J_{Y0}$ ,  $J_{Z0}$ ) of the moment of inertia of the handling weight at its centre of gravity.

*Figure 4 Maximum weight permitted for load mounted on the mounting flange at different positions (centre of gravity).*

**Process forces**

Max. force through the wrist centre:

- 0 to 65° relative to the vertical line, F = 5000 N
- 65 to 90° relative to the vertical line, F = 4500 N
- 90 to 115° relative to the vertical line, F = 3500 N

Max. offset force from the wrist centre:

- 3500 N when r = 100 mm.

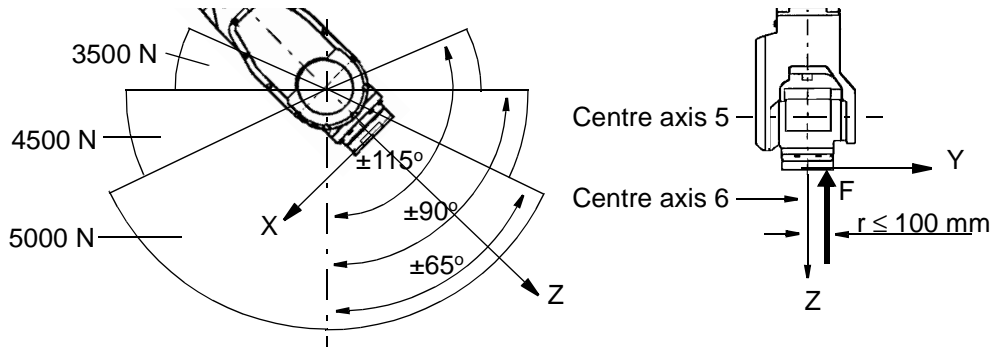


Figure 5 Max. force through the wrist centre.

The direction of force F must be parallel to the z-axis in the tool coordinate system.

Time at max. force:

- < 1 second excluding rewelds
- < 3 seconds for rewelds

Due to the dynamic forces and the backward elastic deflection in the robot, the rise time for rebuilding the forces in the air cylinder must comply with the values below:

- Min. time to achieve 90% of max force:
 

F > 3500 N	> 0.15 sec.
F ≤ 3500 N	> 0.03 sec.
- Min. time to go from 100% load to 0% load:
 

F > 3500 N	> 0.1 sec.
F ≤ 3500 N	> 0.03 sec.

The angular fault from the z-axis must be less than 5°.

The distance between the weld cylinder and weld plate: 15 mm.

The number of poke points permitted per minute:

The force contact surface = 1 sec. (Cabinet temperature 45° C).

The number of points can be increased if the cabinet temperature can be decreased.

Axis	% Torque <sup>1</sup>	Number of points/minute <sup>2</sup>
1	100	3-5
	75	6-8
	50	15-20
2 and 3	100	12-25
	75	26-40

<sup>1</sup> 100% = maximum torque load on current axis.

<sup>2</sup> The lower value applies when the current robot axis is executing large movements. The higher value applies for small movements of the current axis.

# Description

## Mounting equipment

Extra loads can be mounted on the upper arm and the frame. Definitions of distances and masses are shown in Figure 6 (upper arm) and in Figure 7 (frame). The robot is supplied with holes for mounting extra equipment (see Figure 8).

### Upper arm

Permitted extra load on upper arm plus the maximum handling weight

(See Figure 6):

$M1 \leq 35$  kg with distance  $a \leq 500$  mm, centre of gravity in axis 3 extension  
or

$M2 \leq 35$  kg with distance  $b \leq 400$  mm

or

$M3 \leq 10$  kg with distance  $c \geq 300$  mm

If the handling weight is lower than the maximum weight, M1 alt. M2 can be increased as follows:

$M1$  (alt.  $M2$ ) + handling weight  $\leq 35$  kg + max. handling weight

For example, if the handling weight for 2.4-120 is only 80 kg, M2 can be 75 kg.



Figure 6 Permitted extra load on upper arm.

### Frame (Hip Load)

Permitted extra load on frame is  $J_H = 120$  kgm<sup>2</sup>.

Recommended position (see Figure 7).

$$J_H = J_{H0} + M4 \cdot R^2$$

where  $J_{H0}$  is the moment of inertia of the equipment  
 $R$  is the radius (m) from the centre of axis 1  
 $M4$  is the total mass (kg) of the equipment including bracket and harness ( $\leq 320$  kg)

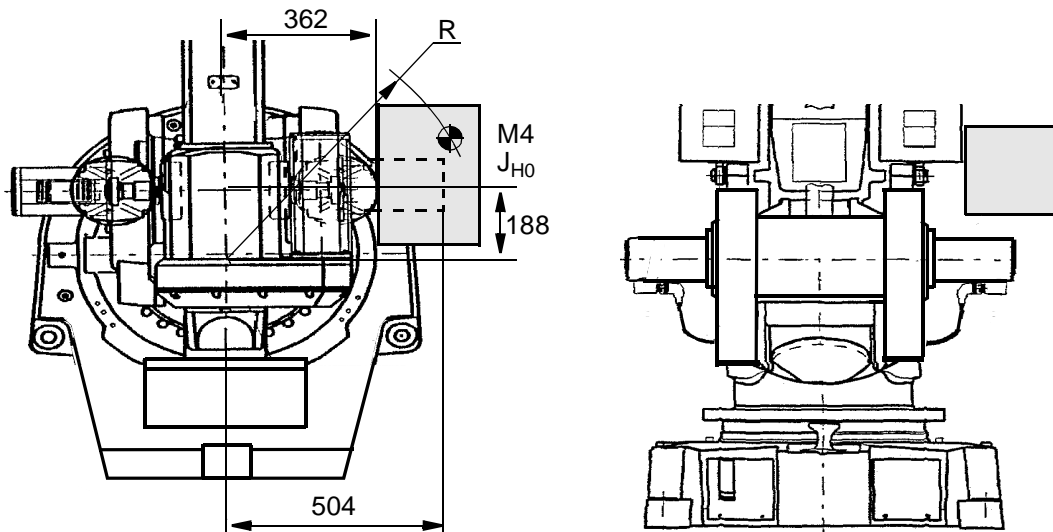


Figure 7 Extra load on frame of IRB 6400PE (dimensions in mm).

Holes for mounting equipment

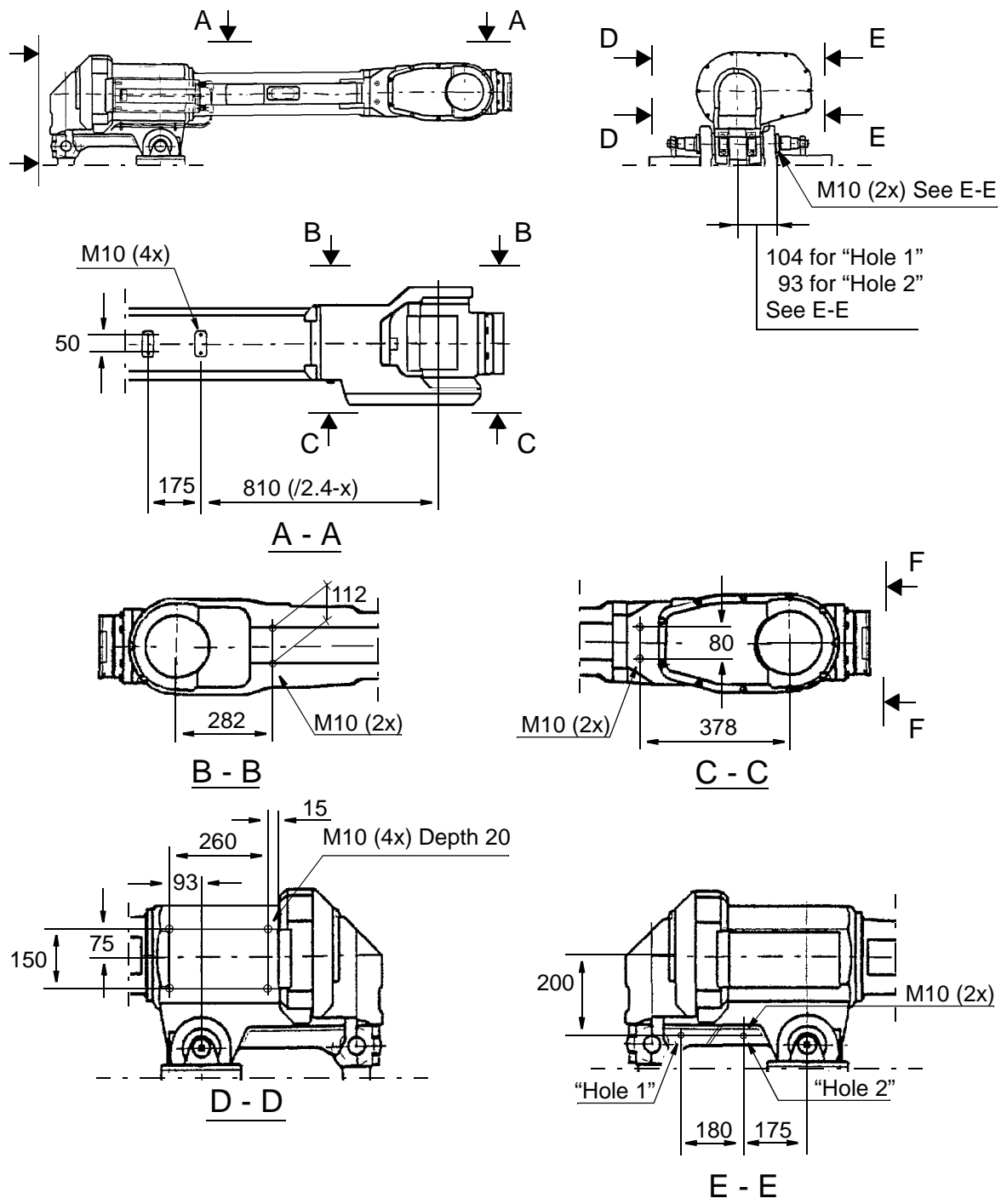


Figure 8 Holes for mounting extra equipment (dimensions in mm).

## Description

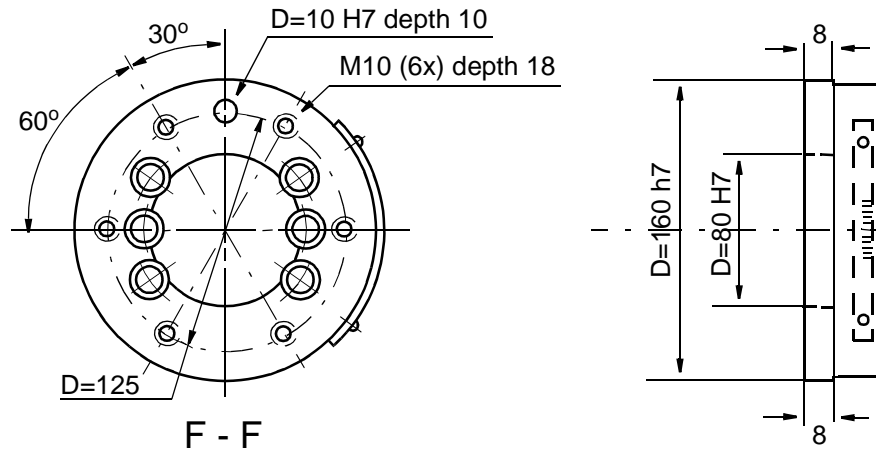


Figure 9 The mechanical interface (mounting flange) ISO 9409-1-A125 (dimensions in mm).

As an option there is an electrically insulated tool flange.  
For more information see Figure 13.

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## 1.4 Maintenance and Troubleshooting

The robot requires only a minimum of maintenance during operation. It has been designed to make it as easy to service as possible:

- Maintenance-free AC motors are used.
- Liquid grease or oil is used for the gear boxes.
- The cabling is routed for longevity, and in the unlikely event of a failure, its modular design makes it easy to change.

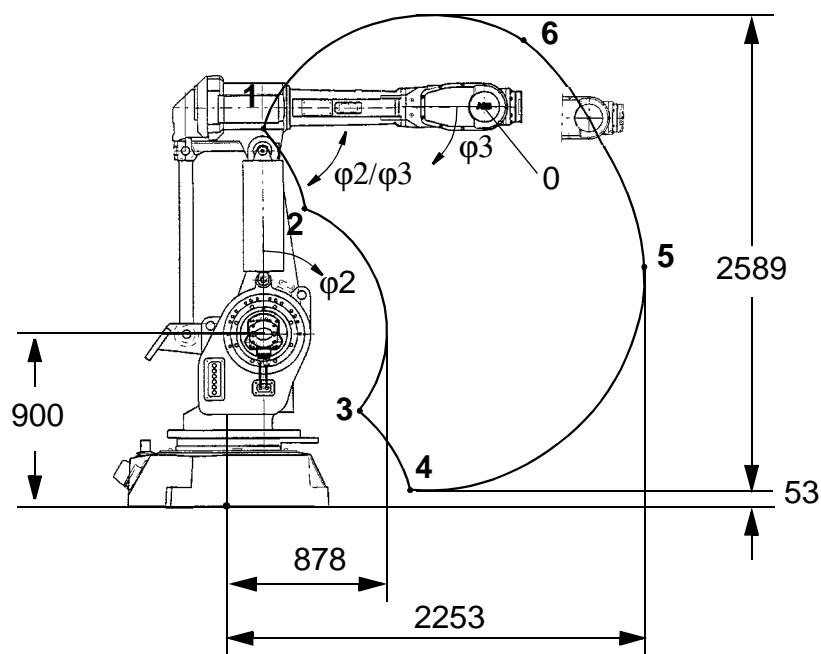
The following maintenance is required:

- Changing filter for the transformer/drive unit cooling every year.
- Changing grease and oil every third year.
- Changing batteries every third year.
- Some additional checks every year.

The maintenance intervals depends on the use of the robot. For detailed information on maintenance procedures, see Maintenance section in the Product Manual.

## 1.5 Robot Motion

Type of motion	Range of movement
Axis 1 Rotation motion	+180° to -180°
Axis 2 Arm motion	+70° to -70°
Axis 3 Arm motion	+105° to -28°
Axis 4 Wrist motion	+200° to -200°
Axis 5 Bend motion	+120° to -120°
Axis 6 Turn motion	+300° to -300°



Positions at wrist centre (mm)

pos.	X	Z
0	1338	2075
1	205	1963
2	421	1549
3	718	459
4	1000	56
5	2246	1349
6	1669	2397

Angle  $\phi_2$ ,  $\phi_3$  (degrees)

pos.	axis 2 ( $\phi_2$ )	axis 3 ( $\phi_3$ )
0	0	0
1	-70	-28
2	-70	-5
3	40	105
4	70	105
5	70	5
6	37	-28

Angle 2/3 ( $\phi_2/\phi_3$ )

Min. 25° Max. 155° 90° at pos. 0
-------------------------------------

All dimensions refer to the wrist centre (mm)

Figure 10 The extreme positions of the robot arm (dimensions in mm).

## Description

### Performance according to ISO 9283

At rated load and 1 m/s velocity on the inclined ISO test plane with all six robot axes in motion.

Unidirectional pose repeatability:

RP = 0.2 mm

Linear path accuracy:

AT = 2.5 - 3.0 mm

Linear path repeatability:

RT = 0.8 - 1.4 mm

Minimum positioning time, to within 0.4 mm of the position:

0.3 - 0.5 sec. (on 35 mm linear path)

0.7 - 0.9 sec. (on 350 mm linear path)

The above values are the range of average test-results from a number of robots. If guaranteed values are required, please contact your nearest ABB Flexible Automation Centre.

### Velocity

Axis no.	1	70°/s
	2	70°/s
	3	70°/s
	4	210°/s
	5	150°/s
	6	210°/s

There is a supervision function to prevent overheating in applications with intensive and frequent movements.

### Resolution

Approx. 0.01° on each axis.

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## 1.6 Signals

### Signal connections on robot arm

For connection of extra equipment on the manipulator there are cables integrated into the manipulator's cabling, and two connectors, one Burndy 23-pin UTG 018-23S and one Burndy 12-pin UTG 014-12S, on the moveable part of the upper arm.

Signals	23	50 V, 250 mA
Power	10	250 V, 2 A
Air	1	Max. 10 bar, inner hose diameter 11 mm



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## 2 Specification of Variants and Options

The different variants and options for the IRB 6400PE are described below. The same numbers are used here as in the Specification form. For controller options, see Product Specification S4Cplus, and for software options, see Product Specification RobotWare Options.

### 1 MANIPULATOR

#### VARIANT

##### 022 IRB 6400PE/2.25-75

IRB 6400 Application, Mounting / Reach-Handling capacity

Application:	PE	Robot adapted for poke welding.
Mounting:	-	Floor-mounted manipulator.
Reach:		Specifies the max. reach at the wrist centre.
Handling capacity:		Specifies the max. handling capacity.

#### Manipulator colour

330 The manipulator is painted with ABB orange.

331- Colours according to RAL-codes.

348

#### Protection

035 Standard

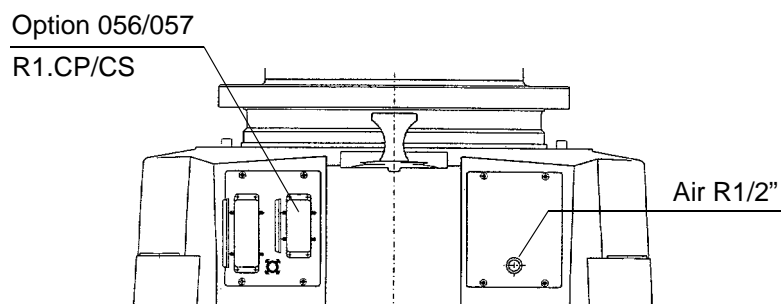
### APPLICATION INTERFACE

#### Air supply and signals for extra equipment to upper arm

042 Integrated hose for compressed air. There is an inlet at the base (see Figure 11) and an outlet on the upper arm (see Figure 12). Connections: R1/2".

For connection of extra equipment on the manipulator there are cables integrated into the manipulator's cabling, and two connectors, one Burndy 23-pin UTG 018-23S and one Burndy 12-pin UTG 014-12S, on the moveable part of the upper arm.

This option is standard on 6400PE.



# Specification of Variants and Options

Figure 11 Option 042, connection of signals and air to the base.

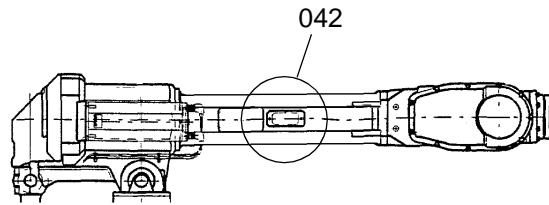


Figure 12 Connection of signals on the upper arm.

## Connection of signals to

### 056 Manipulator

The signals are connected directly to the robot base to one Harting 40-pin connector (see Figure 11). The cables from the manipulator base are not supplied.

### 057 Cabinet

The signals are connected to 12-pole screw terminals, Phoenix MSTB 2.5/12-ST-5.08, in the controller.

The cable between R1.CP/CS and the controller is supplied.

## Connection to cabinet (Cable lengths)

675 7m

676 15m

677 22m

678 30m

## EQUIPMENT

### 691 Safety lamp

A safety lamp with an orange fixed light can be mounted on the manipulator.

The lamp is active in MOTORS ON mode.

The safety lamp is required on a UL/UR approved robot.

### 058 Dressing

Mounting of extra equipment, e.g. tool system on robot before delivery, ordered from ABB Flexible Automation/Dpt U.

### 092 Fork lift device

Lifting device on the manipulator for fork-lift handling is mounted at delivery.

Lifting eyes for use with an overhead crane are integrated as standard.

### 091 Brake release cover

Protective cover over push-buttons on brake release unit.

### 089 Insulated flange

Electrically insulated tool flange. In case of an electrical fault in the spot welding equipment mounted on the tool flange, the tool flange withstands dangerous voltage (100V AC during 60 seconds or 300V AC during 10 seconds) in non water applications without passing it further to electronics in the robot and controller.

See Figure 13.

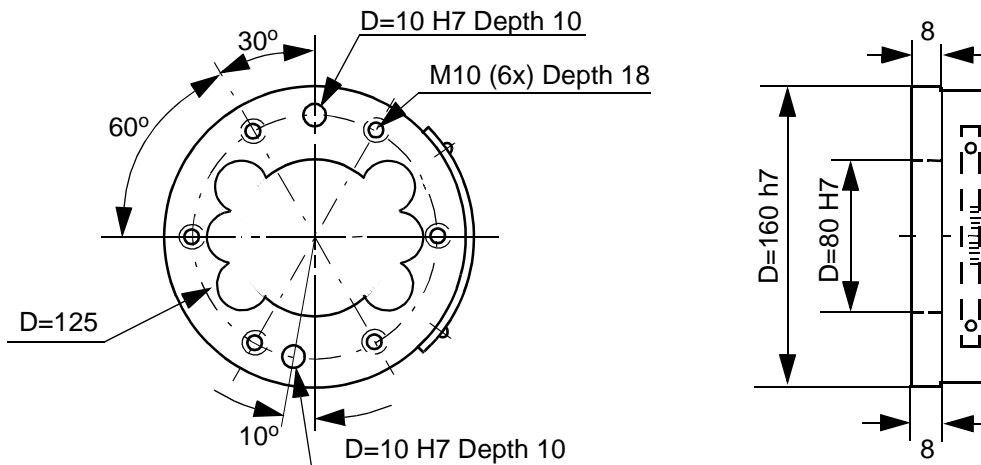


Figure 13 The mechanical interface of the insulated flange (dimensions in mm).

## POSITION SWITCH

Position switches indicating the position of one or two of the main axes. Rails with separate adjustable cams are attached to the manipulator. The cams, which have to be adapted to the switch function by the user, can be mounted in any position in the working range for each switch.

The position switch device is delivered as a kit to be assembled when installing the robot. Assembly instruction is included.

**Note!** This option may require external safety arrangements, e.g. light curtains, photocells or contact mats.

**Note** The switches are not recommended to be used in severe environment with sand or chips.

1, 2 or 3 switches indicating the position of axis 1.

Switch type: Telemecanique XCK-M1/ZCK-D16, 2 pole N/C + N/O, according to IEC 947-5-1.

- 069** 1 switch, axis 1
- 070** 2 switches, axis 1
- 071** 3 switches, axis 1
- 072** 1 switch, axis 2

### Connection to

#### **075 Manipulator**

Connection on the manipulator base with one FCI 23-pin connector.

#### **076 Cabinet**

The signals are connected to 12-pole screw terminals, Phoenix MSTB 2.5/12-ST-5.08, in the controller. The cable between the manipulator base R1.SW and the controller, is included.

## *Specification of Variants and Options*

### **Connection of signals (Cable lengths)**

<b>083</b>	7m
<b>084</b>	15m
<b>085</b>	22m
<b>086</b>	30m

### **WORKING RANGE LIMIT**

To increase the safety of the robot, the working range of axes 1, 2 and 3 can be restricted by extra mechanical stops.

#### **621 Axis 1**

2 stops which allow the working range to be restricted in any increment of 20°.

#### **622 Axis 2**

6 stops which allow the working range to be restricted in increments of 20°. Each stop decreases the motion by 20°. This means that the motion can be decreased by 6 x 20° from the maximum axis motion.

#### **623 Axis 3**

6 stops which allow the working range to be restricted in increments of 20°. Each stop decreases the motion by 20°. This means that the motion can be decreased by 6 x 20° from the maximum axis motion.

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## **3 Accessories**

There is a range of tools and equipment available, specially designed for the robot.

### **Basic software and software options for robot and PC**

For more information, see Product Specification S4Cplus, and Product Specification RobotWare Options.

### **Robot Peripherals**

- Track Motion
- Tool System
- Motor Units
- Spot welding system for transformer gun

## *Accessories*

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