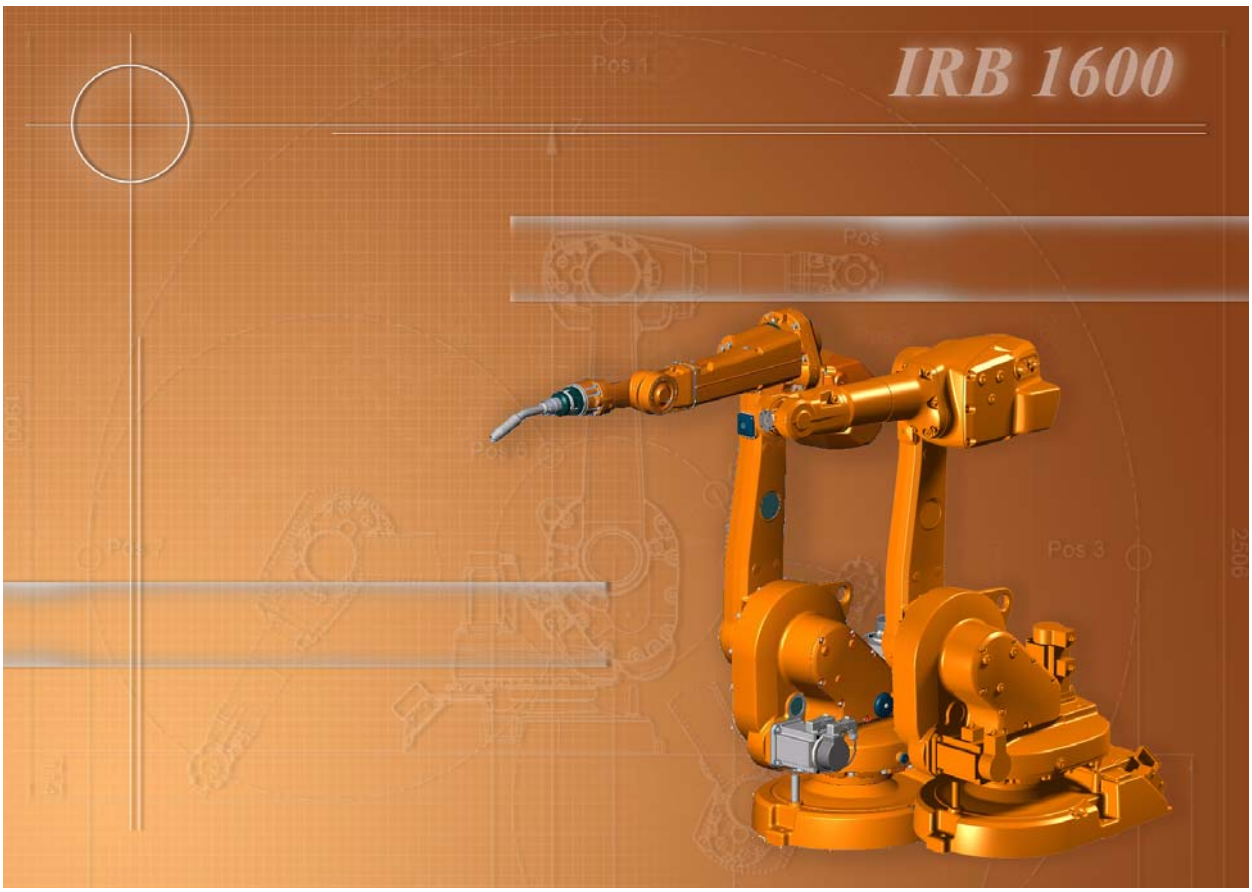
Product specification

Articulated robot

IRB 1600-6/1.2
IRB 1600-6/1.45
IRB 1600-8/1.2
IRB 1600-8/1.45
IRB 1600ID-4/1.5
M2004



Product specification

Articulated robot
3HAC023604-001
Rev.H
IRB 1600-6/1.2
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IRB 1600-8/1.2
IRB 1600-8/1.45
IRB 1600ID-4/1.5

M2004

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Overview

About this Product specification

It describes the performance of the manipulator or a complete family of manipulators in terms of:

- The structure and dimensional prints
- The fulfilment of standards, safety and operating requirements
- The load diagrams, mounting of extra equipment, the motion and the robot reach
- The integrated auxiliary equipments as that is: Customer Connections
- The specification of variant and options available

Users

It is intended for:

- Product managers and Product personnel
- Sales and Marketing personnel
- Order and Customer Service personnel

Contents

Please see Table of Contents on page 3

Revisions

Revision	Description
Revision 3	- Calibration positions and Absolute Accuracy information added in chapter 1.4 - New Inside address for ABB RobotLoad - New wrist, Type A added in chapter 1.5.5 - Figures for customer connections added
Revision D	- Option 287-5 Wash removed
Revision E	- New versions IRB 1600ID-4/1.5, IRB 1600-6/x and IRB 1600-8/x added - Changes in Safety/Standards - Directions of forces added - Increased payloads for standard robots - Arc welding options added - Warranty information for load diagrams
Revision F	- Old versions removed and AW offer changed.
Revision G	- Changes for Calibration data - Work range - Explanation of ISO values (new figure and table) - Stopping distance - Changes in chapter Specification of Variants and Options, Track Motion and Process equipment - User documentation on DVD
Revision H	- Added information about moutin equipment on upper arm

Complementary documentation

Product specification	Description
Controller	IRC5 with FlexPendant, 3HAC021785-001
Controller Software IRC5	RobotWare 5.11, 3HAC022349-001
Robot User Documentation	IRC5 and M2004, 3HAC024534-001
Product Manual	**Description**
Manipulator	IRB 1600, 3HAC026660-001

1 Description

1.1 Structure

1.1.1 Introduction

Robot family

A number of new possibilities open up with ABB’s IRB 1600 robot. It is available in five versions, and the latest one is the dedicated AW robot, IRB 1600ID-4/1.5 with an compact AW dressed process upper arm.

The IRB 1600 family is ideal for Arc Welding, Machine Tending, Material Handling, Gluing and Deburring/Grinding applications.

Software product range

We have added a range of software products - all falling under the umbrella designation of Active Safety - to protect not only personnel in the unlikely event of an accident, but also robot tools, peripheral equipment and the robot itself.

Operating system

The robot is equipped with the operating system RobotWare RW. RobotWare RW controls every aspect of the robot, like motion control, development and execution of application programs, communication etc. see Product specification - Controller IRC5 with FlexPendant.

Additional functionality

For additional functionality, the robot can be equipped with optional software for application support - for example spot welding, communication features - network communication - and advanced functions such as multi-tasking, sensor control, etc. For a complete description on optional software, see Product specification - Controller software IRC5.

Protection Foundry

With Protection Foundry, the robot is suitable to operate in harsh environments and has special surface treatment and paint for excellent corrosion protection. The connectors are designed for severe environments and bearings, gears and other sensitive parts are carefully protected. The robot has Foundry Plus protection, which means that the whole manipulator is IP 67 classified and steam washable.

Clean room robots

The Clean room robots are classified for room class 10 according to US Federal Standard 209 or class 4 according to ISO 14644-1.

The performed clean room test has classify the air cleanliness exclusively in terms of concentration of airborne particles generated by the robot. Other aspects of the clean room test or other clean room requirements are not considered.

Manipulator axes

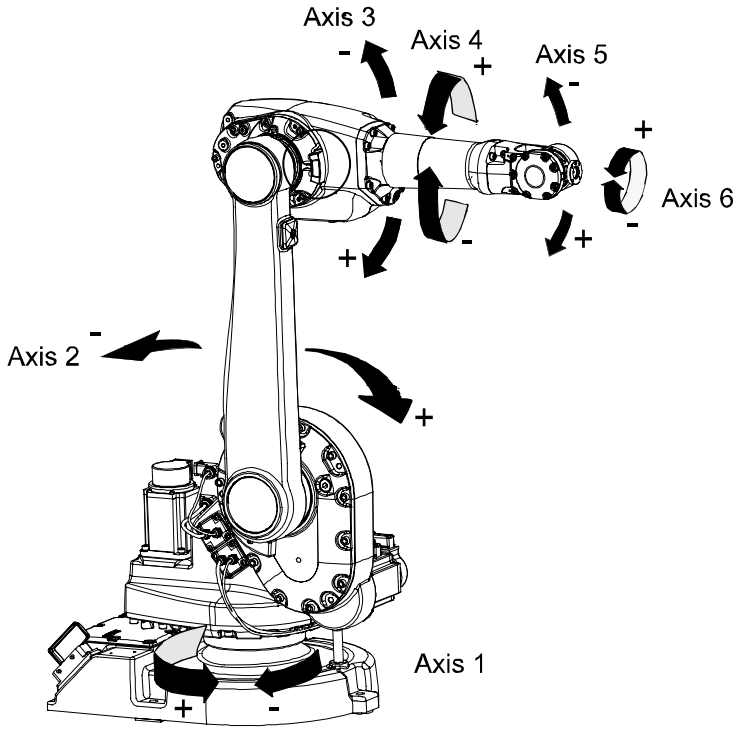


Figure 1 The IRB 1600 manipulator has 6 axes.

1.1.2 Different robot versions

General

The IRB 1600 is available in five versions and four of them can be mounted on the floor, wall or inverted. Tilting of 30º of the robot base is allowed for the floor mounted with a rotation of axis 1 within ± 60º. For wall mounted robot with 6 kg payload the rotation of axis 1 is limited within ± 20º. For wall mounted robot with 8 kg payload the rotation of axis 1 is limited within ± 60°.

The IRB 1600ID-4/1.5 can only be mounted on the floor or inverted.

Robot type	Handling capacity (kg)	Reach (m)
IRB 1600	6 kg	1.2 m
IRB 1600	6 kg	1.45 m
IRB 1600	8 kg	1.2 m
IRB 1600	8 kg	1.45 m
IRB 1600ID	4 kg	1.5 m

Manipulator weight

Robot	Weight
IRB 1600-X/1.2	250 kg
IRB 1600-X/1.45	250 kg
IRB 1600ID-4/1.5	250 kg

Other technical data

Data	Description	Note
Airborne noise level	The sound pressure level outside the working space	< 70 dB (A) Leq (acc. to Machinery directive 89/392 EEC)

Power consumption

Path E1-E2-E3-E4 in the ISO Cube, max.load.

Speed (mm/s)	Power consumption (kW)	
	IRB 1600-x/1.2	IRB 1600(ID)-x/1.45(1.5)
Max.	0.58	0.57
1000	0.49	0.50
500	0.45	0.45
100	0.41	0.43

1.1.2 Different robot versions

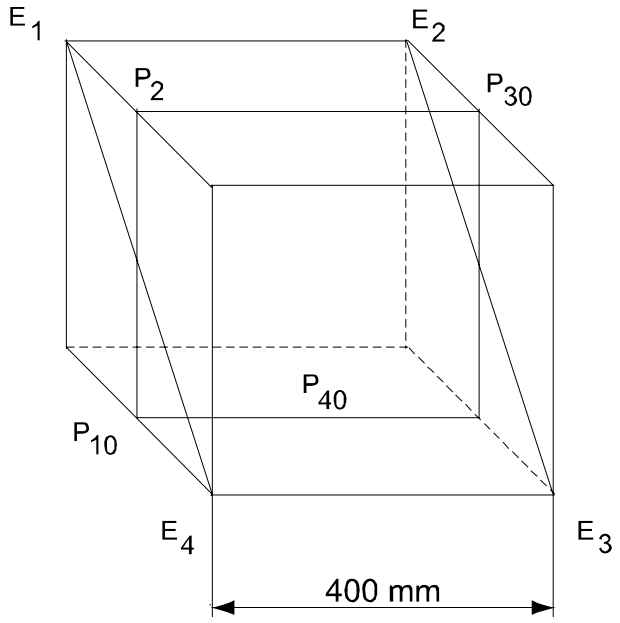


Figure 2 Path E-E2-E3-E4 in the ISO Cube, maximum load.

Dimensions IRB 1600-X/1.2 (1.45)

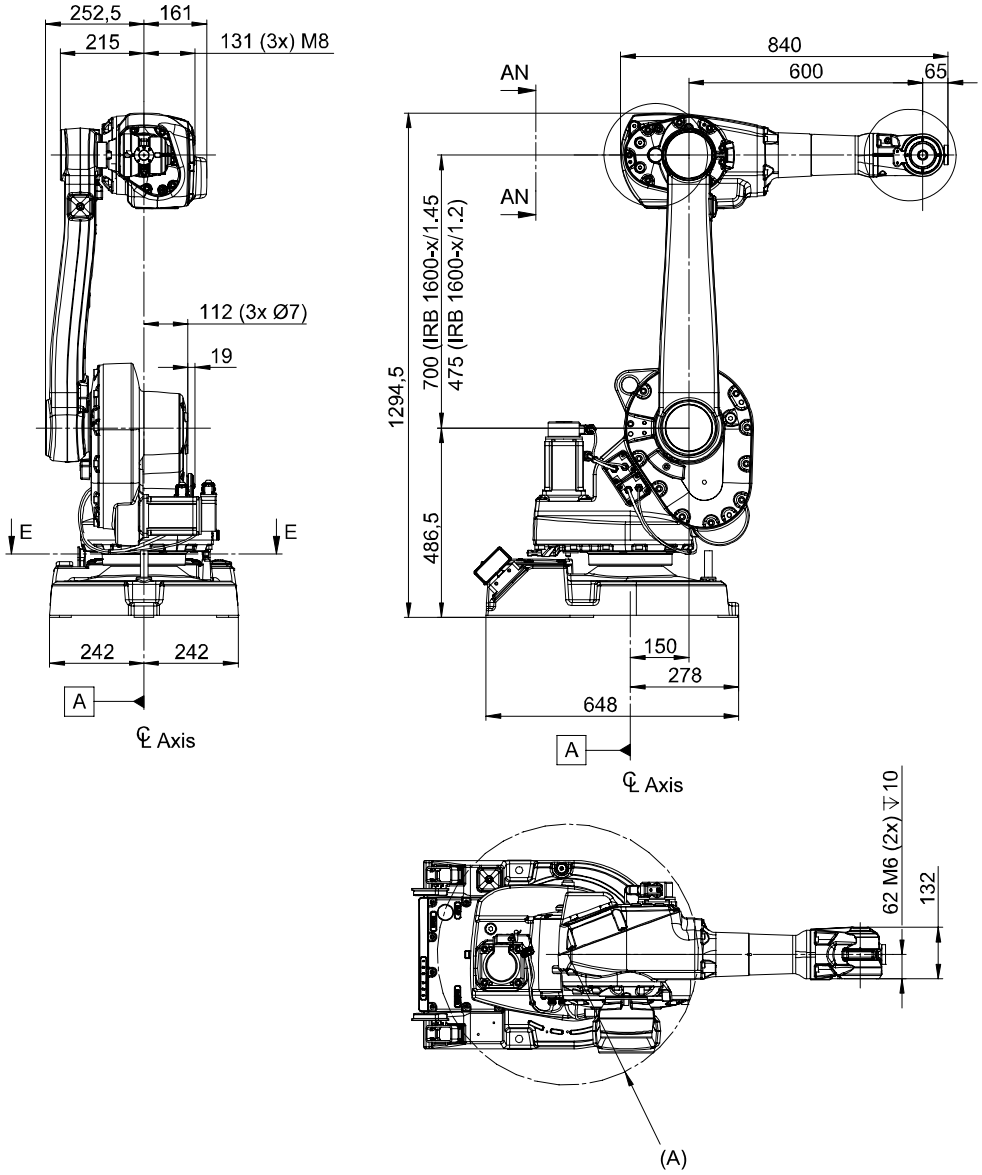


Figure 3 View of the manipulator from the back, side and above (dimensions in mm).

Pos	Description
A	R335 Minimum turning radius

1.1.2 Different robot versions

Dimensions IRB 1600ID-4/1.5

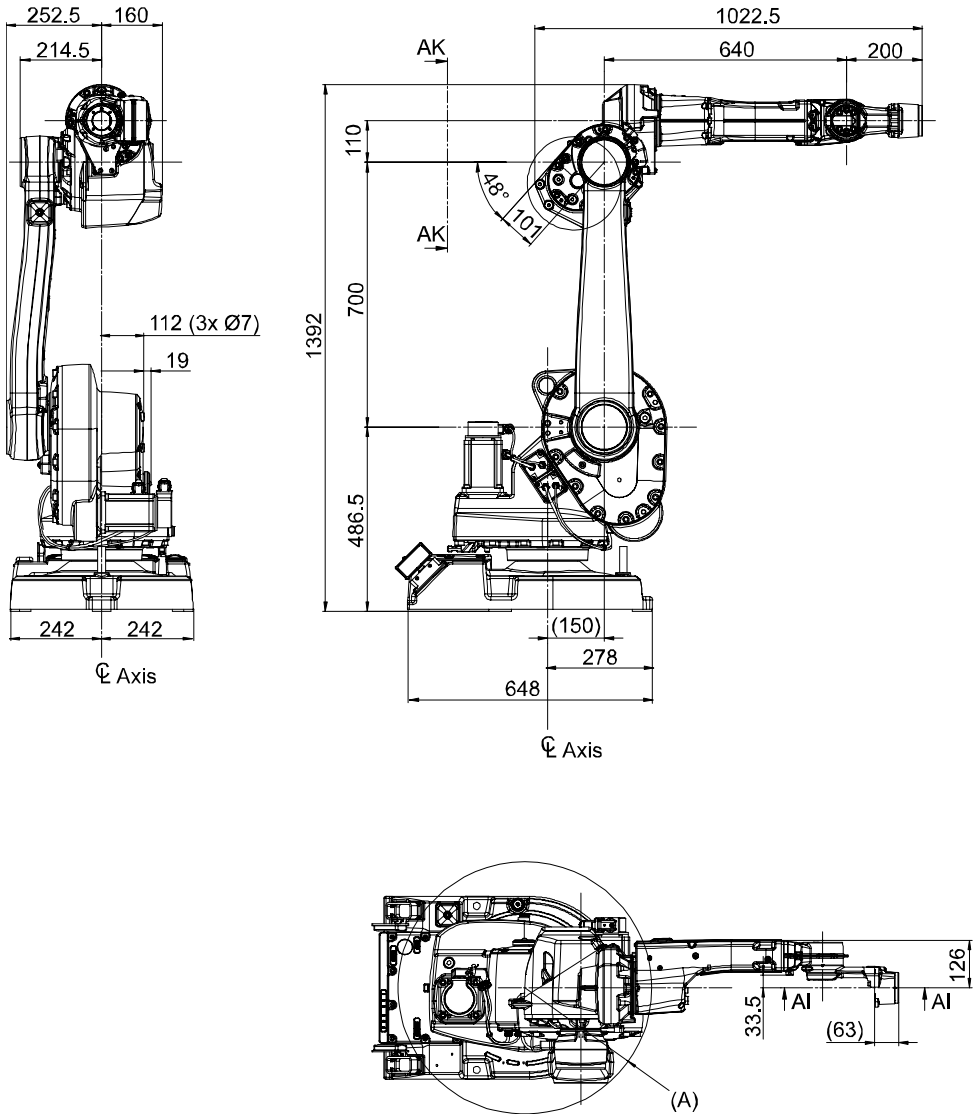


Figure 4 View of the manipulator from the back, side and above (dimensions in mm).

Pos	Description
A	R335 Minimum turning radius

1.2 Safety/Standards

1.2.1 Standards

The robot conforms to the following standards:

Standard	Description
EN ISO 12100 -1	Safety of machinery, terminology
EN ISO 12100 -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
EN ISO 60204-1:2006	Safety of machinery - Electrical equipment of machines
EN ISO 10218-1:2006[a]	Robots for industrial environments - Safety requirements
EN 609074-10: 2003	Arc welding equipment - part 10: electro magnetic capability (EMC) requirements
EN 61000-6-4: 2001[b]	EMC, Generic emission
EN 61000-6-2: 2005	EMC, Generic immunity

a. There is a deviation from paragraph 6.2 in that only worst case stop distances and stop times are documented.
b. Not valid for IRB 1600ID-4/1.5

Standard	Description
IEC 60529	Degrees of protection provided by enclosures

Standard	Description
ISO 9787	Manipulating industrial robots, coordinate Systems and motions

Standard	Description
ANSI/RIA 15.06/1999	Safety Requirements for Industrial Robots and Robot Systems.
ANSI/UL 1740-1998 (option)	Safety Standard for Robots and Robotic Equipment
CAN/CSA Z 434-03 (option)	Industrial Robots and Robot Systems - General Safety Requirements
US Federal Standard 209	Clean room classification

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

Safety function	Description
The Service Information System (SIS)	The service information system gathers information about the robot's usage and determines how hard the robot is used. The usage is characterized by the speed, the rotation angles and the load of every axis. With this data collection, the service interval of every individual robot of this generation can be predicted, optimized and service activities planned ahead. The collection data is available via the FlexPendant or the network link to the robot. The Process Robot Generation is designed with absolute safety in mind. It is dedicated to actively or passively avoid collisions and offers the highest level of safety to the operators and the machines as well as the surrounding and attached equipment. These features are presented in the active and passive safety system. The time the robot is in operation (brakes released) is indicated on the FlexPendant. Data can also be monitored over network, using for example WebWare.

The Active Safety System	Description
General	The active safety system includes those software features that maintain the accuracy of the robot's path and those that actively avoid collisions which can occur if the robot leaves the programmed path accidentally or if an obstacle is put into the robot's path.
The Active Brake System (ABS)	All robots are delivered with an active brake system that supports the robots to maintain the programmed path in General Stop (GS), Auto Stop (AS) and Superior Stop (SS). The ABS is active during all stop modes, braking the robot to a stop with the power of the servo drive system along the programmed path. After a specific time the mechanical brakes are activated ensuring a safe stop. The stopping process is in accordance with a class 1 stop. The maximum applicable torque on the most loaded axis determines the stopping distance. In case of a failure of the drive system or a power interruption, a class 0 stop turns out. Emergency Stop (ES) is a class 0 stop. All stops (GS, AS, SS and ES) are reconfigurable. While programming the robot in manual mode, the enabling device has a class 0 stop.
The Self Tuning Performance (STP)	The Process Robot Generation is designed to run at different load configurations, many of which occur within the same program and cycle. The robot's installed electrical power can thus be exploited to lift heavy loads, create a high axis force or accelerate quickly without changing the configuration of the robot. Consequently the robot can run in a "power mode" or a "speed mode" which can be measured in the respective cycle time of one and the same program but with different tool loads. This feature is based on QuickMove™. The respective change in cycle time can be measured by running the robot in NoMotionExecution with different loads or with simulation tools like RobotStudio.

The Active Safety System	Description
The Electronically Stabilised Path (ESP)	The load and inertia of the tool have a significant effect on the path performance of a robot. The Process Robot Generation is equipped with a system to electronically stabilize the robot's path in order to achieve the best path performance. This has an influence while accelerating and braking and consequently stabilizes the path during all motion operations with a compromise of the best cycle time. This feature is secured through TrueMove™.
Over-speed protection	The speed of the robot is monitored by two independent computers.
Restricting the working space	The movement of each axis can be restricted using software limits. As options there are safeguarded space stops for connection of position switches to restrict the working space for the axes 1-3. Axes 1-3 can also be restricted by means of mechanical stops.
Collision detection (option)	In case of an unexpected mechanical disturbance, such as a collision, electrode sticking, etc., the robot will detect the collision, stop on the path and slightly back off from its stop position, releasing tension in the tool.

The Passive Safety System	Description
General	The Process Robot Generation has a dedicated passive safety system that by hardware construction and dedicated solutions is designed to avoid collisions with surrounding equipment. It integrates the robot system into the surrounding equipment safely.
Compact robot arm design	The shape of the lower and upper arm system is compact, avoiding interference into the working envelope of the robot. The lower arm is shaped inward, giving more space under the upper arm to re-orientate large parts and leaving more working space while reaching over equipment in front of the robot. The rear side of the upper arm is compact, with no components projecting over the edge of the robot base even when the robot is moved into the home position.
Moveable mechanical limitation of main axes (option)	All main axes can be equipped with moveable mechanical stops, limiting the working range of every axis individually. The mechanical stops are designed to withstand a collision even under full load.
Electronic Position Switches (EPS) on up to 7 axes (option)	EPS offers axes position status signals, fulfilling applicable regulations for personnel safety. Five outputs can each be configured to reflect the position of a single axis or a combination of axes. For each output, the range for each included axis can be set arbitrarily.

1.2.1 Standards

The Internal Safety Concept	Description
General	The internal safety concept of the Process Robot Generation is based on a two-channel circuit that 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 FlexPendant, that is 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 Center 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 FlexPendant must be used to move the robot when in manual mode. The enabling device consists of a switch with three positions, meaning 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 FlexPendant to find the right key.
Emergency stop	There is one emergency stop push button on the controller and another on the FlexPendant. 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 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 is shut off.
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 Laboratories Inc.) 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

1.3.1 Introduction

General

IRB 1600 can be mounted on the floor, wall or inverted. A tilting of 30º of the robot base is allowed with a rotation of axis 1 within ± 45º. For wall mounted robot with 6 kg payload the rotation of axis 1 is limited to within ± 20º. For wall mounted robot with 8 kg payload the rotation of axis 1 is limited within ± 60º. IRB 1600ID-4/1.5 can only be mounted on the floor or inverted. An end effector with max. weight of 6 kg or 8 kg including payload, can be mounted on the tool flange (axis 6), 4 kg valid for the IRB 1600ID-4/1.5 robot. See chapter *Robot load and Load diagrams* on page 25.

Extra equipment can be mounted on to the hip and on the upper arm. See *Mounting of equipment* on page 33.

Extra Loads

Extra load, which is included in the load diagrams, can be mounted on the upper arm. No extra arm load is included in the load diagram for IRB 1600ID-4/1.5. An extra load of 15 kg can also be mounted on the frame of axis 1. See Holes for mounting extra equipment on IRB 1600 page 33.

Working Range

The working range of axes 1-3 can be limited by mechanical stops. Electronic Position Switches can be used on all axes for position indication of the manipulator.

1.3.2 Operating requirements

Protection Standards

Robot version	Protection Standard IEC60529
Standard manipulator	IP 54
Protection Foundry	IP 67
Protection Wash	IP 67
IRB 1600ID-4/1.5	IP 40

Clean room standards

Clean room manipulator US Federal Standard 209, class 10 or ISO 14644-1 class 4.

Explosive Environments

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

Ambient Temprature

Description	Standard/Option	Temperature
Manipulator during operation	Standard	+ 5°C (+ 41°F) to + 45°C (+ 113°F)
For the controller	Standard/Option	See Product specification - IRC5 with FlexPendant
Complete robot (incl. controller) during transportation and storage	Standard	- 25°C (- 13°F) to + 55°C (+ 131°F) For short periods not > 24 hours: + 70°C (+ 158°F)

Relative Humidity

Description	Relative humidity
Complete robot during operation, transportation and storage	Max. 95% at constant temperature

1.3.3 Mounting the manipulator

Maximum load in relation to the base coordination system. See Figure 6.

	Mounting	Endurance load in operation	Max. load at Emergency stop
Force XY	Floor mounted Suspended Wall mounted Tilted ± 30º	± 1650 N ± 1650 N ± 3900 N ± 2500 N	± 3150 N ± 3150 N ± 5300 N ± 6000 N
Force Z	Floor mounted Suspended Wall mounted Tilted ± 30º	- 2500 ± 1150 N + 2500 ± 1150 N ± 1300 N + 2100 ± 1600 N	- 2500 ± 2200 N + 2500 ± 2200 N ± 2400 N + 2100 ± 3000 N
Torque XY	Floor, suspended	± 1700 Nm	± 3750 Nm
Torque Z	Floor, suspended	± 855 Nm	± 1400 Nm
Torque XY	Wall mounted	± 2310 Nm	± 3850 Nm
Torque Z	Wall mounted	± 855 Nm	± 1430 Nm

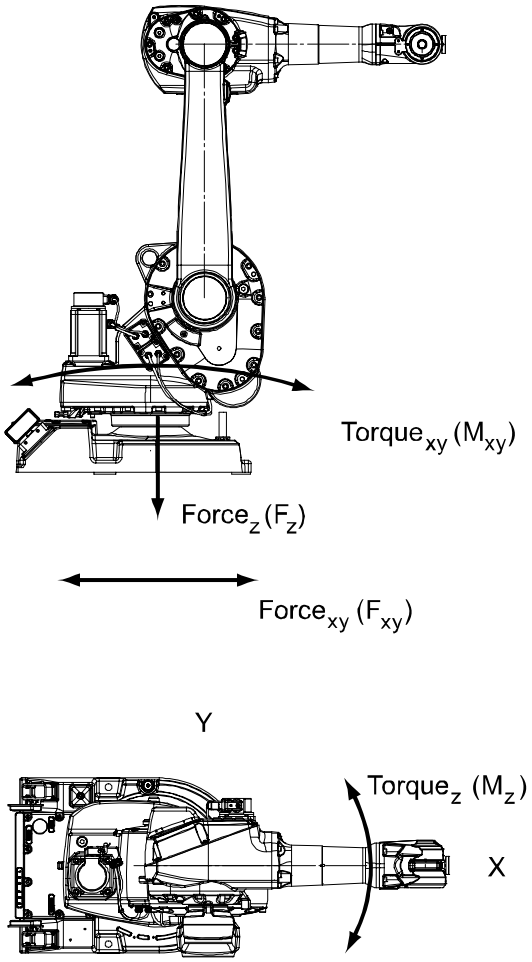


Figure 5 Directions of forces.

Note regarding M_{xy} and F_{xy}

The bending torque (M_{xy}) can occur in any direction in the XY-plane of the base coordinate system.

The same applies to the transverse force (F_{xy}).

Fastening holes Robot base

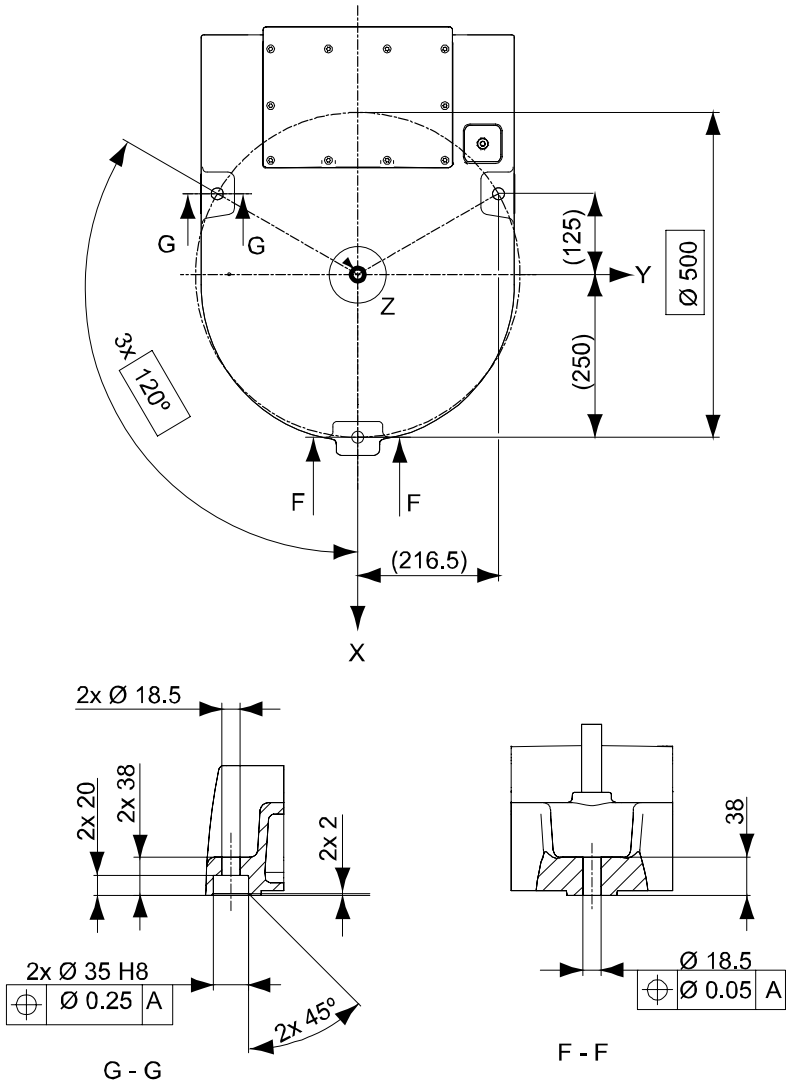


Figure 6 Hole configuration for robot base (dimensions in mm). View from the bottom of the base.

Attachment bolts, specification

The table below specifies required bolts and washers for securing the robot at installation site.

Specification	Description
Attachment bolts, 3 pcs	M16 x 60 (installation directly on foundation) M16 x 70/80 (installation on foundation or base plate, using guiding sleeves)
Washers, 3 pcs	17 x 30 x 3
Quality	Quality 8.8, wall mounted quality 12.9
Tightening torque	200 Nm

Note: For wall mounted robot, two guide bushings according to Figure 7 are needed.

Regarding Abs.Acc. performance, the chosen guide holes according to Figure 5 are recommended.

Mounting surface and bushings

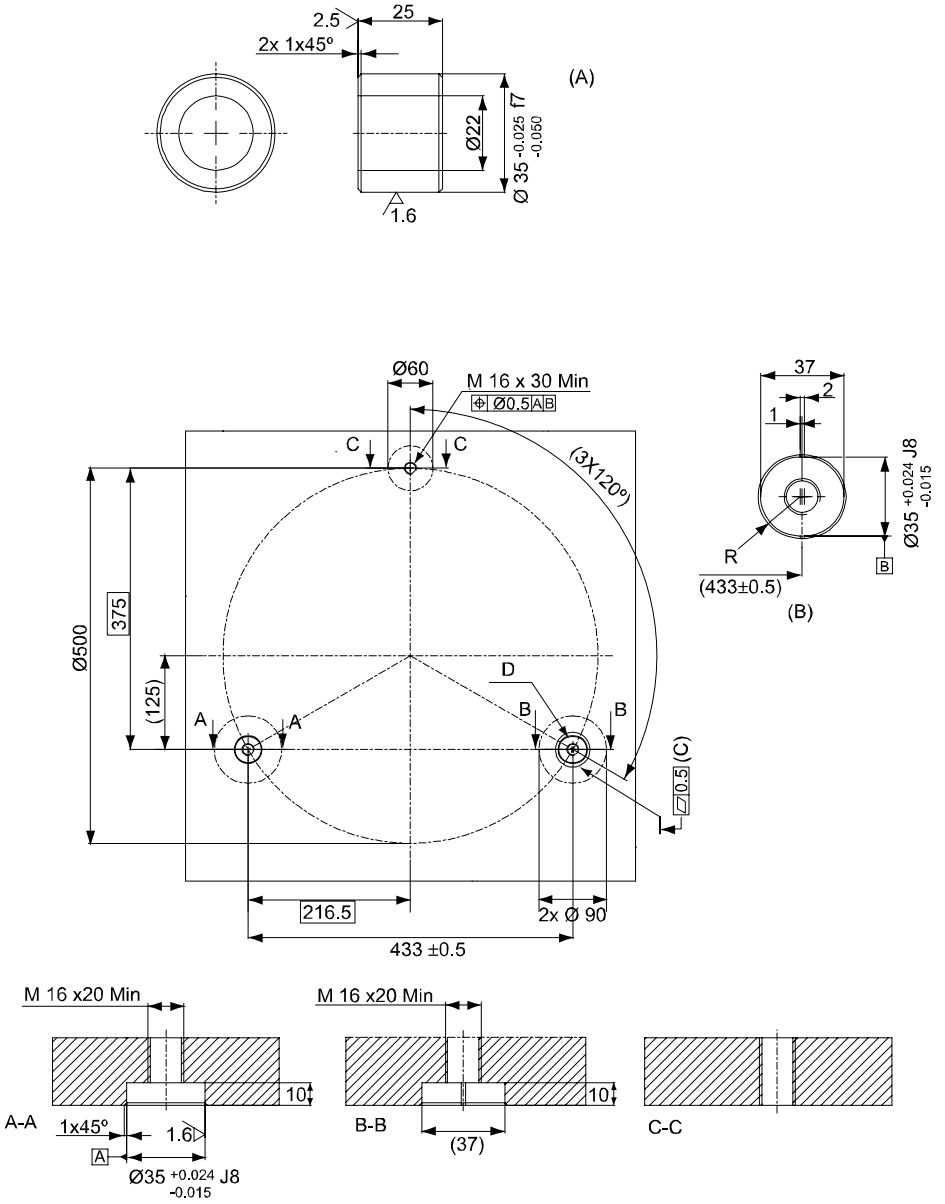


Figure 7 Mounting surface and bushings.

Pos	Description
A	Surface treatment, ISO 2081 Fe/Zn 8 c2, Guide bushing
B	View D
C	3x common zone

1.4 Calibration and References

1.4.1 Fine calibration

General

Fine calibration is made using the Calibration Pendulum, please see Operating manual - Calibration Pendulum.

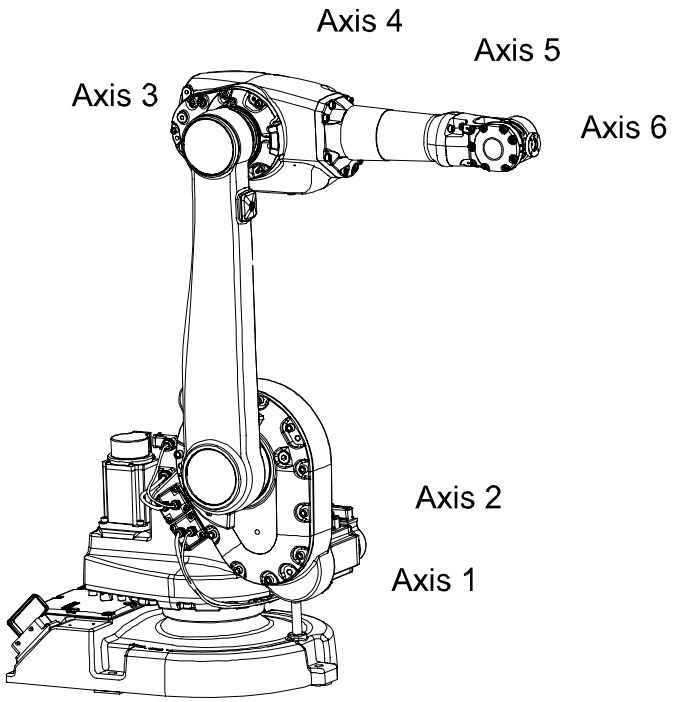


Figure 8 All axes in zero position.

Calibration

Calibration	Position
Calibration of all axes	All axes are in zero position
Calibration of axis 1 and 2	Axis 1 and 2 in zero position
	Axis 3 to 6 in any position
Calibration of axis 1	Axis 1 in zero position
	Axis 2 to 6 in any position

1.4.2 Absolute Accuracy calibration

General

Requires RobotWare option Absolute Accuracy, please see Product specification - Controller software IRC5/RobotWare Options for more details.

The calibration concept

Absolute Accuracy (AbsAcc) is a calibration concept, which ensures a TCP absolute accuracy of better than ± 1 mm in the entire working range (working range of bending backward robots, for example IRB 1600, are limited to only forward positions).

Absolute accuracy compensates for:

- Mechanical tolerances in the robot structure
- Deflection due to load

Absolute accuracy calibration is focusing on positioning accuracy in the cartesian coordinate system for the robot. It also includes load compensation for deflection caused by the tool and equipment. Tool data from robot program is used for this purpose. The positioning will be within specified performance regardless of load.

Calibration data

The user is supplied with robot calibration data (compensation parameters saved on the manipulator SMB) and a certificate that shows the performance (Birth certificate). The difference between an ideal robot and a real robot without AbsAcc can typically be 8 mm, resulting from mechanical tolerances and deflection in the robot structure.

If there is a difference, at first start-up, between calibration data in controller and the robot SMB, correct by copying data from SMB to controller.

Absolute Accuracy option

Absolute Accuracy option is integrated in the controller algorithms for compensation of this difference and does not need external equipment or calculation.

Absolute Accuracy is a RobotWare option and includes an individual calibration of the robot (mechanical arm).

Absolute Accuracy is a TCP calibration in order to Reach (m) a good positioning in the Cartesian coordinate system.

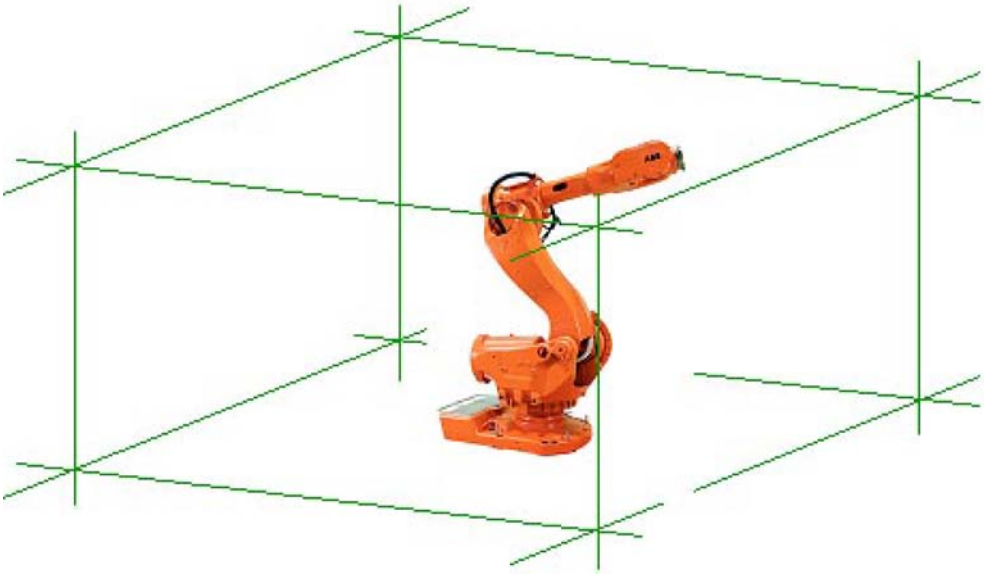


Figure 9 The Cartesian coordinate system.

Production data

Typical production data regarding calibration are:

Robot	Positioning accuracy (mm)		
	Average	Max	% Within 1 mm
IRB 1600-6/1.2 -6/1.45 -8/1.2 -8/1.45	0.30	0.65	100
IRB 1600ID-4/1.5	0.35	0.65	100

1.5 Robot load and Load diagrams

1.5.1 Introduction

It is very important to always define correct actual load data and correct payload of the robot. Incorrect definitions of load data can result in overloading of the robot.

If incorrect load data and/or loads outside load diagram is used the following parts can be damaged due to overload:

- motors
- gearboxes
- mechanical structure

Robots running with incorrect load data and/or with loads outside load diagram will not be covered by the robot warranty.

General

The load diagrams include a nominal pay load inertia, J_0 of 0.012 kgm^2, and an extra load of 15 kg for the IRB 1600-6/x variants and IRB 1600ID-4/1.5 (hose package included), 5 kg for the IRB 1600-8/x variants , at the upper arm housing.

At different arm load and moment of inertia the load diagram will be changed.

Control of load case by “RobotLoad”

For an easy check of a specific load case, use the calculation program ABB RobotLoad. Please contact your local ABB organization.

1.5.2 Load diagrams

IRB 1600-6/1.2, IRB 1600-6/1.45

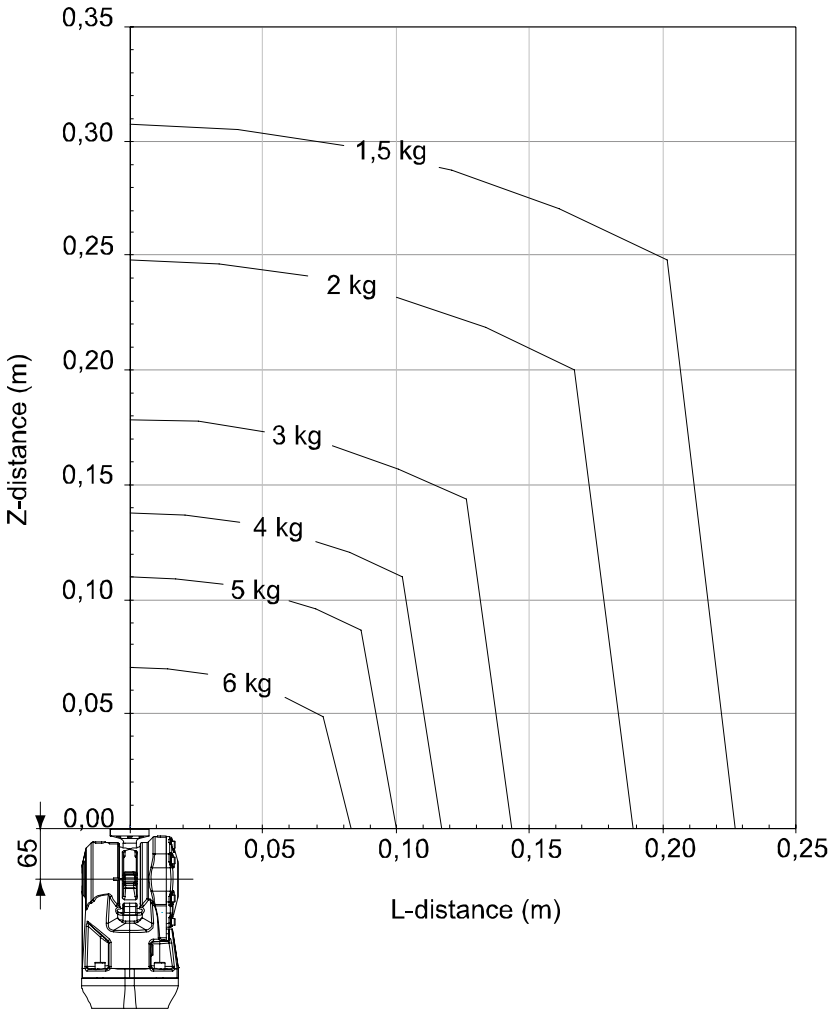


Figure 10 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity).

IRB 1600-6/1.2, IRB 1600-6/1.45 “Vertical Wrist” (±10º)

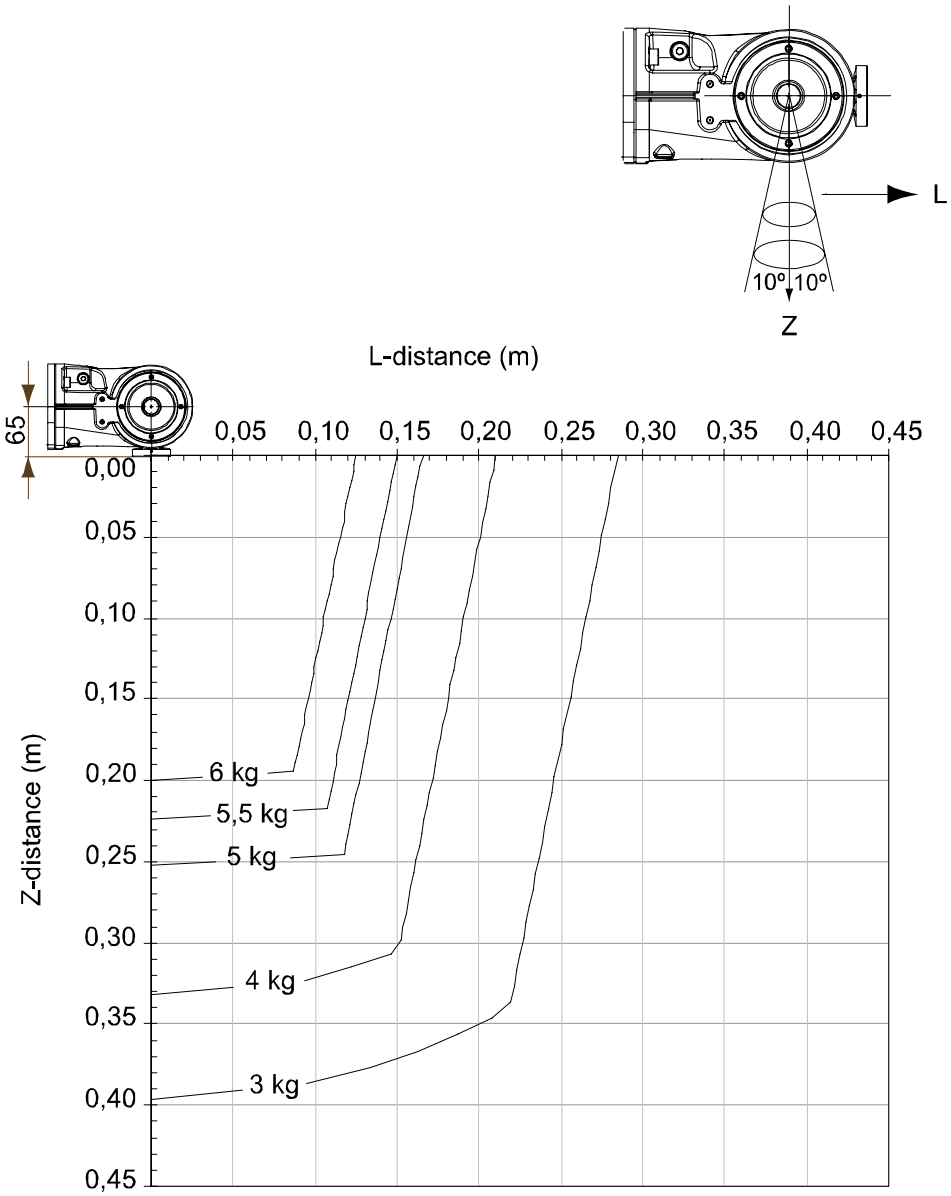


Figure 11 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity) at “Vertical Wrist” (±10º).

Description	Values
For wrist down (0° deviation from the vertical line) and no arm loads.	Max load = 13 kg Z_{Max} = 0.057 m L_{Max} = 0.031 m

IRB 1600-8/1.2, IRB 1600-8/1.45

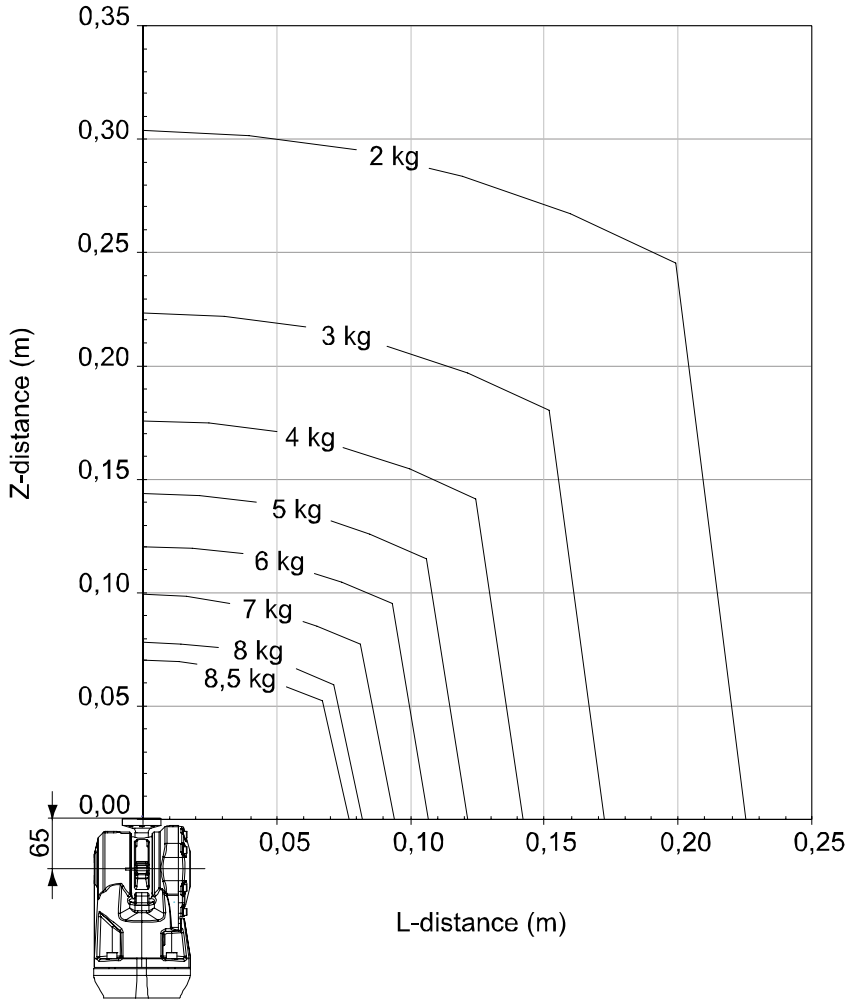


Figure 12 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity).

IRB 1600-8/1.2, IRB 1600-8/1.45 “Vertical Wrist” (±10º)

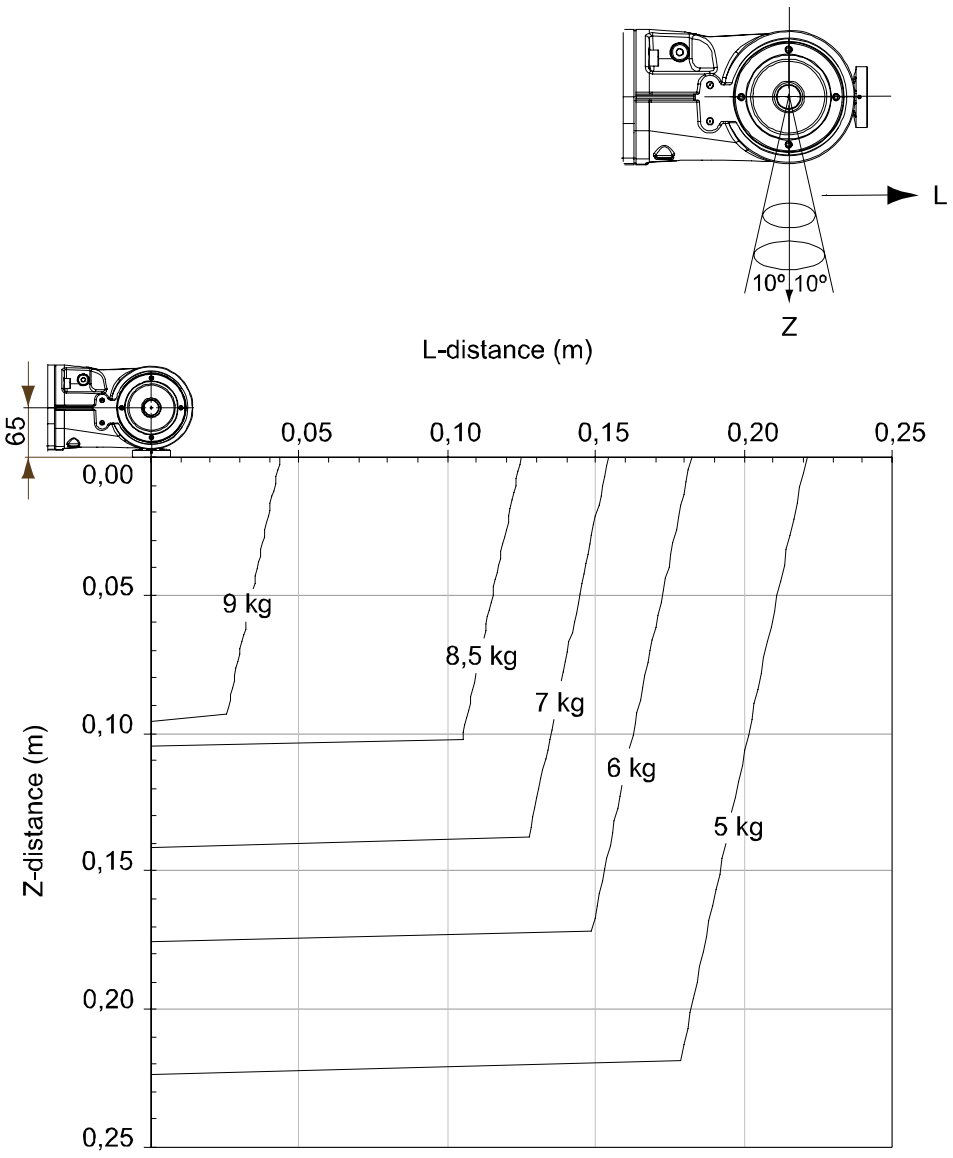


Figure 13 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity) at “Vertical Wrist” (±10º).

Description	Values
For wrist down (0° deviation from the vertical line) and no arm loads.	Max load = 12 kg Z_{Max} = 0.055 m L_{Max} = 0.017 m

IRB 1600ID-4/1.5

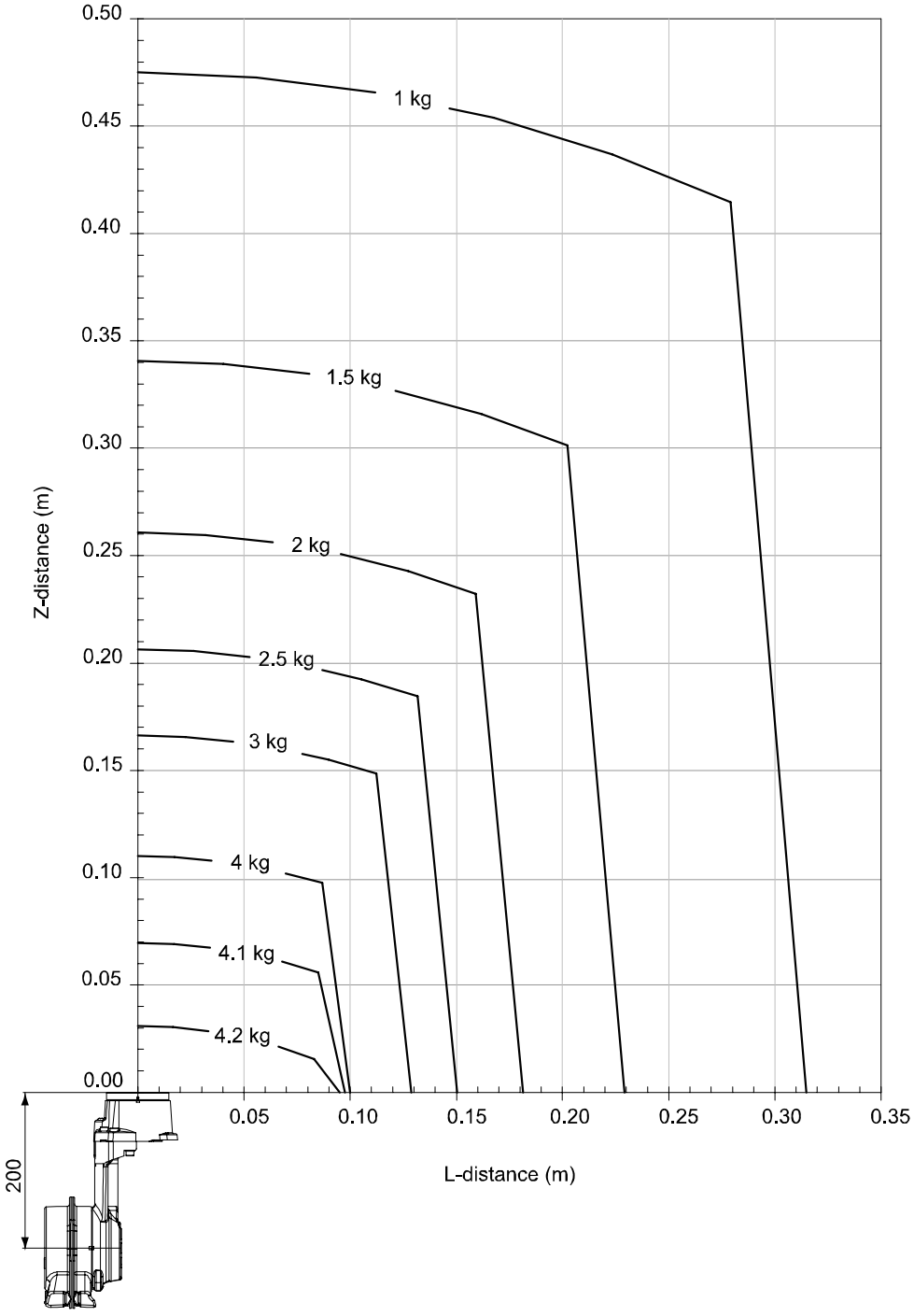


Figure 14 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity)

1.5.3 Maximum load and moment of inertia for full and limited axis 5 (center line down) movement

General

Total load given as: Mass in kg, center of gravity (Z and L) in m and moment of inertia (J_{ox}, J_{oy}, J_{ox}) in kgm^2. $L = \sqrt{(X2 + Y2)}$, see Figure 15.

Full movement of Axis 5 (±115º)

Axis	Robot Type	Max. value
5	IRB 1600-6/x	J_5 = Mass x $((Z + 0.065)^2 + L^2)$ + max (J_{ox}, J_{oy}) ≤ 0.42 kgm^2
6	IRB 1600-6/x	J_6= Mass x L^2 + J_{0Z} ≤ 0.30 kgm^2

Axis	Robot Type	Max. value
5	IRB 1600-8/x	J_5 = Mass x $((Z + 0.065)^2 + L^2)$ + max (J_{ox}, J_{oy}) ≤ 0.53 kgm^2
6	IRB 1600-8/x	J_6= Mass x L^2 + J_{0Z} ≤ 0.39 kgm^2

Full movement of Axis 5 (+155º to -90º)

Axis	Robot Type	Max. value
5	IRB 1600ID-4/1.5	J_5 = Mass x $((Z + 0.200^2 + L^2)$ + max (J_{ox}, J_{oy}) ≤ 0.58 kgm^2
6	IRB 1600ID-4/1.5	J_6= Mass x L^2 + J_{0Z} ≤ 0.24 kgm^2

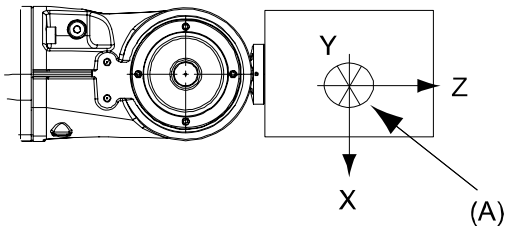


Figure 15 Moment of inertia when full movement of axis 5.

Pos	Description
A	Center of gravity

	Description
J_{ox}, J_{oy}, J_{oz}	Max. moment of inertia around the X, Y and Z axes at center of gravity.

Limited axis 5, Center line down

Axis	Robot Type	Max. value
5	IRB 1600-6/x	J_5 = Mass x ((Z + 0.065)^2 + L^2) + max (J_{ox}, J_{oy}) ≤ 0.55 kgm^2
5	IRB 1600-8/x	J_5 = Mass x ((Z + 0.065)^2 + L^2) + max (J_{ox}, J_{oy}) ≤ 0.65 kgm^2
6	IRB 1600-6/x	J_6= Mass x L^2 + J_{0Z} ≤ 0.40 kgm^2
6	IRB 1600-8/x	J_6= Mass x L^2 + J_{0Z} ≤ 0.48 kgm^2

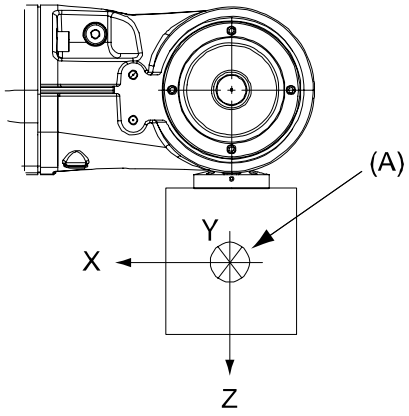


Figure 16 Moment of inertia when axis 5 center line down.

Pos	Description
A	Center of gravity

	Description
J_{ox}, J_{oy}, J_{oz}	Max. moment of inertia around the X, Y and Z axes at center of gravity.

1.5.4 Wrist torque

The table below shows the maximum permissible torque due to payload.

Note! The values are for reference only, and should not be used for calculating permitted load offset (position of center of gravity) within the load diagram, since those also are limited by main axes torques as well as dynamic loads. Also arm loads will influence the permitted load diagram. For finding the absolute limits of the load diagram, please use the ABB RobotLoad. Please contact your local ABB organization.

Robot type	Max wrist torque axis 4 and 5	Max wrist torque axis 6	Max torque valid at load
IRB 1600-6/1.2(1.45)	8.58 Nm	4.91 Nm	5 kg
IRB 1600-81.2(1.45)	11.25 Nm	6.43 Nm	6.5 kg
RB 1600ID-4/1.5	12.16 Nm	3.92 Nm	4 kg

1.5.5 Mounting of equipment

General

Extra loads can be mounted on the wrist, the upper arm housing and on the frame. Definitions of load areas and permitted load are shown in Figure 17. The center of gravity of the extra load shall be within the marked load areas. The robot is supplied with holes for mounting of extra equipment. (See Figure 18).

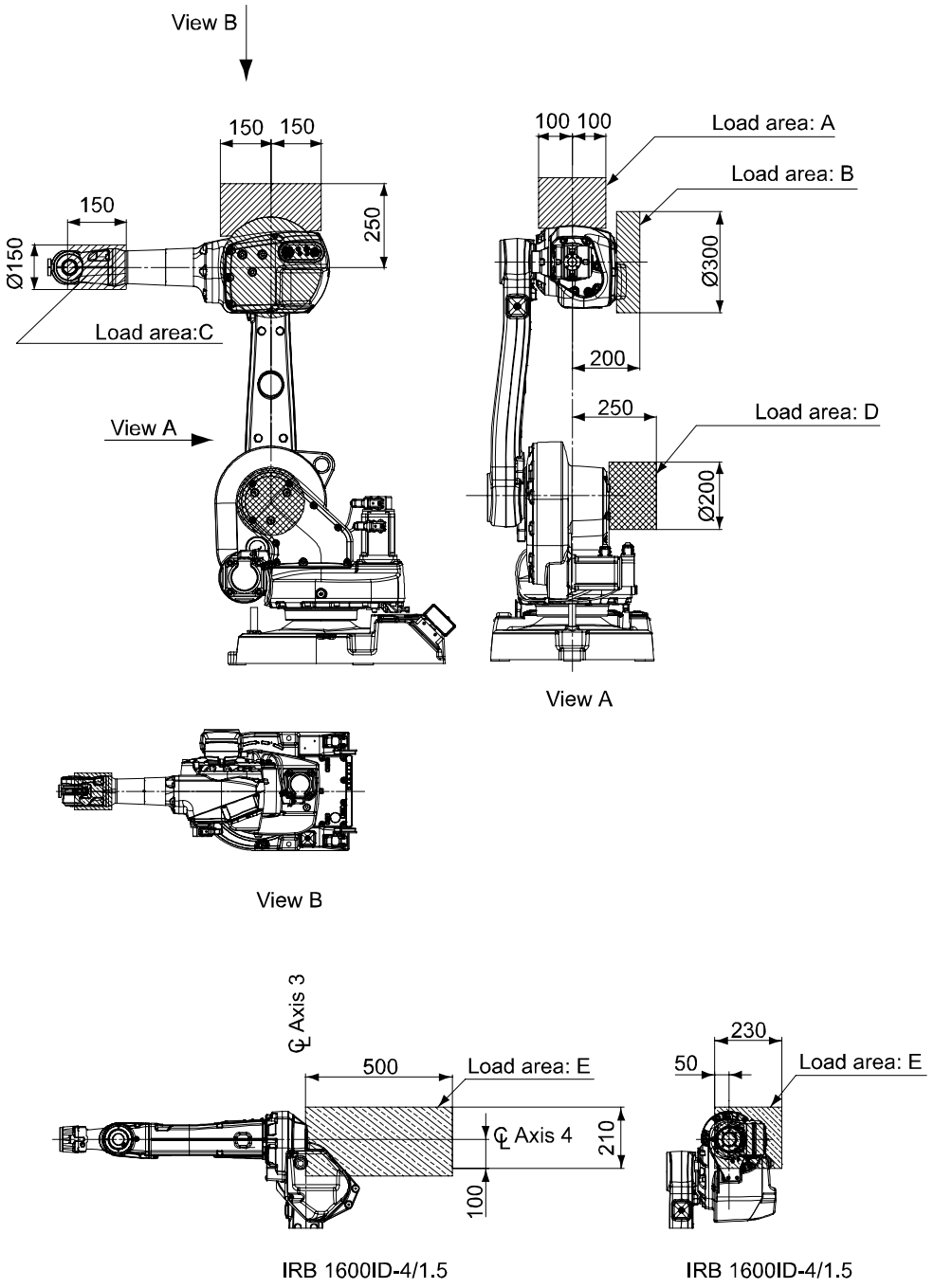


Figure 17 The shaded area indicates the permitted positions (center of gravity) for extra load mounted on the robot (dimensions in mm).

1.5.5 Mounting of equipment

Load area / Robot	Max. load					
	A	B	A+B	C	D	E
IRB 1600-6/X	15 kg	5 kg	15 kg	0.5 kg	15 kg	-
IRB 1600-8/X	5 kg	5 kg	5 kg	0.5 kg	15 kg	-
IRB 1600ID-4/1.5	-	-	-	-	15 kg	15 kg

Holes for mounting of extra equipment

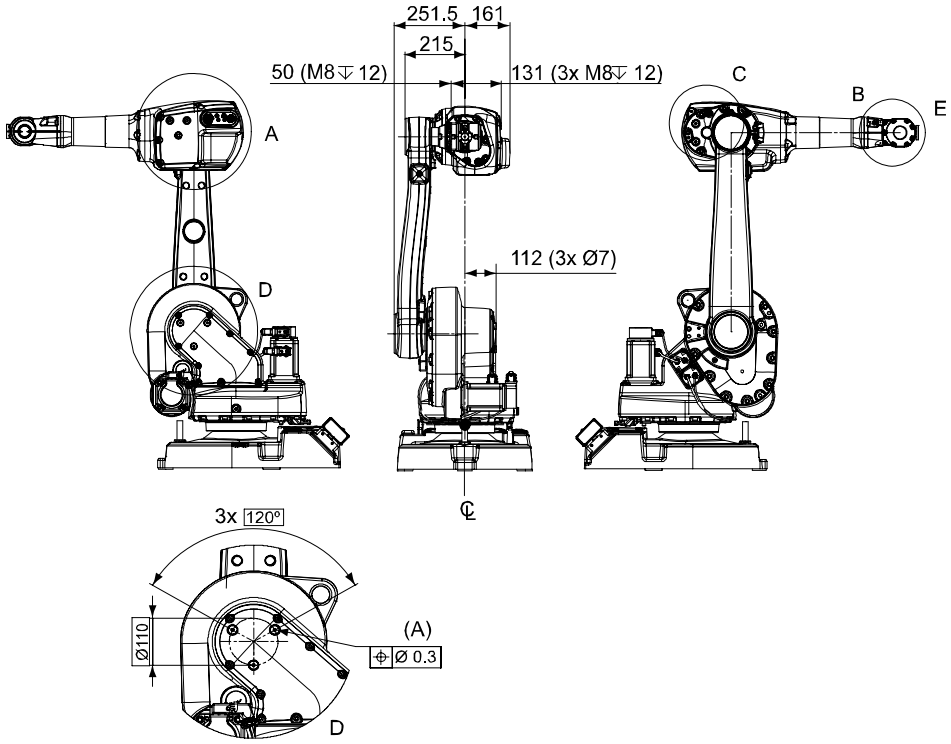
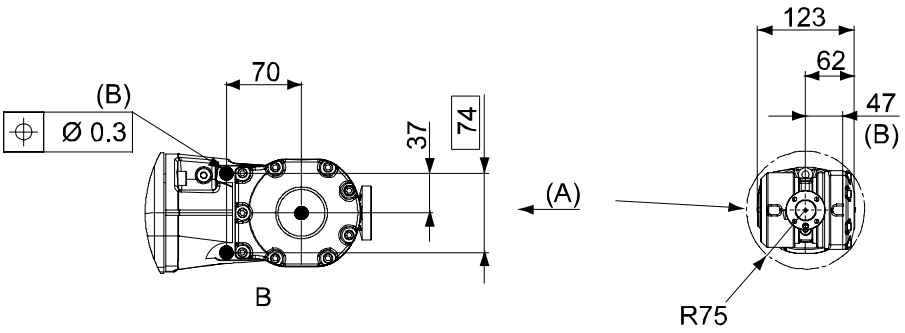
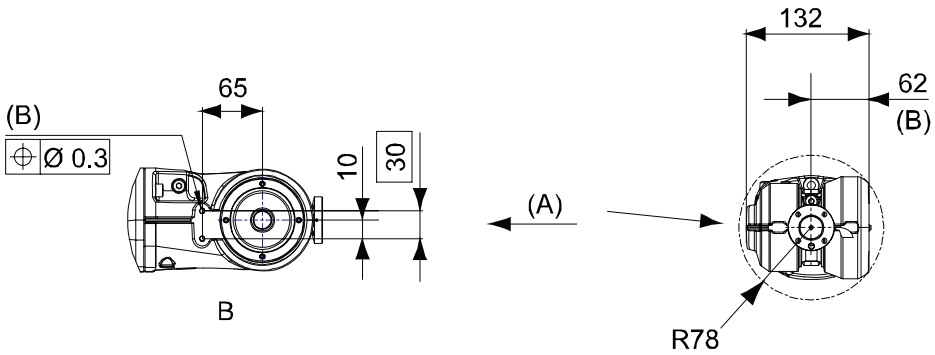


Figure 18 Holes for mounting extra equipment on the wrist, the upper arm housing and on the frame.

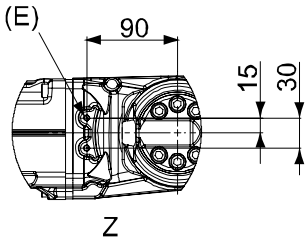
Design until June 2006



Design after June 2006, Type A

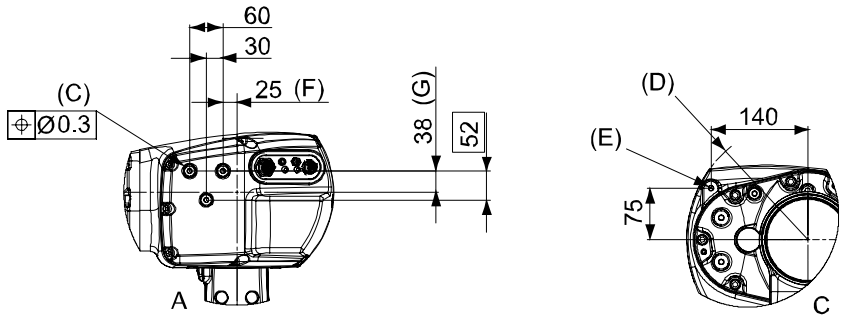


Design IRB 1600ID-4/1.5



1.5.5 Mounting of equipment

Mounting hole for equipment



Pos	Description
A	View E
B	Design until June 2006: 2x M5 depth 7.5, Mounting holes for equipment Design after June 2006, Type A: 2x M6 depth 10, Mounting holes for equipment
C	3x M8 depth 12, Mounting holes for equipment
D	R175, Axis 3 turning radius
E	3 x M8 depth 16, Mounting hole for equipment
F	From center line axis 2
G	From center line axis 4

Note! When mounting heavier equipment, e.g. wire feeders, in holes (C) must the bracket be support in the opposite holes (E).

Holes for mounting of extra equipment for IRB 1600ID-4/1.5

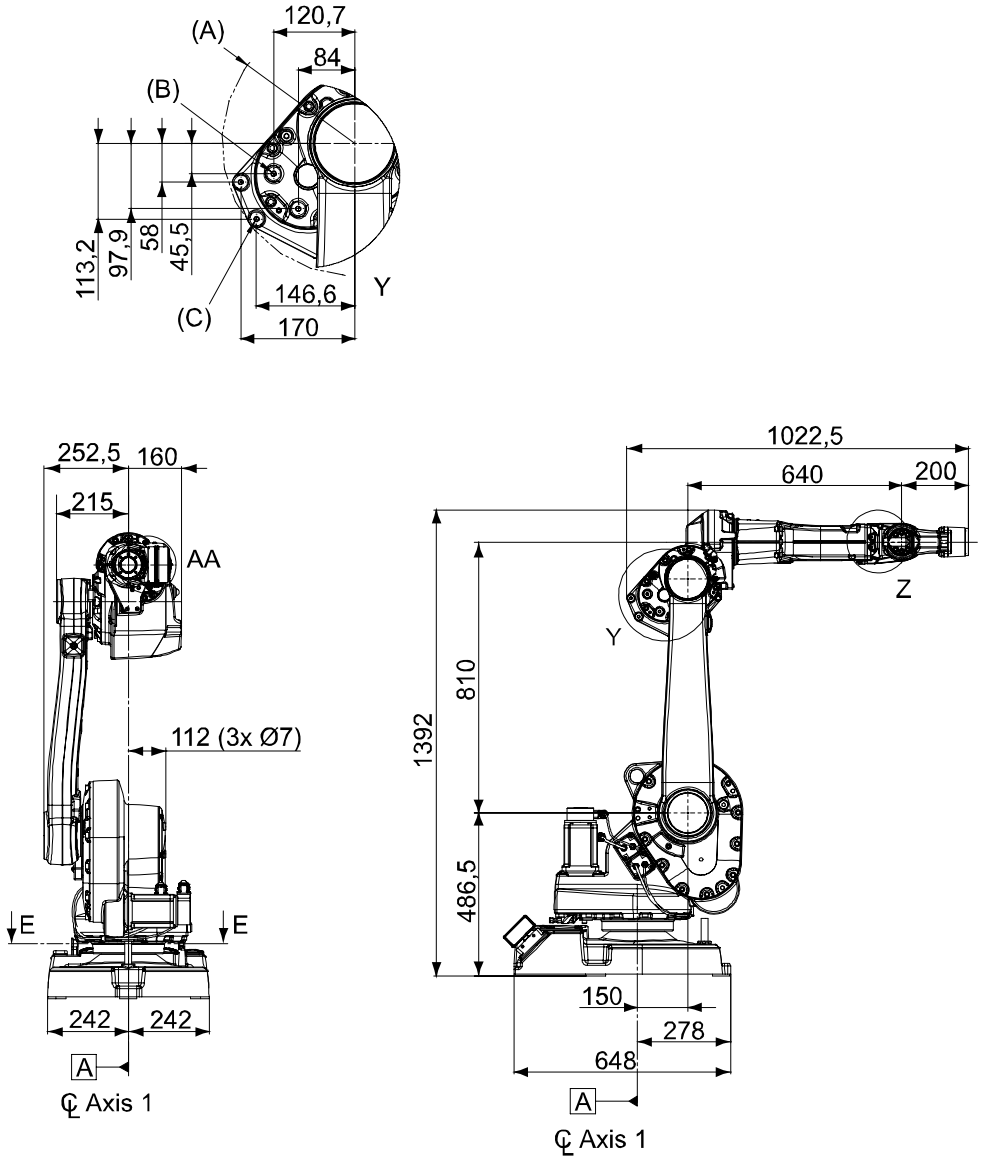


Figure 19 Holes for mounting extra equipment on the wrist, the upper arm housing and on the frame of IRB 1600ID-4/1.5.

Pos	Description
A	R198, Axis 3 turning radius
B	2x M8 depth 16, Mounting holes for equipment
C	2x M8, Mounting holes for equipment

1.5.5 Mounting of equipment

Robot tool flange

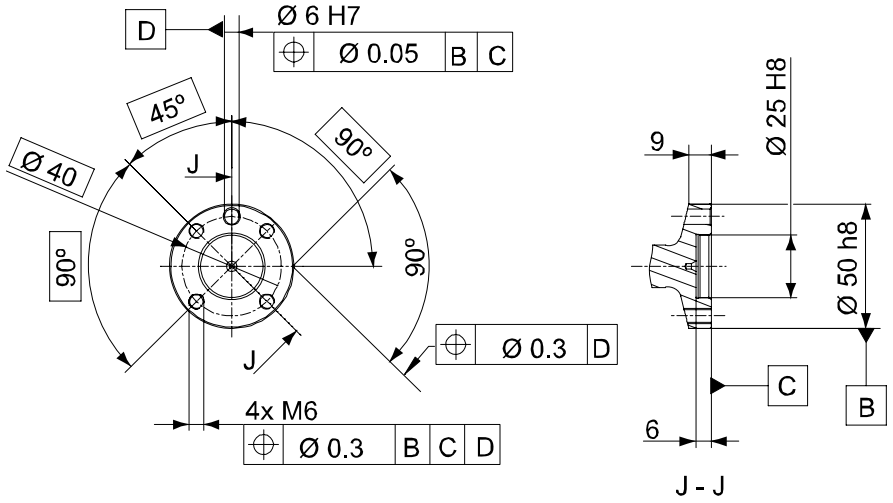


Figure 20 Robot tool flange (dimensions in mm).

Robot tool flange for IRB 1600ID-4/1.5

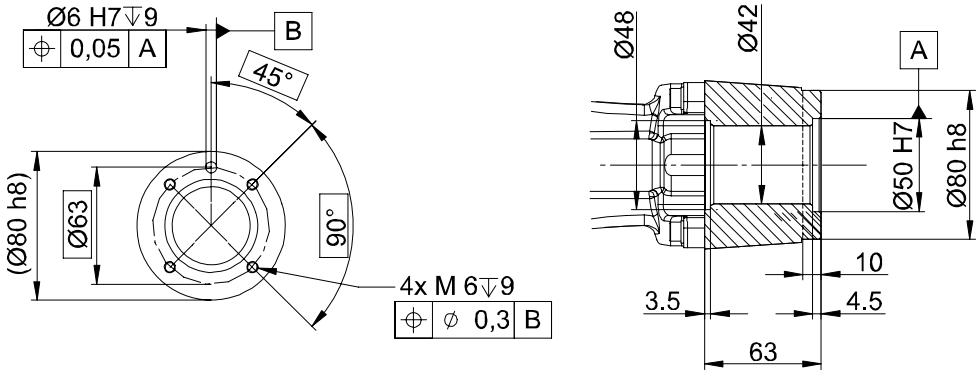


Figure 21 Robot tool flange for IRB 1600ID-4/1.5 (dimensions in mm).

1.6 Robot Motion

1.6.1 Introduction

IRB 1600-X/1.2 and 1.45

Axis	Type of motion	Range of movement 1.2 m reach	Range of movement 1.45 m reach
1	Rotation motion	+180° to -180° [a]	+180° to -180° [a]
2	Arm motion	+110° to -63° +136° to -63° with Axis 1 limited to ±100°	+120° to -90° +150° to -90° with Axis 1 limited to ±95°
3	Arm motion	+55° to -235°	+65° to -245°
4	Rotation motion	+200° to -200° Default +190 rev.[b] to -190 rev. Max.[c]	+200° to -200° Default +190 rev.[b] to -190 rev. Max.[c]
5	Bend motion	+115° to -115°	+115° to -115°
6	Turn motion	+400° to -400° default +288 rev.[b] to -288 rev. Max.[c]	+400° to -400° default +288 rev.[b] to -288 rev. Max.[c]

a. Axis 1 working range has the following limitations:
+45° to -45° when tilting the robot up to 30º
+20° to -20° for wall mounted IRB 1600-6/X
+60° to -60° for wall mounted IRB 1600-8/X
b. rev. = Revolutions
c. The default working range for axis 4 and axis 6 can be extended by changing parameter values in the software.
Option 610-1 “Independent axis” can be used for resetting the revolution counter after the axis has been rotated (no need for “rewinding” the axis).

IRB 1600ID-4/1.5

Axis	Type of motion	Range of movement
1	Rotation motion	+180° to -180°
2	Arm motion	+150° to -90°
3	Arm motion	+79° to -238°
4	Rotation motion	+155° to -155°
5	Bend motion	+135° to -90°
6	Turn motion	+200° to -200°

1.6.1 Introduction

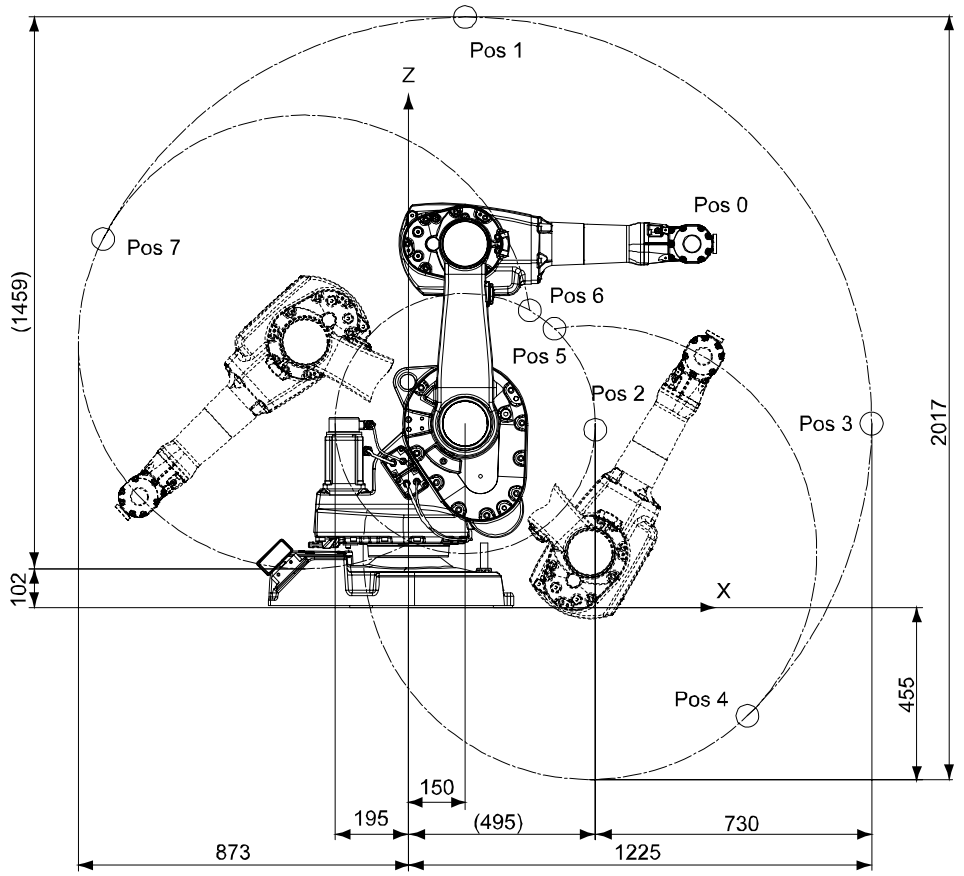


Figure 22 The extreme positions of the robot arm with 1.2 m reach.

Positions at wrist center 1.2 m reach

Pos No. see Figure 22	X Position (mm)	Z Position (mm)	Axis 2 Angle (degrees)	Axis 3 Angle (degrees)
0	750	962	0	0
1	150	1562	0	-90
2	494	470	0	+55
3	1225	487	+90	-90
4	897	-287	+136	-90
5	386	737	+136	-235
6	321	786	-63	+55
7	-808	975	-63	-90

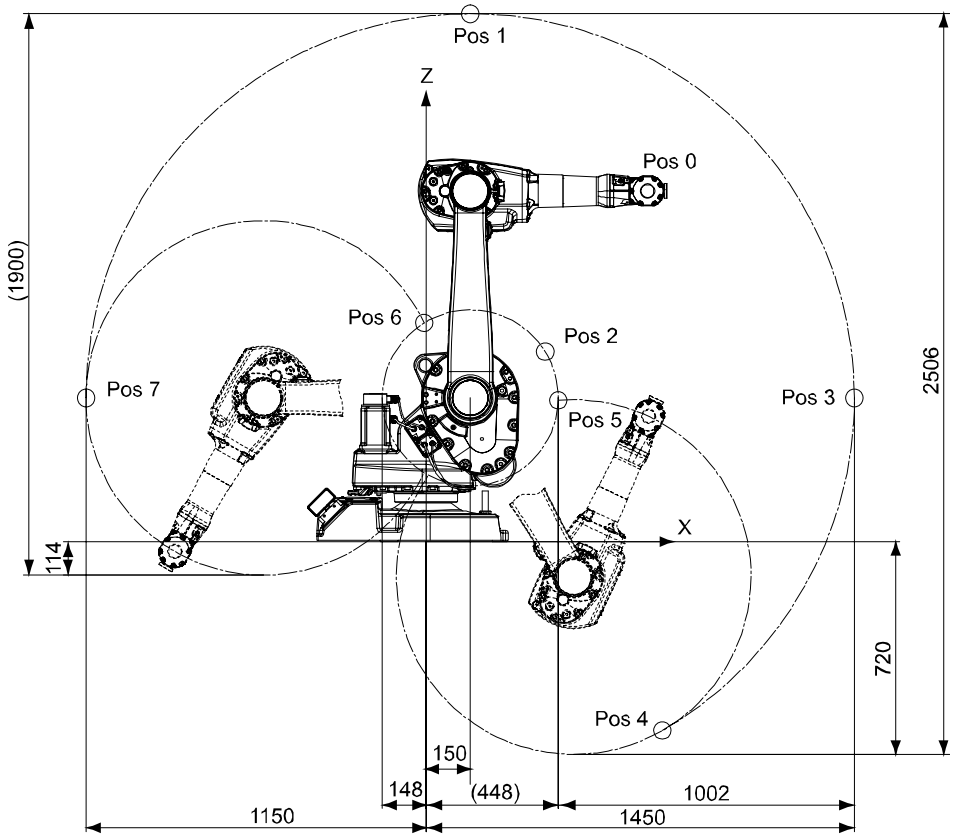


Figure 23 The extreme positions of the robot arm with 1.45 m reach.

Positions at wrist center 1.45 m reach

Pos No. see Figure 23	X Position (mm)	Z Position (mm)	Axis 2 Angle (degrees)	Axis 3 Angle (degrees)
0	750	1187	0	0
1	150	1787	0	-90
2	404	643	0	+65
3	1450	487	+90	-90
4	800	-639	+150	-90
5	448	478	+150	-245
6	-6	740	-90	+65
7	-1150	487	-90	-90

1.6.1 Introduction

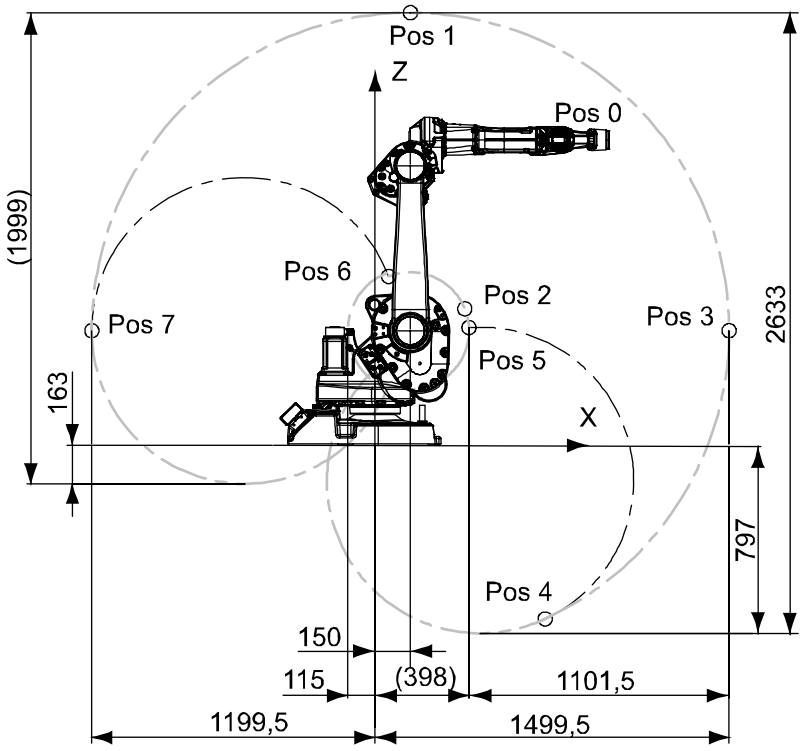


Figure 24 The extreme positions of the robot IRB 1600ID arm with 1.5 m reach.

Positions at wrist center IRB 1600ID-4/1.5

Pos No. see Figure 24	X Position (mm)	Z Position (mm)	Axis 2 Angle (degrees)	Axis 3 Angle (degrees)
0	790	1297	0	0
1	150	1836	0	-80
2	380	579	0	+79
3	1500	487	+90	-80
4	721	-737	+150	-80
5	398	500	+150	-238
6	58	717	-90	+79
7	-1200	487	-90	-80

1.6.2 Performance according to ISO 9283

General

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

The figures for AP, RP, AT and RT are measured according to Figure 25.

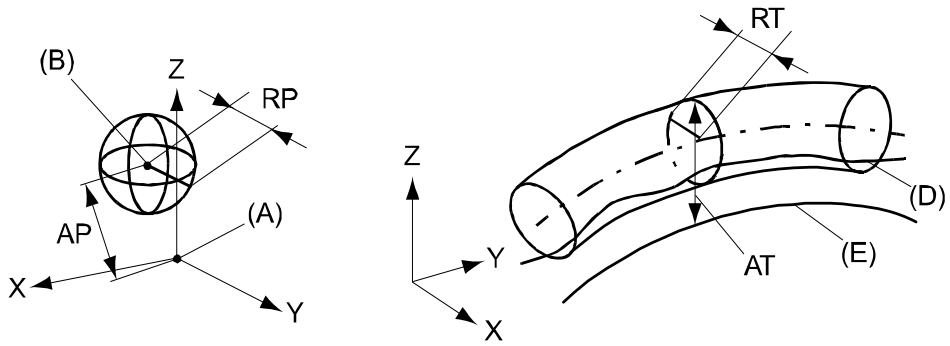


Figure 25 Explanation of ISO values.

Pos	Description	Pos	Description
A	Programmed position	E	Programmed path
B	Mean position at program execution	D	Actual path at program execution
AP	Mean distance from programmed position	AT	Max deviation from E
RP	Tolerance of position B at repeated positioning	RT	Tolerance of the path at repeated program execution

Description	IRB 1600				IRB 1600ID
	-6/1.2	-6/1.45	-8/1.2	-8/1.45	ID-4/1.5
Pose repeatability, RP (mm)	0.02	0.02	0.04	0.05	0.02
Pose accuracy, AP [a] (mm)	0.04	0.04	0.04	0.05	0.04
Linear path repeatability, RT (mm)	0.13	0.19	0.14	0.12	0.48[b]
Linear path accuracy, AT (mm)	0.97	1.03	0.96	0.42	1.98
Pose stabilization time, (PSt) to within 0.2 mm of the position (s)	0.11	0.11	0.20	0.04	0.35

a. AP according to the ISO test above, is the difference between the teached position (position manually modified in the cell) and the average position obtained during program execution.
b. Measured at a velocity of 100 mm/s.

The above values are the range of average test results from a number of robots.

1.6.3 Velocity

Maximum axis speeds

Axis No.	IRB 1600-6/1.2 IRB 1600-6/1.45	IRB 1600-8/1.2 IRB 1600-8/1.45	IRB 1600ID-4/1.5
1	150°/s	180°/s	180°/s
2	160°/s	180°/s	180°/s
3	170°/s	200°/s	180°/s
4	320°/s	400°/s	320°/s
5	400°/s	400°/s	380°/s
6	460°/s	460°/s	460°/s

Axis Resolution

Approx. 0.01º on each axis.

1.6.4 Stopping distance/time

Stopping distance/time for emergency stop (category 0), program stop (category 1) and at mains power supply failure at max speed, max stretched out and max load, categories according to EN 60204-1. All results are from tests on one moving axis. All stop distances are valid for floor mounted robot, without any tilting.

Robot Type		Category 0		Category 1		Main power failure	
	Axis	A	B	A	B	A	B
IRB 1600-6/1.2 (1.45) IRB 1600-8/1.2 (1.45)	1	25	0.2	45	0.4	31	n.a.
	2	23.	0.2	32	0.3	30	n.a.
	3	14	0.2	25	0.2	18	n.a.

Robot Type		Category 0		Category 1		Main power failure	
	Axis	A	B	A	B	A	B
IRB 1600ID-4/1.5	1	23	0.2	47	0.5	29	n.a.
	2	24	0.3	34	0.4	27	n.a.
	3	17	0.2	32	0.3	24	n.a.

	Description
A	Distance in degrees
B	Stop time (s)

1.7 Typical cycle times

1.7.1 Introduction

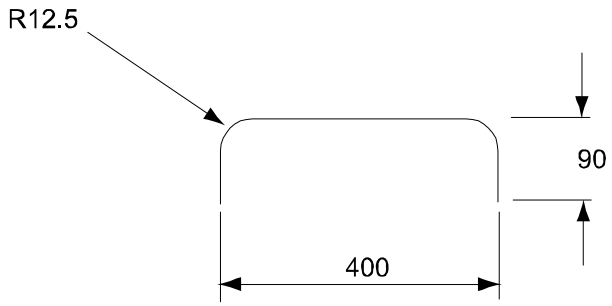


Figure 26 Packer cycle (dimensions in mm).

Approx. cycle times

	IRB 1600-6/x	IRB 1600-8/x
Pay load at wrist down	7 kg	10 kg
Cycle time Packer cycle	0.95 s	1.01 s

1.8 Customer connections

1.8.1 Introduction

General

Customer connections are options, the cables for them are integrated in the robot and the connectors are placed on the upper arm housing.

The customer connections are:

- The Standard connections for Signals, Power and Air.
- The Integrated wire feed cabling for Signals and Power.
- The 7-Axis connection.

For the specification of the customer connection, see chapter 2 Specification of Variants and Options, Application interface Connection type.

Note: No customer/application connections available for IRB 1600ID-4/1.5.

Connections at robot base

Figure 27 to Figure 30 show the customer connections at the robot base. For description of all connection types see table below Figure 30.

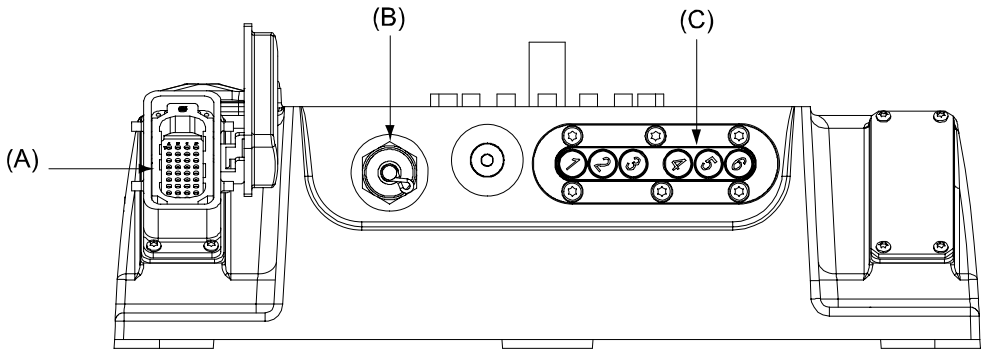


Figure 27 No application interface.

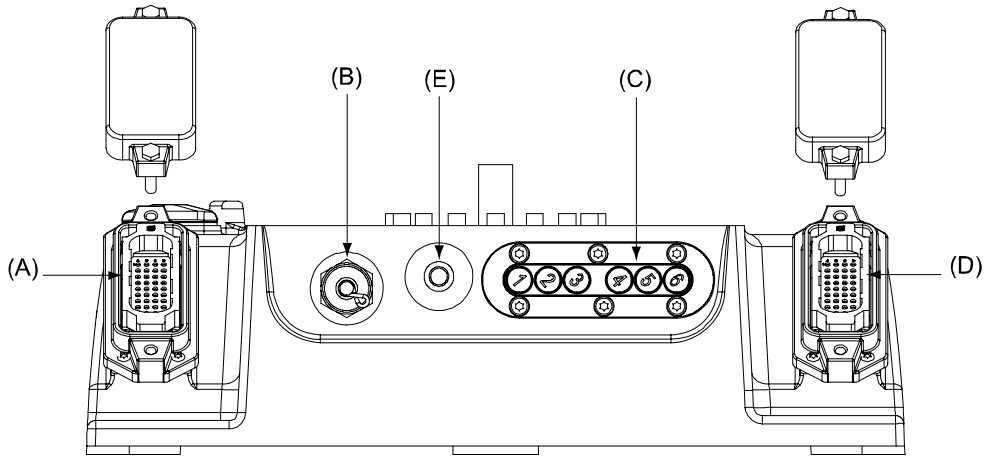


Figure 28 Standard application interface.

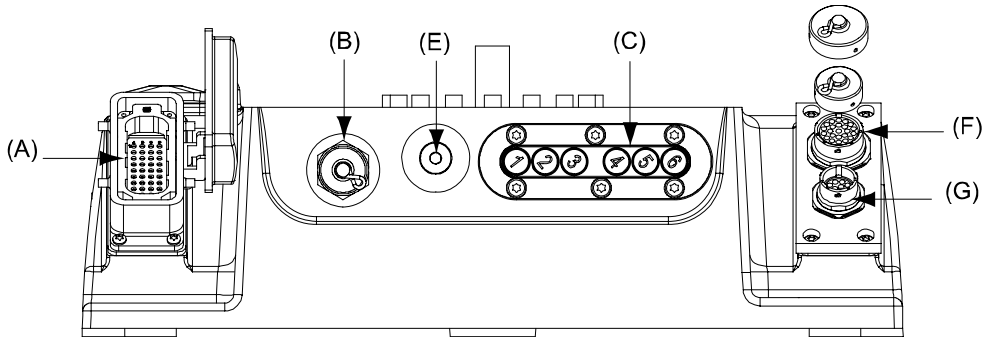


Figure 29 Integrated wirefeed interface.

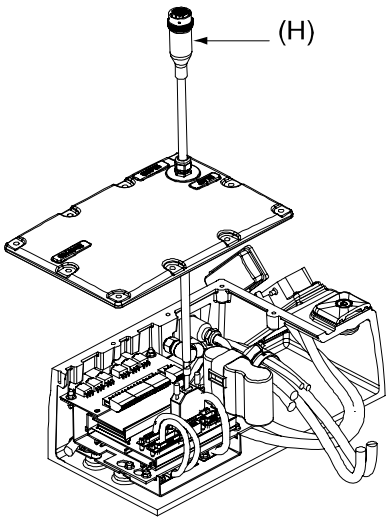


Figure 30 Axis 7 connection.

Pos	Connection type	Description
A	R1.MP	Motor power
B	R1.SMB	Serial measurement board signal
C	-	Robot axes brake release buttons
D	R.1 CP/CS	Standard Customer Power and Customer Signal
E	R.1Air	Standard Air
F	R1.CS	Customer Signal for Integrated wirefeed interface
G	R1.CP	Customer Power for Integrated wirefeed interface
H	R1.FB7	Axis 7 connection, 1.5 m cable

Connections at upper arm

Figure 31 shows the Customer connections at the upper arm.

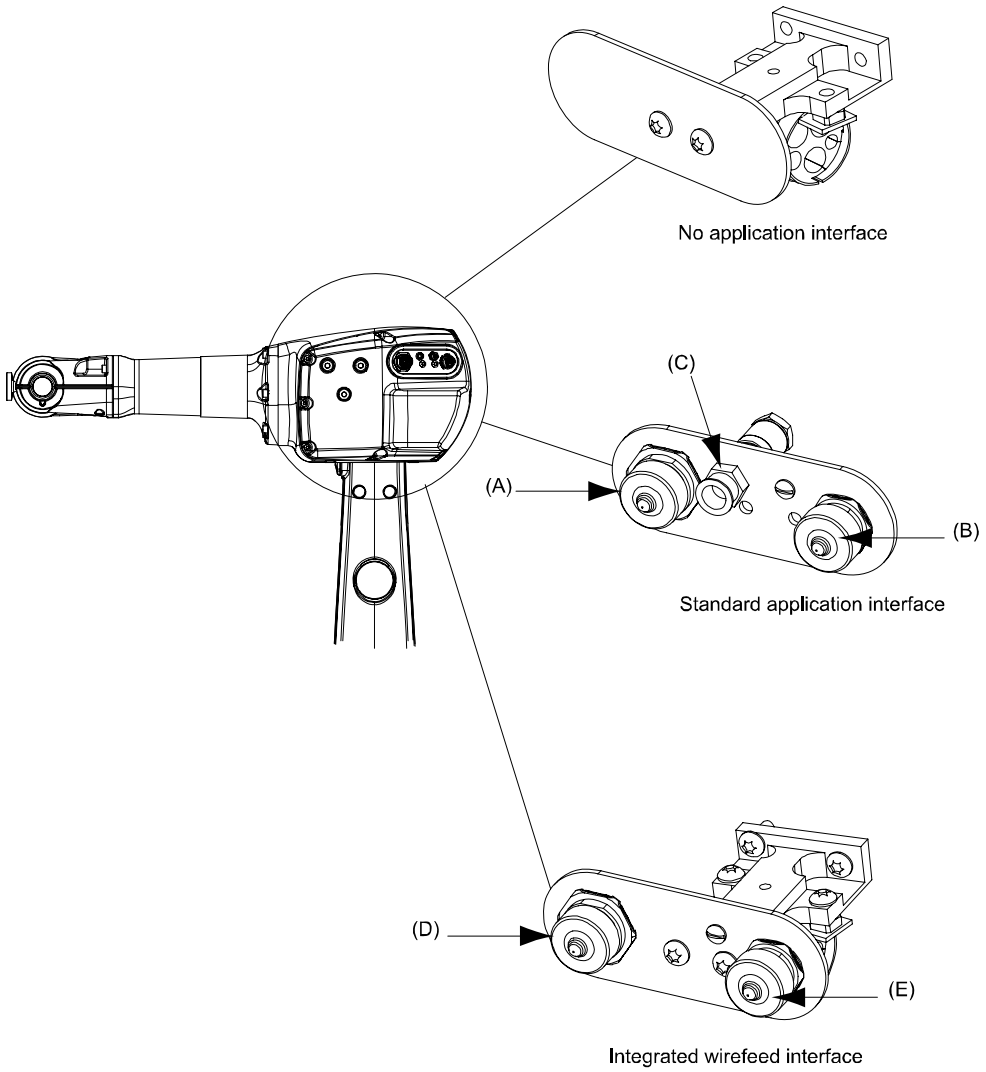


Figure 31 Customer connections at the upper arm.

Pos	Connection type	Description
A	R3.CP	Standard Customer Power
B	R3.CS	Standard Customer Signal
C	R3.Air	Standard Air
D	R3.CP	Customer Power for Integrated wirefeed interface
E	R3.CS	Customer Signal for Integrated wirefeed interface

1.9 Maintenance and Troubleshooting

1.9.1 Introduction

General

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

- Maintenance-free AC motors are used.
- Oil and grease are 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.
- It has a progam memory “battery low” alarm.

Maintenance

The maintenance intervals depend on the use of the robot, the required maintenance activities also depends on selected options. For detailed information on maintenance procedures, see Maintenance section in the Product Manual.

1.9.1 Introduction

2 Specification of Variants and Options

2.1 Introduction

2.1.1 General

The different variants and options for the IRB 1600 are described below. The same numbers are used here as in the Specification Form.

For controller options, see Product specification - Controller IRC5 with FlexPendant and for software options, see Product specification - Controller software IRC5/ RobotWare Options.

2.1.2 Manipulator

Variants

Option	IRB Type	Handling capacity (kg)/Reach (m)
435-79	1600ID	4/1.5
435-89	1600	8/1.2
435-90	1600	8/1.45
435-91	1600	6/1.2
435-92	1600	6/1.45

Manipulator color

Option	Name	Description
209-1	ABB Standard	The robot is painted in color ABB Orange.
209-2	ABB White	The robot is painted in white color.
209-4--192	RAL code	The manipulator is painted with the chosen RAL-color.

Protection

Option	Name	Description
287-4	Standard	IP 54, IP 40 for IRB 1600ID-4/1.5
287-3	Foundry Plus	The robot has the Foundry Plus protection which means that the whole manipulator is IP 67 classified and steam washable. An excellent corrosion protection is obtained by a special coating. The connectors are designed for severe environments, and bearings, gears and other sensitive parts are highly protected. Not valid for IRB 1600ID-4/1.5.
287-1	Clean room	Robot with clean room class 10 according to US Federal Standard 209 and with the same protection as in option 287-4. The robot is labeled with “Clean Room”. Not valid for IRB 1600ID-4/1.5.

Application interface Connected to

Option	Name	Description
16-1	Cabinet[a]	The signals are connected to 12-pole screw terminals, Phoenix MSTB 2.5/12-ST-5.08, to the Control Module. Not together with option 17-6 Integrated wire feed cabling. Not valid for IRB 1600ID-4/1.5.

a. Note! In a MultiMove application, additional robots have no Control Module. The screw terminal with internal cabling are then delivered separately to be mounted in the main robot Control Module or in another encapsulation, for example a PLC cabinet.

Application interface Connection type

Option	Name	Description	
17-5[a]	Standard	One Souriau UTOW6 1210 P-H One Souriau UTOW6 1626 P-H Signals 23 Power 10 Air 1	 50 V, 250 mA 250 V, 2 A Max. 8 bar, hose inner diameter 8 mm. R $^1/_4$ " at base and upper arm.
17-6[a]	Integrated wire feed cable	Signals 16 Power 12	49 V, 500 mA Connector on upper arm housing: -Souriau UT0W7 1626 S-H. Connector on robot base: - FCI 23-pin socket UT 001823SHT 300 V, 4 A - Souriau UT07 1412 S-H. Connector on robot base: -FCI 12-pin UT 001412PHT
17-7	No application interface		

a. Not valid for IRB 1600ID-4/1.5.

Connector kit upper arm

The kit consists of connetor, pins and sockets, fitting connectors in option 17-5.

Option	Name	Description
431-1	Upper arm	Customer Power (CP) and Customer Signals (CS).

Safety lamp

Option	Name	Description
213-1	Safety lamp	It has an orange fixed light, is active in MOTORS ON mode and is std. on an UL/UR approved robot.

Electronic Position Switches (EPS)

The mechanical position switches indicating the position of the three main axes are replaced with electronic position switches for up to 7 axes, for increased flexibility and robustness.

For more detailed information, see Product specification - Controller IRC5 with FlexPendant and Application Manual Electronic Position Switches, art. No. 3HAC0277709-001.

Working range limit

To increase the safety of the robot, the working range of axis 1, 2 and 3 can be restricted.

Option	Name	Description
28-1	Axis 1 Working range limit	One or two mechanical stops for restricting the working range of axis 1. The option includes two stops. See Figure 32.

The working range can be restricted freely within the shown scope, depending on where the mechanical stop is installed along the casted groove.

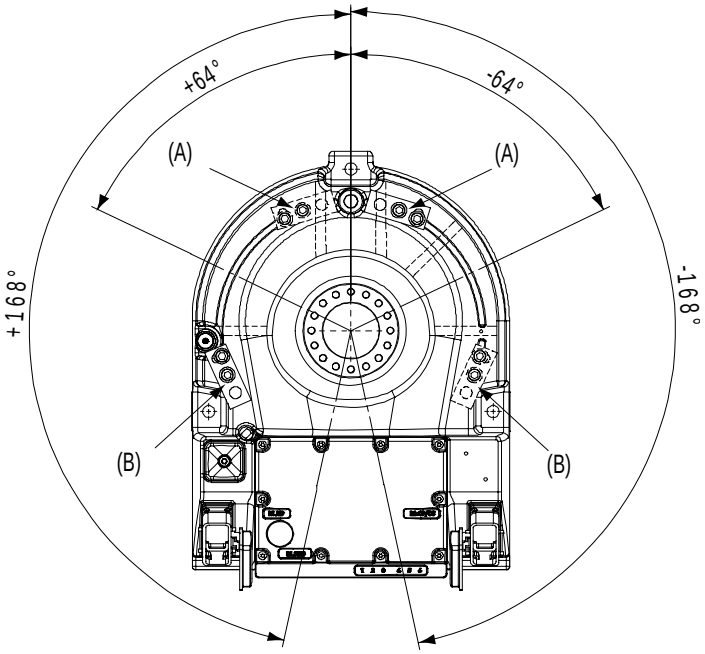


Figure 32 Mounting area of the additional stops for Axis 1.

Pos	Description
A	Mounting position of two additional stops for maximum working area (+/- 160°).
B	Mounting position of two additional stops for maximum working area (+/- 64°).

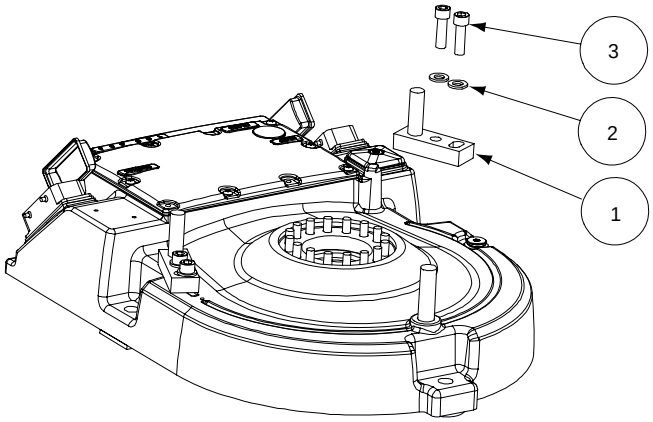


Figure 33 Material included in the option 28-1.

Pos	Description
1	Mechanical stop (x2)
2	Washers (x4)
3	Screws (x4)

Option	Name	Description
32-1	Axis 2 working range limit	An additional mechanical stop for restricting the working range of axis 2 can be mounted on the frame. The working range can only be restricted backwards as shown in Figure 34. Notice the different working range for the different models.

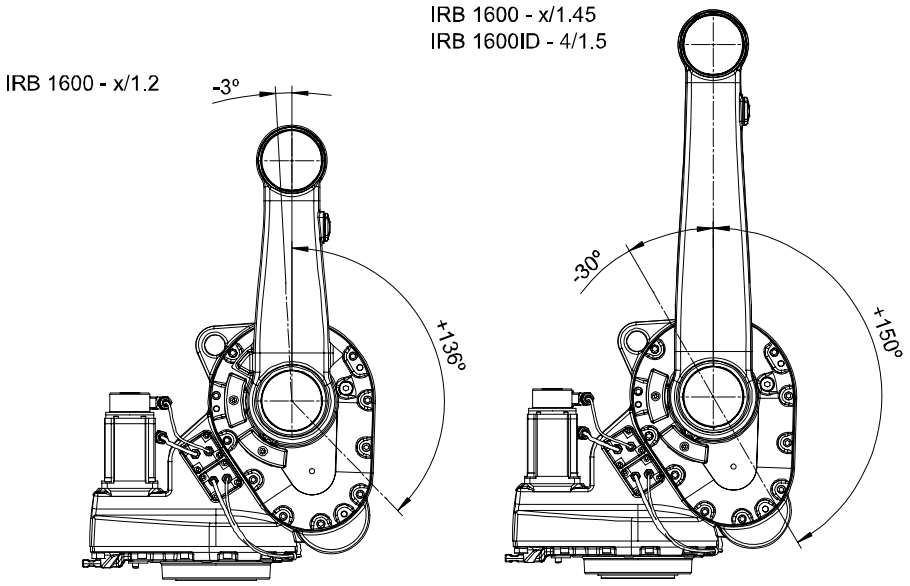


Figure 34 Mounting area of additional stop Axis 2.

2.1.2 Manipulator

Option	Name	Description
34-1[a]	Axis 3 working range limit	The mechanical stop to restrict the working range within zone A and B for axis 3 can be mounted at the upper arm housing. See Figure 35. Notice the different working range for the different models.

a. Not valid for IRB 1600ID-4/1.5.

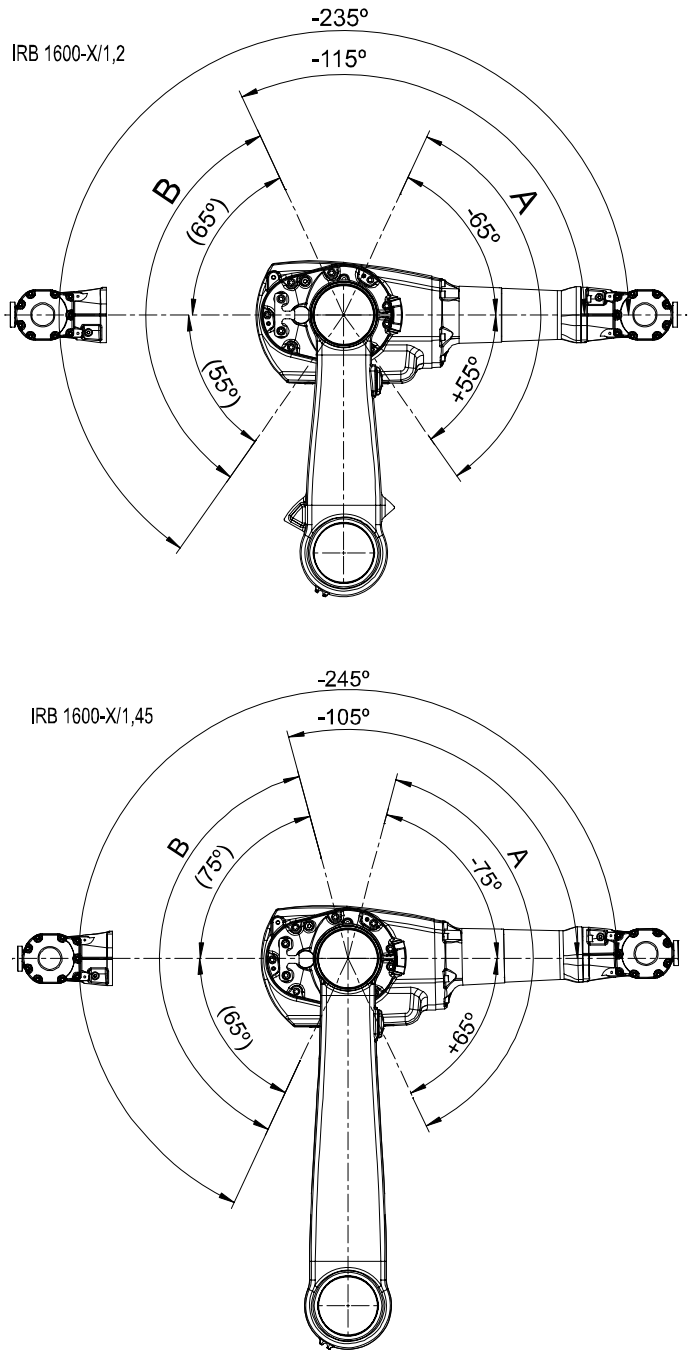


Figure 35 Mounting area of additional stop Axis 3.

2.1.3 Positioners

General

Regarding positioners, see Product specification - 3HAC028283-001.

2.1.4 Track Motion

Track Motion type

Option	Type	Description
1000-5	no AW	For IRB 1600/2400 robot, with a travel length of 1.7 m For for example material handling robot.
1000-6	for AW	For IRB 1600/2400 robot, with a travel length of 1.7 m For AW robot with Marthon-pac or Bobbin holder.

Additional travel length

Option	Description	Note
1001-1	(1-18) Add travel length	Chose additional travel length in meter, above the min. length under Track Motion Type. The selection 1 adds 1m travel length, 2 adds 2m travel length and so on.....

Example of ordering a track motion RTT, with a requested travel length of 7.5 m:

Track Motion Type

☒ 1000-5 RTT with Bobbin

6 1001-1 Add travel length

In this case, option 1000-5 specify a track motion with a travel length of 1.7 m, option 1001-1 adds 6 meters to that, ending up with a total travel length of 7.7 m.

Warranty

Option	Type	Description
438-1	Standard Warranty	Standard warranty is 18 months (1 1/2 years)
438-2	Standard + 12 months	18 + 12 months (2 1/2 years)
438-4	Standard + 18 months	18 + 18 months (3 years)
438-5	Standard + 24 months	18 + 24 months (3 1/2 years)
438-6	Standard + 6 months	18 + 6 months (2 years)
438-8	Stock Warranty	Maximum 6 months postponed warranty starting from shipment date ABB Robotics Production unit (PRU) + Option 438-1. Warranty commences automatically after 6 months or from activation date of standard warranty. (See ABB Robotics BA Warranty Rules).

2.2 Floor cables

2.2.1 Manipulator

Manipulator cable length

Option	Lengths
210-2	7 m
210-3	15 m
210-4	22 m
210-5	30 m

Connection of Parallel communication

Option	Lengths
94-1	7 m
94-2	15 m
94-3	22 m
94-4	30 m

2.2.2 Positioner

Positioner cable 1

Option	Lengths
1067-1	7 m
1067-2	10 m (Standard length)
1067-3	15 m

Positioner cable 2

Option	Lengths
1068-1	7 m
1068-2	10 m (Standard length)
1068-3	15 m

Positioner cable type

Option	Type	Description
1048-1	Flexible	Only available with one or two MTC 250/500/750/2000/5000

Weld return cable

Option	Lengths
1056-1	7 m
1056-2	7 m x 2
1056-3	10 m
1056-4	10 m x 2
1056-5	15 m
1056-6	15 m x 2

Return cable

Option	Type	Description
1057-1	OKC T-connection	Choose quantity, 1-2

2.3 Process

2.3.1 DressPack

Welding torch package

The robot can either be ordered without AW equipment (option 878-1) or fully dressed with torch including hose package (option 878-2 or 878-3) and AristoMig 4000i (option 1029-13) or 5000i (option 1029-14). Only torch and hose package without AristoMig is not possible to order from SEROP but can be ordered from supplier locally.

Option	Description
878-1	None, upper arm without any AW process equipment
878-2	Self cooled torch, iSTM-ABIROB A 22 degrees
878-3	Water cooled torch, iSTM-ABIROB W 22 degrees

Side impact protection (SIP)

Option	Description
883-1	Upper arm process cable protection, see Figure 36.

Figure 36 Process cable protection to be mounted on the upper arm.

Process module

Option	Type	Description
768-1	Empty cabinet small	See Product specification - Controller IRC5 with FlexPendant, chapter 2.2.1
768-2	Empty cabinet large	See Product specification - Controller IRC5 with FlexPendant, chapter 2.2.1
768-5	AWC / WeldGuide	Only together with AristoMig 4000i/5000i, MigRob and TPS power sources.

Installation kit

Option	Type	Description
715-1	Installation kit	See Product specification - Controller IRC5 with FlexPendant, chapter 2.2.1

2.3.2 Process equipment

Power source

Option	Type	Description
1029-13	AristoMig 4000i	400V (requires option 650-10) Only together with option 878-2 or 878-3.
1029-14	AristoMig 5000i	400V (requires option 650-10) Only together with option 878-2 or 878-3.

Current/Hose set

Option	Type	Description
1030-4	7.5 m	For external suspension mounting, not included. Only together with option 1029-13 or 1029-14.
1030-5	10 m	Internal suspension mounting, hose package attatched to the robot base. Protective hose included. Only together with option 1029-13 or 1029-14.

Feed kit

Option	Type	Description
1033-2	Marathon Pac Octagon	Liner for 250 kg Marathon Pac.Plastic hood for round Maraton-Pac included.
1033-3	Bobin	A 15 kg bobin holder on the robot.

Torch service

Option	Type	Description
1037-1	ABB TSC	ABB Torch Service Center.
1037-2	ABB TC96	ABB Torch cleaner.
1037-5	BullsEye	BullsEye stand alone.

2.3.3 AW Safety options

Working area

Option	Type	Description
1072-1	One working area	
1072-2	Two working areas	

Operator panel

Option	Type	Description
1054-1	Operator panel 1 area	For one working area
1054-2	Operator panel 2 areas	For two working areas.
1054-3	2 x operators panel 2 areas	Two operator panels, one for each working area.

AW Safety interface

Option	Type	Description
1058-1	Safety interface	SIB
1058-2	Active relay	Active relay supervision (open relay).

Gate switch

Option	Type	Description
1060-1	Gate switch	
1060-2	Gate switch/ ext. reset	

Lightbeam

Option	Type	Description
1059-1	Lightbeam	Qty 1 or 2, one working area requires one PC of ”two level light beams”. Two working areas rerquire two PCs of “two level light beams”.

Home position switch

Option	Type	Description
1061-1	Home position switch	Home position switch for IRB 1600/2400, one working area.

Station indication

Option	Type	Description
1062-1	Station indication	Station indication for IRB 1600/2400, two working areas.

Pre-reset unit

Option	Type	Description
1063-1	Pre-reset unit	Qty 1 or 2, one working area requires one PC of “Pre-reset”. Two working areas require two PCs of “Pre-reset”.

Activation unit

Option	Type	Description
1064-1	Activation unit	Qty 1 or 2, one requires one PC of “Activation unit”. Two working areas require two PCs of “Activation unit”.

Extended EM stop

Option	Type	Description
1065-1	Extended EM stop	Required when using external EM-stop push buttons and when ordering a dual arc system (two welding packages).

2.3.4 Documentation

DVD User Documentation

Option	Type	Description
808-1	Documentation on DVD	See Product Specification - Robot User Documentation

2.3.4 Documentation

3 Accessories

General

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

Robot software options for robot and PC

For more information, see Product specification - Controller IRC5 with FlexPendant and Product specification - Controller software IRC5/RobotWare Options.

Robot Peripherals

- Track Motion
- Motor Units

3HAC 023604-001, Revision H, en

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