Product manual
Integrated Force Control

ABB

Product manual

Integrated Force Control

RobotWare 6.04

Document ID: 3HAC048488-001

Revision: B

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Overview of this manual

About this manual

This manual contains information about the option Force Control package.

Usage

This manual can be used to find out what Force Control package is and how to use it. It provides information about system parameters and RAPID components related to Force Control package, and examples of how to use them.

Who should read this manual?

This manual is intended for:

- installation personnel.
- maintenance personnel.

Prerequisites

Maintenance/repair/installation personnel working with Force Control package must:

- be trained by ABB and have the required knowledge of mechanical and electrical installation/repair/maintenance work.
- have the knowledge of RAPID programming with FlexPendant in Robotware

Organization of chapters

The manual is organized in the following chapters:

Chapter	Contents
Safety	Safety information about Force Control package.
Installation and commissioning	Installation procedure of the Force Control package which contains mechanical and electrical connection of force sensor, Force Control Base software option selection. Commissioning procedure of the force sensor after installation.
Configuration	System parameters overview and configuration example.
System parameter reference information	Detailed description for system parameters.
Maintenance	Maintenance of the force sensor.
Decommissioning	Decommissioning of the force sensor.
Reference reference	Reference information as how to use the TSV tool, calculation method of the force/torque etc.
Troubleshooting	Error and solution when using the Force Control package.
Spare parts	Spare parts of the force sensor.

References

Reference	Document ID
Application manual - MultiMove	*3HAC050961-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - RobotStudio	*3HAC032104-001*
Product manual - IRC5	*3HAC021313-001*
Technical reference manual - RAPID overview	*3HAC050947-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Technical reference manual - System parameters	*3HAC050948-001*
Application manual - Force Control	*3HAC050377-001*

Revisions

Revision	Description
-	First edition
A	Corrected reference number for control cables in *Spare parts on page 53*.
B	Released with RobotWare 6.04: • Minor corrections.

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1 Safety

Safety of personnel

A robot is heavy and extremely powerful regardless of its speed. A pause or long stop in movement can be followed by a fast hazardous movement. Even if a pattern of movement is predicted, a change in operation can be triggered by an external signal resulting in an unexpected movement.

Therefore, it is important that all safety regulations are followed when entering safeguarded space.

Safety regulations

Before beginning work with the robot, make sure you are familiar with the safety regulations described in the manual *Operating manual - General safety information*.

About the force sensor

The contact force affects the robot path. For example, something is blocking the path or the work piece is outside of the predefined work range of the robot, the robot may deviate the intended path and may cause unexpected damage.

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2 Installation

2.1 Introduction

2.1.1 Overview

Integrated Force Control overview

ABB Integrated Force Control contains all required hardware and software to run the robot in force control mode. Following illustration shows the components of the product.

xx1300002251

Figure 2.1: ABB Integrated Force Control component

Item	Name	Description
A	ABB force sensor	Can be used to measure force and torque. For detailed information about ABB force sensor, see *ABB force sensor on page 14*.
B	VMB	Voltage measurement box. For detailed information about VMB, see *Voltage measurement box on page 18*.
C	Control cable	Cable between the VMB box and IRC5 control cabinet. For detailed information about the control cable, see *Cables on page 21*.
D	Sensor cable	Cable between the force sensor and the VMB box. For detailed information about the sensor cable, see *Cables on page 21*.
E	Adapter unit	Adapter flange(s) used to mount the force sensor onto the robot wrist. For detailed information about the adapter unit, see *Adapter unit on page 26*.

Application example

It is commonly used in robot machining application and robot assembly application. The illustration below gives an example of Force Control Package in machining application.
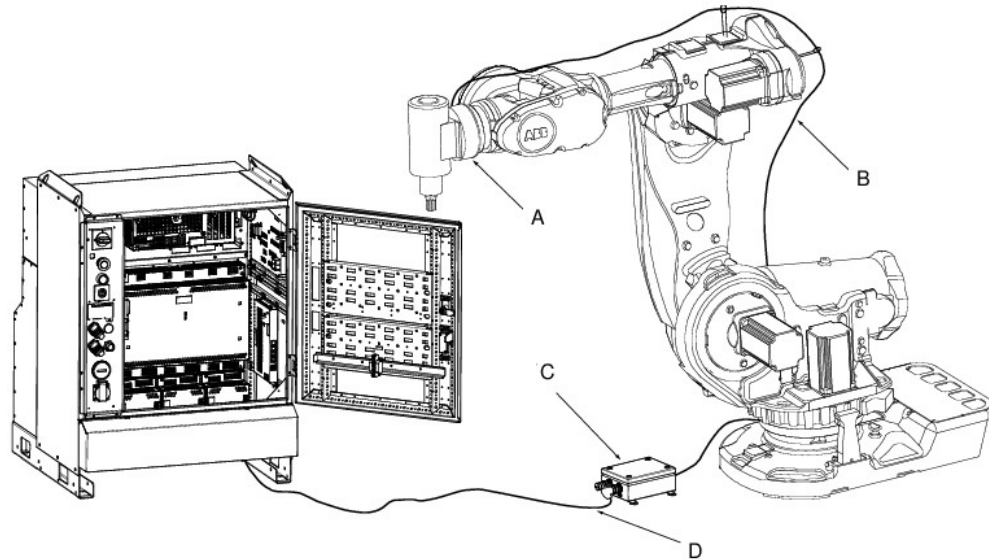
A: ABB force sensor

B: Cable between the force sensor and VMB box

C: VMB(Voltage measurement box)

D: Cable between VMB box and the robot controller

2.1.2 Delivery

Default delivery

Please check if the delivered product package contains all components that ordered. ABB Integrated Force Control has the following components as the default delivery:

- ABB Force sensor. For detailed information, see *ABB force sensor on page 14*.
- Sensor cable. For detailed information, see *Cables on page 21*.
- VMB box. For detailed information, see *Voltage measurement box on page 18*.
- Control cable. For detailed information, see *Cables on page 21*.
- Adapter unit. For detailed information about the adapter unit, see *Adapter unit on page 26*.
- Force Control Package CD (Contains the calibration file for ABB Force Sensor which is suffixed with .cfg and the force sensor mounting instruction)

Options

ABB Integrated Force Control has the following options which users can choose according to their application and demand:

- RobotWare Machining FC. It is the graphical user interface for machining application.

	Note

ABB Integrated Force Control must be used together with ABB robot and IRC5 control cabinet.

	Tip

ABB Integrated Force Control has integrated the functions of machining application and assembly application. For information about how to use Integrated ABB Force Control in machining and assembly applications, see *Application manual - Force Control*.
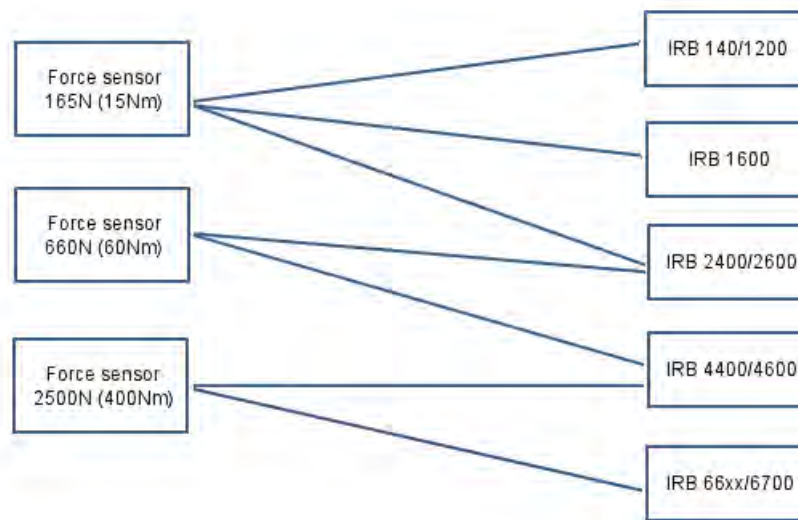

2.1.3 ABB force sensor

Overview

ABB force sensor is a 6 DOF force sensor that is fully integrated into the robot hardware and software. There are three models of ABB Force sensor: small model, medium model and large model.

Specification type	Small force sensor	Medium force sensor	Large force sensor
DOF	6 DOF	6 DOF	6 DOF
Protection	IP65	IP65	IP65
Material	SS304	SS304	SS304
Force measurement range	Fx/Fy: 165N; Fz: 495N	Fx/Fy: 660N; Fz: 1980N	Fx/Fy: 2500N; Fz: 6250N
Torque measurement range	Mx/My/Mz:15Nm	Mx/My/Mz:60Nm	Mx/My/Mz:400Nm
Weight	1.25kg	1.25kg	3.3kg
Outside diameter x height (unit: mm)	104x40	104x40	160x55
Non-linearity	1.50%	1.50%	1.50%
Hysteresis	1.50%	1.50%	1.50%
Crosstalk	2%	2%	2%
Zero offset	10%FS	10%FS	10%FS
Stiffness	F>3.0*E+7N/m; T>3.0*E+3Nm/rad	F>3.0*E+7N/m; T>3.0*E+3Nm/rad	F>6.0*E+7N/m; T>6.0*E+3Nm/rad
Resonance frequency	>1000	>1000	>1000
Cut-off frequency	>500Hz	>500Hz	>500Hz
Sensitivity (outputFS)	6-8Hz	6-8Hz	6-8Hz
Overload protection	10 times	10 times	10 times
Temperature compensation	Yes	Yes	Yes
Orientation	Aligned with tool co-ordination system of robot	Aligned with tool co-ordination system of robot	Aligned with tool co-ordination system of robot

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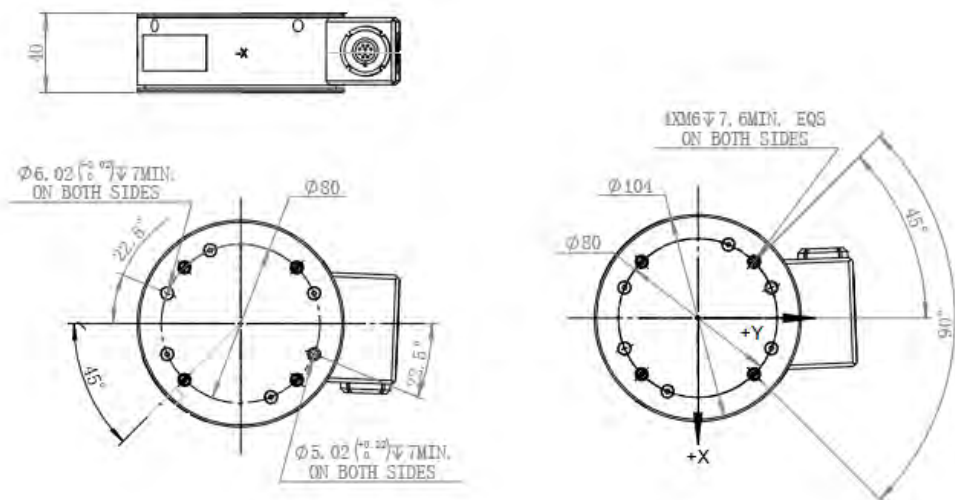
Force sensor and robot type mapping

> ℹ️ **Note**
>
> ABB force sensor can be substituted by ATI force sensor in ABB force control applications. For detailed information about how to configure ATI force sensor,see *Application manual - Force Control*.

ABB Force sensor dimension

Small & medium ABB force sensor

2.1.3 ABB force sensor
Continued

Large ABB force sensor
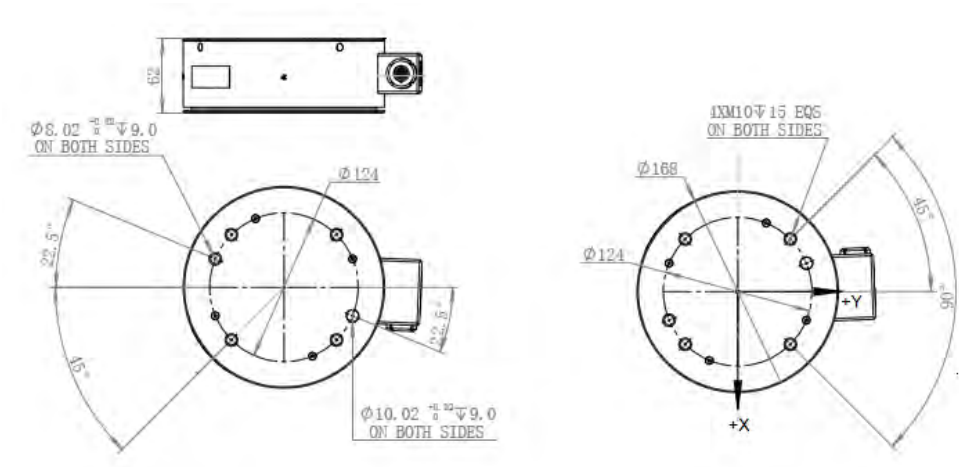
ABB force sensor output voltage scope

Sensor type	Fx(unit:V)	Fy(unit:V)	Fz(unit:V)	Mx(unit:V)	My(unit:V)	Mz(unit:V)
Small force sensor	4.2	4.2	4.8	5.0	5.0	5.2
Medium force sensor	7.0	7.0	7.0	7.0	7.0	7.5
Large force sensor	6.8	6.8	6.3	6.5	6.5	5.6

I/O pin configuration
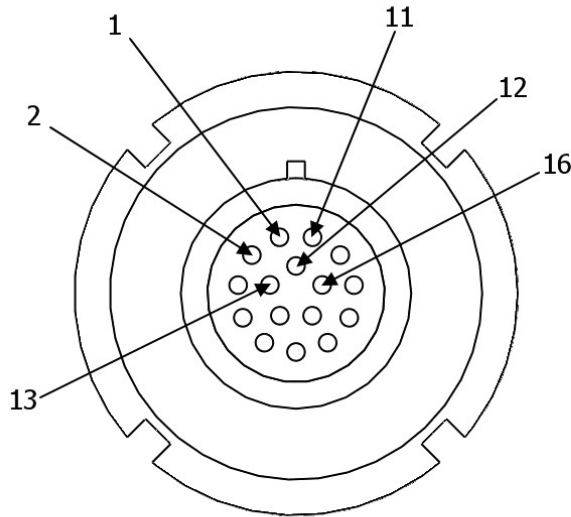
xx1300002425

Figure 2.2: Connector

Pin	Description	Pin	Description
1	GND	9	+Fz

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Pin	Description	Pin	Description
2	GND	10	-Fz
3	+15V	11	+Mx
4	-15V	12	-Mx
5	+Fx	13	+My
6	-Fx	14	-My
7	+Fy	15	+Mz
8	-Fy	16	-Mz

Environment conditions

	Storage temperature	Operating temperature	Calibration temperature
Force sensor	-40˚C - +70˚C	0 ˚C- 52˚C	20˚C-25˚C

CE Conformity

This device complies with EMC Directive 2004/108/EC.

2.1.4 Voltage measurement box

Voltage measurement box 3HAC034234-001

The voltage measurement box has the function of A/D converter. It is used to measure the output voltage from the ABB force sensor and transfer it into the IRC5 control cabinet which then would transfer the voltage value into force/torque values. One channel is used for a sensor safety signal and one channel is used for the spindle sensor signal used for SpeedChange.

Input voltage requirements

Voltage description	Maximum value
Differential input voltage (for example between U_0+ and U_0-)	+/- 10 V
Input voltage (relative to 0 V Common)	+/- 10 V

I/O pin configuration

This is a description of the connectors on the voltage measurement box.

Connector X3

Connector X3 is used for connecting the cable from the force sensor. The cable connector should be a Lemo (article number: FGA.3K.320.CLAC60) male connector to match the X3 connector on the box.
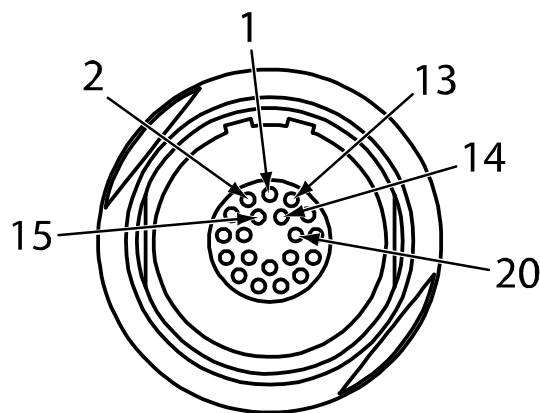
xx0900001057

Pin	Description	Pin	Description
1	U_0+	11	U_5+
2	U_0-	12	U_5-
3	U_1+	13	Not used
4	U_1-	14	SpeedChange single channel +
5	U_2+	15	SpeedChange single channel -
6	U_2-	16	Safety +
7	U_3+	17	Safety -
8	U_3-	18	0V (Common)

Continues on next page

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Pin	Description	Pin	Description
9	U_4+	19	-15V
10	U_4-	20	+15V

Connector X1

Connector X1 is used for connecting the cable to the robot controller.
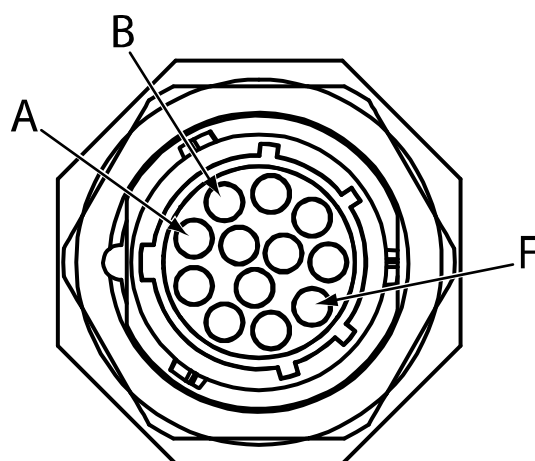
xx0900001058

Pin	Description	Pin	Description
A	SDI_AXC_P	D	SDO_AXC_N
B	SDI_AXC _N	E	0V
C	SDO_AXC_P	F	24V

Connector X2

Connector X2 is used for connecting the cable to the serial measurement link for additional axes. If no additional axes are connected, the jumper connector must be used.
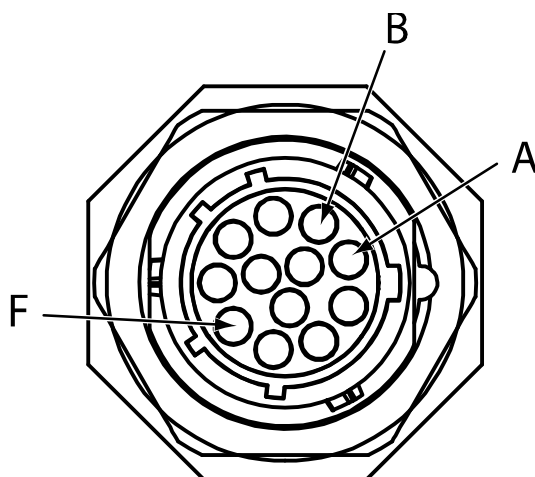
xx0900001059

Pin	Description	Pin	Description
A	SDO_SMB_P	D	SDI_SMB_N

Continues on next page

2 Installation

Pin	Description	Pin	Description
B	SDO_SMB _N	E	0V
C	SDI_SMB_P	F	24V

Hole pattern

When mounting the voltage measurement box, it is attached with four screws in the holes with the following pattern:
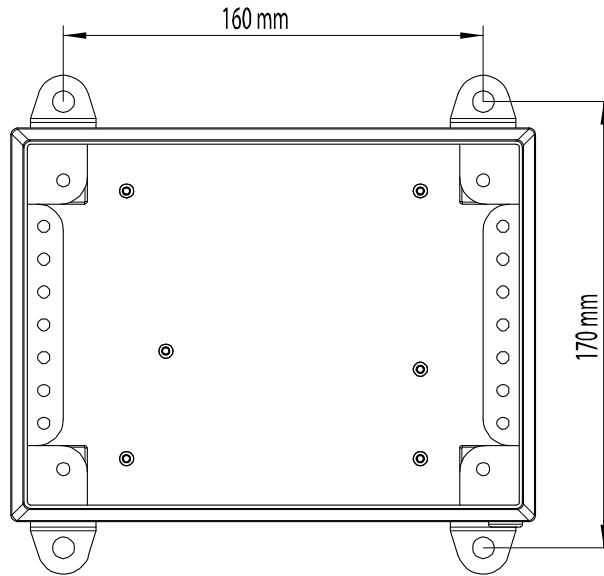
xx1000000052

Protection class

The voltage measurement box has protection class IP66.

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2.1.5 Cables

Overview

The cables are high flexible, well shielded and should be grounded.

I/O pin configuration for sensor cable
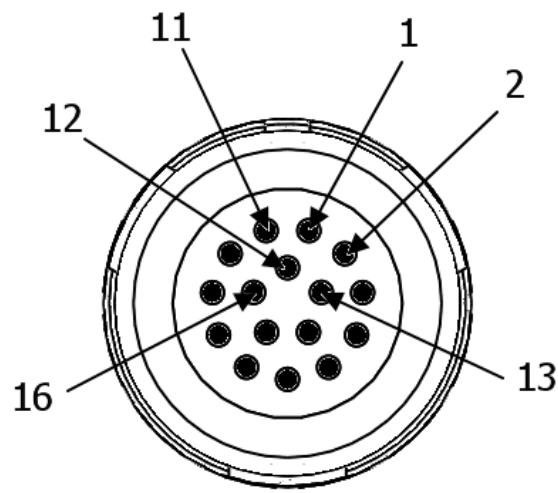
xx1300002695

Figure 2.3: Sensor side connector

Pin	Description	Pin	Description
1	GND	9	+Fz
2	GND	10	-Fz
3	+15V	11	+Mx
4	-15V	12	-Mx
5	+Fx	13	+My
6	-Fx	14	-My
7	+Fy	15	+Mz
8	-Fy	16	-Mz

2.1.5 Cables
Continued

xx1300002696

Figure 2.4: VMB side connector

Pin	Description	Pin	Description
1	U_0+	11	U_5+
2	U_0-	12	U_5-
3	U_1+	13	Not used
4	U_1-	14	SpeedChange single channel +
5	U_2+	15	SpeedChange single channel -
6	U_2-	16	Safety +
7	U_3+	17	Safety -
8	U_3-	18	0V (Common)
9	U_4+	19	-15V
10	U_4-	20	+15V

I/O pin configuration for control cable
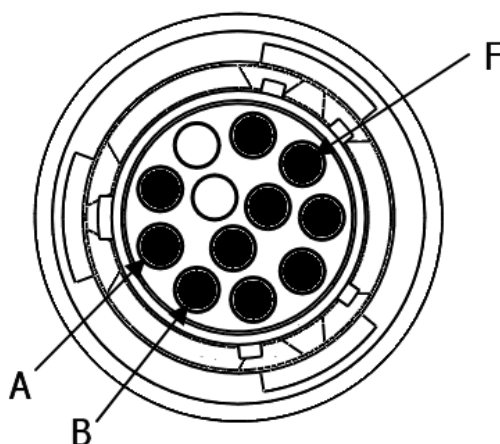
xx1300002697

Figure 2.5: VMB side connector

Pin	Description	Pin	Description
A	SDI_AXC_P	D	SDO_AXC_N
B	SDI_AXC _N	E	0V
C	SDO_AXC_P	F	24V

2.1.5 Cables
Continued

xx1300002698

Figure 2.6: IRC5 side connector

Pin	Description	Pin	Description
A	SDI_AXC_P	D	SDO_AXC_N
B	SDI_AXC _N	E	0V
C	SDO_AXC_P	F	24V

Cable specification

Item	Small force sensor	Medium/Large force sensor
Sensor cable length	5m	5m, 10m
Control cable length	3m, 7m, 15m, 22m, 30m	3m, 7m, 15m, 22m, 30m
Sensor cable lifetime	3 million times of bending	3 million times of bending

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> **ℹ Note**
>
> The control cable has following length to choose: 3m, 7m, 15m, 22m, 30m. While the 3m control cable only can be delivered with IRB120. If the 3m control cable is needed for other robot types, it must be ordered separately.

2.1.6 Adapter unit

2.1.6.1 Overview

Overview introduction

There are six types of adapter unit - A, B, C, D, E, F which contains following components by standard:

- Adapter flange to mount the force sensor on the robot flange. The six types of adapter unit is classified based on the different adapter flange types. For detailed information about what types of and how many adapter flange are needed for different robot types, see *Adapter flange dimension on page 26*.
- Extending plate. It is used to guide and fix the cable between the force sensor and VMB. Three extending plate types- a, b, c are available for choose depending on adapter flange types. For detailed information about the extending plate, see *Extending plate on page 30*.
- Mounting screws. Used to mount the sensor to the robot by adapter flanges and mount the cable bracket on the adapter flange of the sensor.
- Positioning pins. Used for easy and accurate positioning during the installation.

Following is a general overview of the adapter unit types.

Adapter unit type	Applied robot type	Flange amount	Force Sensor type	Adapter flange weight (Kg)	Robot Pay-load(Kg)	Extend-ing plate type
A	IRB 1200	1	Small	0.62	5	a
B	IRB 140/1600	1	Small	0.64	6	a
C	IRB 2400/2600	1	Small/Medium	0.64	10	a
D	IRB 4400/4600	2	Medium	2.9	60	b
E	IRB 4400/4600	2	Large	4.82	60	b
F	IRB 66xx/6700	2	Large	7.9	130	c

Adapter flange dimension

The force sensor should be mounted on the flange of robot axis by ABB specific adapter flange. For IRB 1200, IRB140, IRB1600, IRB2400, IRB2600, they need one adapter flange for mounting the force sensor to the robot arm. For IRB4400, IRB4600, IRB66XX and IRB6700, a pair of adapter flanges are needed to fix the force sensor to the robot arm.
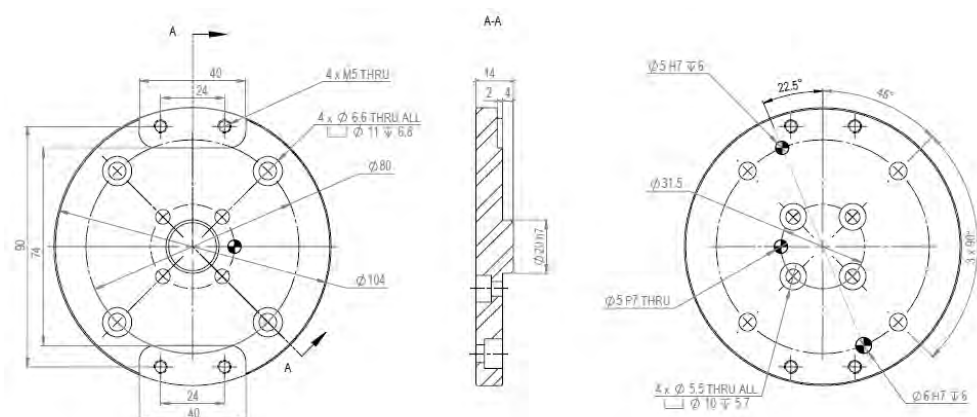
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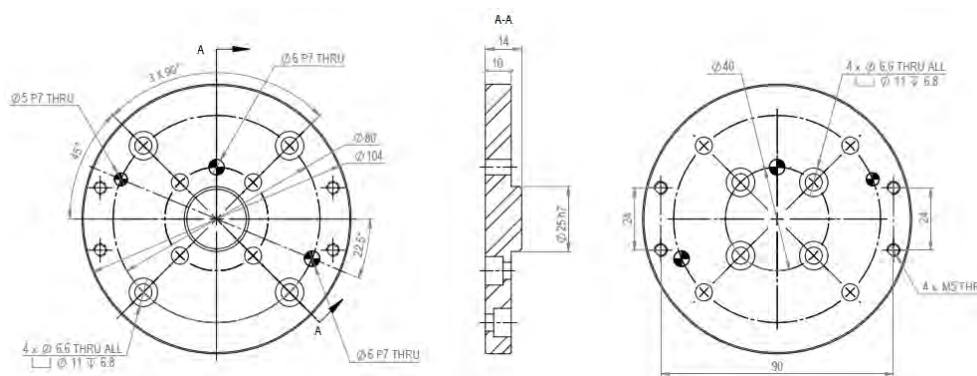Their detailed dimension information is listed below.

Small force sensor used with IRB1200

Small force sensor used with IRB140 & IRB1600

Small/medium force sensor used with IRB2400 & IRB2600
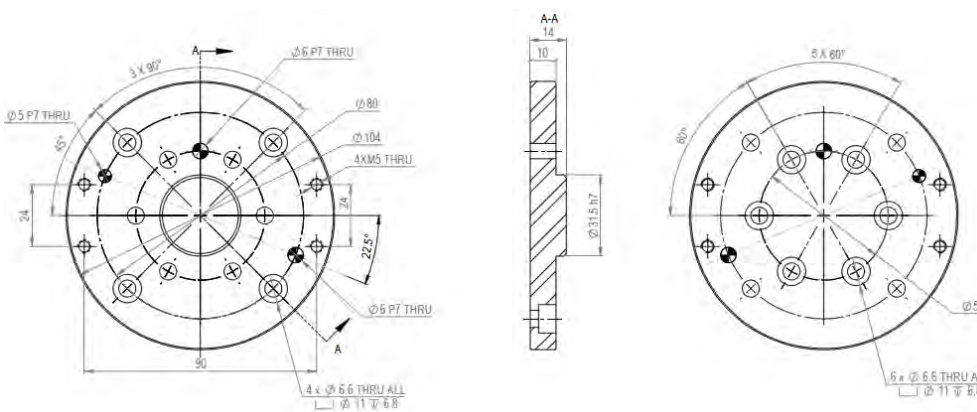
Medium force sensor used with IRB4400 & IRB4600

A pair of adapter flanges are needed to mount the force sensor to the robot axis. Both middle size and large size force sensor can be used on IRB4400 & IRB4600.

When the middle size force sensor is used, the adapter flanges' dimensions are:
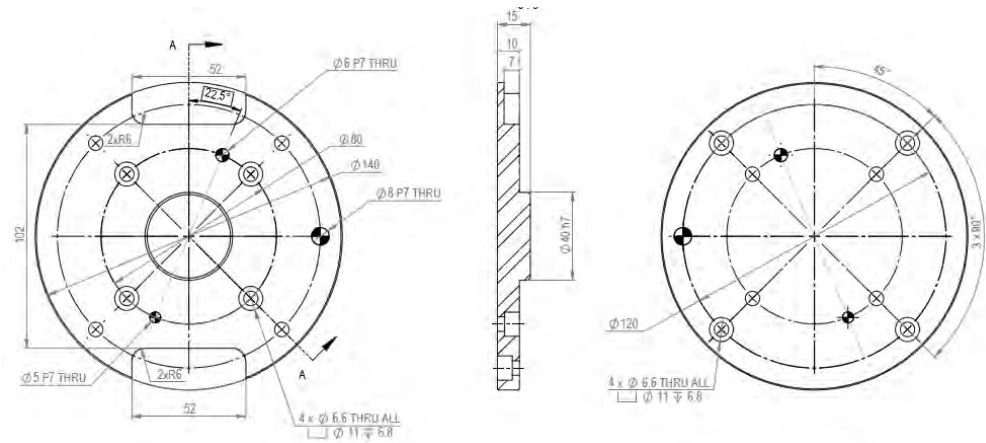
xx1300002366

Figure 2.7: Sensor side adapter flange
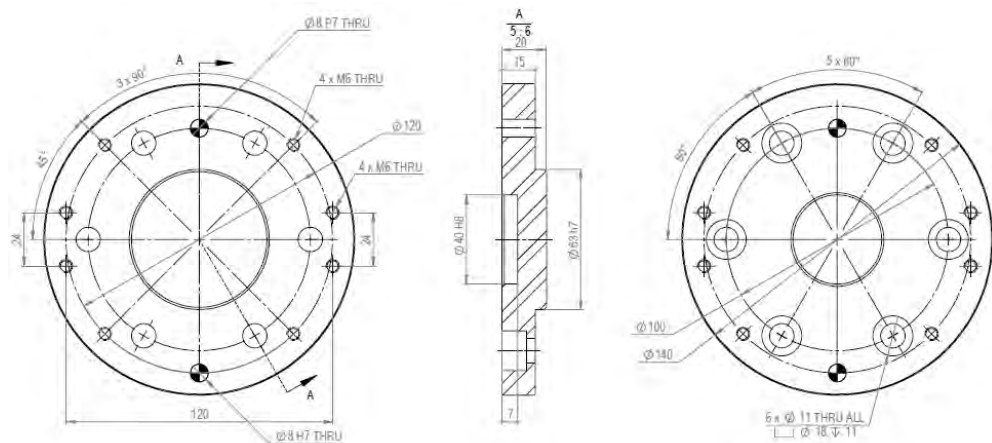
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Figure 2.8: Robot side adapter flange

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Large force sensor used with IRB4400 & IRB4600

When the large size force sensor is used, the adapter flanges' dimensions are:
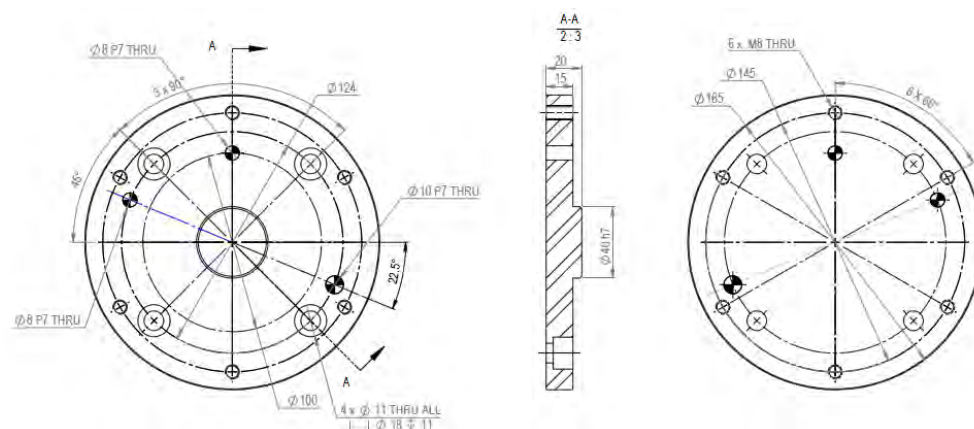
xx1300002362

Figure 2.9: Sensor side adapter flange
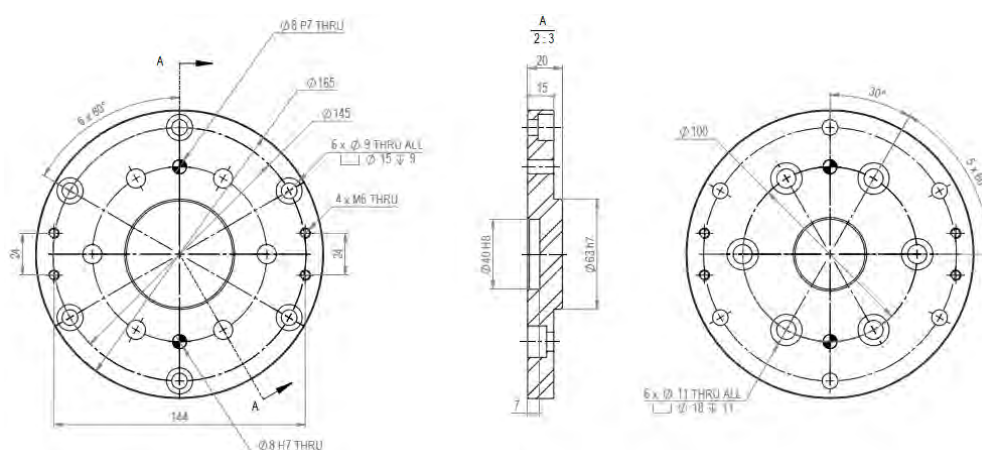
xx1300002361

Figure 2.10: Robot side adapter flange

Large force sensor used with IRB66XX & IRB6700
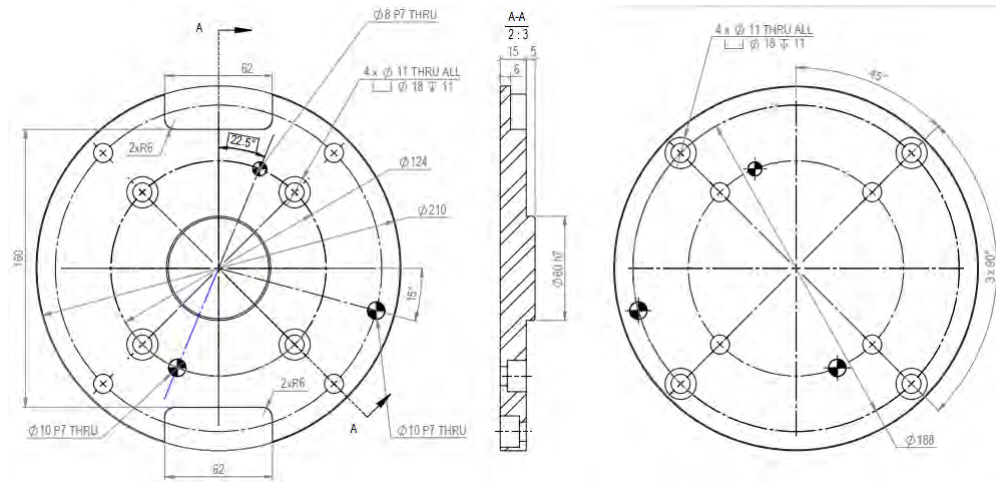
xx1300002363

Figure 2.11: Sensor side adapter flange

xx1300002364

Figure 2.12: Robot side adapter flange

Extending plate

Extending plate type	Material	Weight(Kg)
a	6063	0.075
b	SS304	0.28
c	SS305	0.52

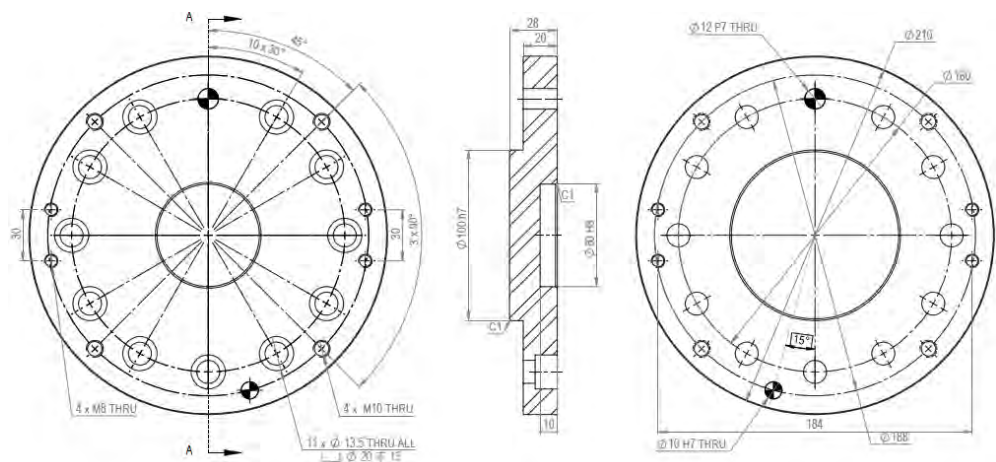## 2.1.6.2 Adapter unit type A

Component

Component of Adapter unit type A are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

No.	Name	Specific-a-tion/Mod-el	Reference no.	Quant-ity(Unit:piece)	Material	Description/Note
1	Adapt flange	A	3HAC048938-001	1	SS 304	
2	Extending plate	a	3HAC047797-001	1	AI 6063	
3	Positioning pin	Φ5x12	9ABA108-24	1	Stainless steel A1-50	To position the sensor side ad-apter flange to the sensor.
4	Positioning pin	Φ6x12	9ABA108-33	1	Stainless steel A1-50	To position the sensor side ad-apter flange to the sensor.
5	Positioning pin	Φ5x16	9ABA108-25	1	Stainless steel A1-50	To position the ro-bot side adapter flange to the ro-bot.
6	Hexagon socket head cap screws	M5x8	9ADA183-11	4	Steel 8.8	To fix the robot side adapter flange to the ro-bot.
7	Hexagon socket head cap screws	M6x10	9ADA183-22	4	Steel 8.8	To fix the sensor to the sensor side adapter flange.
8	Hexagon socket coun-tersunk head screws	M5x12	9ADA625-44	2	Stainless Steel A2-70	To fix the extend-ing plate to the ro-bot side adapter flange.

2.1.6.3 Adapter unit type B

Component

Component of Adapter unit type B are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

No.	Name	Specific- a- tion/Mod- el	Reference no.	Quant- ity(Unit:piece)	Material	Description/Note
1	Adapt flange	B	3HAC047790- 001	1	SS 304	
2	Extending plate	a	3HAC047791- 001	1	AI 6063	
3	Postioning pin	Φ5x16	9ABA108-25	1	Stainless steel A1- 50	To position the sensor side ad- apter flange to the sensor.
4	Postioning pin	Φ6x16	9ABA108-34	2	Stainless steel A1- 50	To position the sensor side ad- apter flange to the sensor and posi- tion the robot side adapter flange to the robot.
5	Hexagon socket head cap screws	M6x10	9ADA183-22	4	Steel 8.8	To fix the sensor side adapter flange to the sensor
6	Hexagon socket head cap screws	M6x12	9ADA183-23	4	Steel 8.8	To fix the robot side adapter flange to to the robot wrist.
7	Hexagon socket coun- tersunk head screws	M5x12	9ADA625-44	2	Stainless steel A2- 70	To fix the extend- ing plate to the ro- bot side adapter flange.

2.1.6.4 Adapter unit type C

Component

Component of Adapter unit type C are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

No.	Name	Specific-a-tion/Model	Reference no.	Quant-ity(Unit:piece)	Material	Description/Note
1	Adapt flange	C	3HAC048926-001	1	SS 304	
2	Extending plate	a	3HAC047791-001	1	AI 6063	
3	Postioning pin	Φ5x16	9ABA108-25	1	Stainless steel A1-50	To position the sensor side adapter flange to the sensor.
4	Postioning pin	Φ6x16	9ABA108-34	2	Stainless steel A1-50	To position the sensor side adapter flange to the sensor and position the robot side adapter flange to the robot.
5	Hexagon socket head cap screws	M6x10	9ADA183-22	4	Steel 8.8 - A2F	To fix the sensor side adapter flange to the sensor
6	Hexagon socket head cap screws	M6x12	9ADA183-23	4	Steel 8.8 - A2F	To fix the robot side adapter flange to to the robot wrist.
7	Hexagon socket countersunk head screws	M5x12	9ADA625-44	2	Stainless steel A2-70	To fix the extending plate to the robot side adapter flange.

2.1.6.5 Adapter unit type D

Component

Component of Adapter unit type D are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

No.	Name	Specific- a- tion/Mod- el	Reference no.	Quant- ity(Unit:piece)	Material	Description/Note
1	Adapt flange	D	3HAC048927-001; 3HAC048928-001	2	SS 304	
2	Extending plate	b	3HAC048988-001	1	AI 6063	
3	Postioning pin	Φ5x16	9ABA108-25	1	Stainless Steel A1-50	To position the sensor side adapter flange to the sensor.
4	Postioning pin	Φ6x16	9ABA108-34	1	Stainless Steel A1-50	To position the sensor side adapter flange to the sensor.
5	Postioning pin	Φ8x20	9ABA108-45	2	Stainless Steel A1-50	To position the ro-bot side adapter flange to the robot and position the sensor side adapter flange to the robot side adapter flange.
6	Hexagon socket head cap screws	M6x10	9ADA183-22	4	Steel 8.8 - A2F	To fix the sensor side adapter flange to the sensor
7	Hexagon socket head cap screws	M6x16	9ADA183-24	4	Steel 8.8 - A2F	To fix the sensor side adapter flange to the robot side adapter flange.
8	Hexagon socket head cap screws	M10x20	9ADA183-49	6	Steel 8.8 - A3F	To fix the robot side adapter flange to to the robot wrist.
9	Hexagon socket coun-tersunk head screws	M6x16	9ADA625-56	2	Stainless Steel A2-70	To fix the extending plate to the robot side adapter flange.

2.1.6.6 Adapter unit type E

Component

Component of Adapter unit type E are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

No.	Name	Specific-a-tion/Mod-el	Reference no.	Quant-ity(Unit:piece)	Material	Description/Note
1	Adapt flange	E	3HAC048929-001; 3HAC048930-001	2	SS 304	
2	Extending plate	b	3HAC048988-001	1	AI 6063	
3	Postioning pin	Φ8x20	9ABA108-45	3	Stainless Steel A1-50	To position the sensor side adapter flange to the sensor; To position the ro-bot side adapter flange to the robot; To position the ro-bot side adapter flange to the sensor side adapter flange.
4	Postioning pin	Φ10x20	9ABA108-56	1	Stainless Steel A1-50	To position the sensor side adapter flange to the sensor;
5	Hexagon socket head cap screws	M10x16	9ADA183-48	4	Steel 8.8 - A3F	To fix the sensor side adapter flange to the sensor
6	Hexagon socket head cap screws	M10x20	9ADA183-49	6	Steel 8.8 - A3F	To fix the robot side adapter flange to to the robot wrist.
7	Hexagon socket head cap screws	M8x16	9ADA183-35	6	Steel 8.8 - A3F	To fix the sensor side adapter flange to the robot side ad-apter flange.
8	Hexagon socket coun-tersunk head screws	M6x16	9ADA625-56	2	Stainless Steel A2-70	To fix the extending plate to the robot side adapter flange.

2.1.6.7 Adapter unit type F

Component

Component of Adapter unit type F are listed in the following table. For detailed adapter flange dimension information and extending plate information, see *Adapter flange dimension on page 26* and *Extending plate on page 30* .

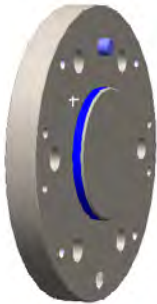| No.	Name	Specific-a-tion/Mod-el	Reference no.	Quant-ity(Unit:piece)	Material	Description/Note
1	Adapt flange	F	3HAC048931-001; 3HAC048932-001	2	SS 304	
2	Extending plate	c	3HAC048989-001	1	AI 6063	
3	Postioning pin	Φ8x20	9ABA108-45	1	Stainless Steel A1-50	To position the sensor side ad-apter flange to the sensor;
4	Postioning pin	Φ10x20	9ABA108-56	1	Stainless Steel A1-50	To position the sensor side ad-apter flange to the sensor;
5	Postioning pin	Φ10x24	9ABA108-57	1	Stainless Steel A1-50	To position the ro-bot side adapter flange to the sensor side ad-apter flange.
6	Postioning pin	Φ12x24	9ABA108-69	1	Stainless Steel A1-50	To position the ro-bot side adapter flange to the robot;
7	Hexagon socket head cap screws	M10x16	9ADA183-48	4	Steel 8.8 - A3F	To fix the sensor side adapter flange to the sensor
8	Hexagon socket head cap screws	M10x20	9ADA183-49	4	Steel 8.8 - A3F	To fix the sensor side adapter flange to the robot side adapter flange.
9	Hexagon socket head cap screws	M12x20	9ADA183-63	11	Steel 8.8 - A3F	To fix the robot side adapter flange to to the robot wrist.
10	Hexagon socket coun-tersunk head screws	M8x20	9ADA625-67	2	Stainless Steel A2-70	To fix the extend-ing plate to the ro-bot side adapter flange.

2.2 Installation

Hardware installation

Tools

This table lists tools to be used when mounting the Force Control System.

No.	Description	Quant-ity
1	Screw driver	1
2	Torque wrench	1
3	Rubber hammer	1

Hardware connection procedure

Use this procedure for mounting the medium size ABB force sensor onto the IRB4600 for example. For information about selecting the correct adapter unit type, sensor type and cable type in force sensor mounting, see *Introduction on page 11*.
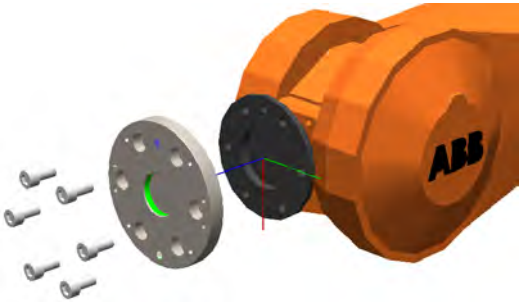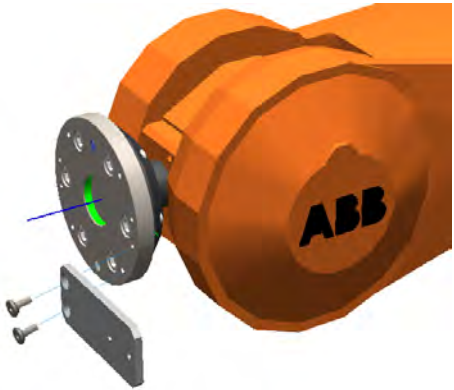
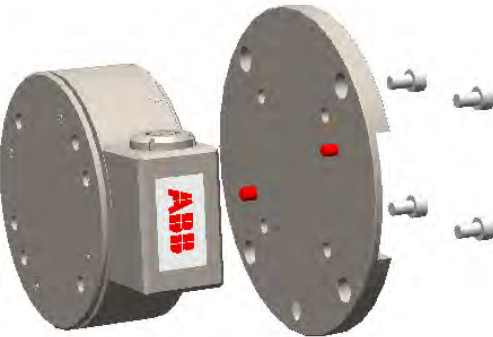| No.	Description	Illustration/Note
1	Jog the robot to the home position.	
2	Insert the φ8x20 positioning pin into the robot side adapter flange. ℹ️ **Note** For IRB1200, IRB140, IRB1600, IRB2400, IRB2600, there is only one adapter flange.	

No.	Description	Illustration/Note
3	Mount the robot side adapter flange onto the robot wrist using 6 M10x20 class 8.8 hexagon socket head cap screws with the positioning pin also inserted into the positioning hole of the robot wrist. Torque:58Nm. 💡 **Tip** Force sensor frame and mounting information: A: Mount the tool to this side B: LEMO connector: EEG.2K.316.CLL; Mating connector: FGG.2K.316.CLAD52Z C: The robot arm is at this side	 ℹ️ **Note** For IRB4600, the fixing screws are M10x20. While specification of positioning screws varies depending on different robot types. For what type of adapter unit are used for different robot types, see *Adapter unit on page 26*.
4	Use two φ6x16 class 8.8 hexagon socket head cap screws to fix the cable bracket on the robot side adapter flange. Torque: 12Nm.	
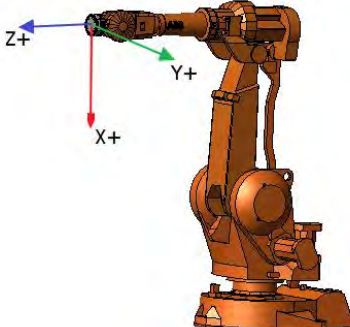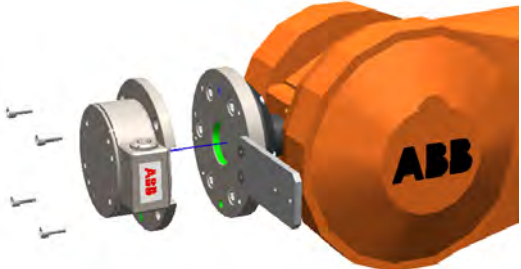
No.	Description	Illustration/Note
5	Insert a φ6x16 positioning pin and a φ5x16 positioning pin into the sensor side adapter flange.	
6	Fix the sensor with the sensor side adapter flange using 4 M6x16 class8.8 hexagon socket head cap screws with the φ6x16 positioning pin and the φ5x16 positioning pin also inserted into the corresponding positioning holes on the sensor. Torque:12Nm. ℹ️ **Note** For IRB1200, IRB140, IRB1600, IRB2400, IRB2600, please skip this step for the force sensor is directly mounted on the robot side adapter flange.	
7	Insert the φ8x20 positioning pin into the corresponding positioning hole in the sensor side adapter flange or directly in the sensor (if only one adapter flange is needed).	

2.2 Installation
Continued

№	Description	Illustration/Note
8	Mount the unit containing the sensor and the adapter flange (or directly mount the sensor when only one adapter is needed) onto the robot side flange using 4 M6x16 class8.8 hexagon socket head cap screws with the φ8x20 positioning pin inserted into the corresponding positioning hole in the robot side adapter flange. ![Note icon] **Note** Make sure the adapter is tightly fixed. Make sure the x+ and y+ marks on the force sensor are aligned with the x+ and y+ directions of the TCP of axis 6, i.e., the orientation of the sensor is the same with tool0. X+,Y+,Z+ direction of the TCP of axis 6: 	 ![Note icon] **Note** If IRB4400/IRB4600 uses the large size force sensor, the four fixing screws must be mounted from the robot side. For other circumstances, the fixing screws are mounted from the force sensor side.
9	Plug the cable connecting the sensor and VMB to the sensor with red marks on the sensor and the cable connector aligned.	

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No.	Description	Illustration/Note
10	Plug the other end of the cable to the voltage measurement box (VMB) with the red marks on the VMB and the cable connector aligned.	A: Connecting the force sensor to VMB
11	Plug the cable connecting the VMB and the control cabinet to the VMB.	A: Connect VMB to IRC5 control cabinet
12	Plug the other end of the cable to the Serial Measurement Link2 on IRC5 Control Cabinet.	

ⓘ Note

The procedure to fixed the ABB force sensor in the room is the same with fixing ABB force sensor to the robot except that the adapter plate is not needed.

Software installation

No.	Description	Illustration/Note
1	Install RobotStudio and RobotWare on a PC.	See *Operating manual - RobotStudio*
2	Create a new system in RobotStudio. Select the RobotWare option **Force Control Base** (option 661-2).	See *Operating manual - RobotStudio*
3	Configure the system using RobotStudio. Force Control parameter are set in the configuration topic *Motion*.	See *Configuration on page 42*.
4	Import the calibration file. Right-click the Configuration node in RobotStudio, select **Load Parameters** and then **Load parameters and replace duplicates**. The sensor calibration data can be loaded from the Force Control Package CD. The file can be found on the CD in the directory calibration/ABB_FTxxxx.cfg, where xxxx is the serial number of the sensor.	
5	Now the system is ready for programming.	

Note

Force sensor calibration is required prior to any operation with force control enabled.

Note

ABB Integrated Force Control has been installed and configured when delivered. While users may still need to create their own system, install the software and do configuration themselves under circumstances as system corruption etc..

Configuration

After the installation, configuration should be done in RobotStudio to start the application.

Base configuration for the Force Control Package is in **Controller -> Motion**. Extra configuration also should be done according to the specific application.

For more information on how to configure a Force Control system, see *Application manual - Force Control*.

3 Maintenance

Periodic inspection

The following items should be periodically inspected for possible damages or wear.

- Cables

Weekly checking these items is recommended.

The following items should be periodically checked or cleaned to keep free of excessive dust, debris or moisture.

- Force sensor

Weekly checking these items is recommended.

Periodic calibration

The force sensor should be periodically calibrated following ISO-9000 standard.

Annually calibration is recommended especially for applications that frequently cycle the loads applied to the transducer.

Please contact ABB when calibration is needed.

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4 Decommissioning

4.1 Introduction

Introduction

This section contains information to consider when taking a product, the force sensor, out of operation. It deals with how to handle potentially dangerous components and potentially hazardous materials.

General

All used grease, oils and dead batteries must be disposed in accordance with the current legislation of the country in which the Integrated Force Control units are installed. If the Integrated Force Control units are partially or completely disposed of, the various parts must be grouped together according to their nature (that is, all iron together and all plastic together), and disposed of accordingly. These parts must also be disposed of in accordance with the current legislation of the country in which the Integrated Force Control units are installed.

4.2 Environmental information

Hazardous material

The table specifies some of the materials in the product and their respective use throughout the product.

Dispose components properly to prevent health or environmental hazards.

Material	Example application
Batteries, NiCad or Lithium	Main computer
Copper	Cables
Steel	Cabinet structure, plates, screws, etc.
Plastic/rubber	Cables, connectors, etc.
Aluminium	Heat sinks on power supplies and drive units
Lead	Electronics
Brominated flame retardants	Electronics

5 Troubleshooting

5.1 Sensor related

Force and torque reading saturation

Description

When the data from the force sensor reaches the positive or negative maximums, the gage in the force sensor is saturated.

Possible cause

Saturation occurs when:
- The sensor is loaded beyond its rated work range
- Electrical failure within the system

Solution

- Gradually reduce the load little by little.
- Check if there is electrical failure within the system.

Signal not accurate

Possible cause

- Zero offset too big
- Force sensor is not accurate

Solution

For too big zero offset, execute the following steps:

1 Move robot to zero position and make sure nothing is attached on the tool side of the sensor.
2 If the raw sensor signal output is larger than 0.5V, the zero offset is too big.
3 Move the robot to different positions and also check these channel signals.

For not accurate force sensor, execute the following steps:

1 Attach a adapter on the sensor. Measure the weight with FCLoadID and record it as m1.
2 Attach a load on the sensor. Measure the total weight again with FCLoadID and record it as m2.
3 Measure the load on a balance and record it as m3.
4 Compare m3 with m2-m1. If the result is larger than 1.5%FS, sensor is not accurate.

Sensor signal not stable

Description

Signal is not stable in TSV output.

Possible cause

- Loose connector connection
- Damaged cable

- Loose sensor attachment
- Disturbance of surrounding equipment
- Sensor failure

Solution

- Check and confirm connections and cables are undamaged and firmly connected.
- Check electromagnetic interference of surrounding equipment
- Check if the sensor fails.

Noise

Possible cause

Excessive noise can be caused by:

- Mechanical vibrations, possibly from a poor ground.
- Electrical disturbances
- Component failure within the system.

Solution

- Check if the ground is horizontal and smooth.
- Check if there is electrical disturbance.
- Check if component failure exists in the system.

> 💡 **Tip**
>
> Errors in force and torque reading could result from the bad data from the force sensor. Bad force/torque reading error could result in problems with threshold monitoring and sensor accuracy. Usually viewing the strain gage data of the force sensor can help to make the problem more clear.

5.2 Robot related

Slow reaction

Description

The robot acts very slowly.

- Robot presses hard on the work piece.
- Robot leaves the work piece.

Possible cause

- FCLoadID is not done.
- Robot is not near working position when calibrated.
- Sensor calibration data is wrong.
- System parameters are not correctly defined. For example, damping is too large, lowest measured contact force is too high, bandwidth of the force loop filter is too low etc.

Solution

- Execute the instruction `FCLoadId`. See *Application manual - Force Control*.
- Recalibrate the robot.
- Recalibrate the force sensor or import the correct calibration data.
- Modify system parameters until proper system parameters are got.

Wrong reaction

Description

The robot moves to the wrong direction when it is being under certain force/torque.

Possible cause

- Damaged cable
- Wrong direction of sensor attachment
- Loose sensor or tool attachment
- Sensor failure
- Wrong calibration data

Solution

- Check if the cable is damaged.
- Check if the sensor is mounted with the right direction.
- Check if the sensor or the tool is firmly fixed.
- Check if the correct calibration data is imported.
- Replace a new sensor.

Drifting

Description

After a load is removed or applied, the force gage in the force sensor does not stabilized, but continue to increase or decrease. This may be observed more easily when viewing resolved force/torque data.

Possible cause

- Sensor is fixed tightly.
- Temperature change
- Mechanical coupling. Mechanical coupling is caused when a physical connection is made between the tool plate and the sensor body (i.e. ???). Some mechanical coupling is common, as hoses and wires are attached to a tool.
- Internal failure of the sensor
- FCLoadID is not done.
- Robot is not near working position when calibrated.
- Sensor calibration data is wrong.
- The orientation of gravity is not with respect to the base frame.
- FC system parameters are not correctly defined. e.g. Damping is too low, lowest measured contact force is too low, bandwidth of force loop filter is too high etc.

Solution

- Keep the temperature in a stable level
- Check if there is physical connection between the tool and the adapter, or between the adapter and the force sensor.
- Check if hoses and wires are attached to the tool.
- Check if the sensor is malfunctioned.

Stop

Description

Robot stop during force control movement.

Possible cause

Generally, check the error message and follow the recommended actions.

- The sensor cable loose or broken will trig emergency stop when Force Sensor Cable Check is enabled.
- TCP speed is higher than Max Press TCP Speed.
- Robot moves more than the supervision distance.
- Robot moves near singularity position.

Solution

- Check if the sensor cable is loose or broke.
- Check if the TCP speed is higher than Max Press TCP Speed.
- Check if the robot moves near singularity position.

- Check if the target is outside the work range of the robot.

- Check if the sensor is malfunctioned.

No reaction

Description

The force sensor does not move under external force when force control is activated.

Possible cause

- Loose connector connection
- Broken cable
- Sensor failure
- Wrong calibration data

Solution

- Check if the cable is loose or broke.
- Check if the correct calibration data is imported.
- Check if the sensor is malfunctioned.

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6 Spare parts

Spare part list

Following are the spare parts for ABB Integrated Force Control.

Item	ABB Reference no.	Description
1	3HAC046093-001	Small ABB force sensor
2	3HAC048735-001	Medium ABB force sensor
3	3HAC048736-001	Large ABB force sensor
4	3HAC049188-001	Adapter unit A
5	3HAC049189-001	Adapter unit B
6	3HAC049190-001	Adapter unit C
7	3HAC049191-001	Adapter unit D
8	3HAC049192-001	Adapter unit E
9	3HAC049193-001	Adapter unit F
10	3HAC043521-001	Sensor cable 5m
11	3HAC043521-004	Sensor cable 10m
12	3HAC034234-001	Voltage measurement box
13	3HAC035320-001	Control cable signal 3m
14	3HAC2493-1	Control cable signal 7m
15	3HAC2530-1	Control cable signal 15m
16	3HAC2540-1	Control cable signal 22m
17	3HAC2566-1	Control cable signal 30m

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7 Reference information

Tightening torque

Before tightening any screw, note the following:

- Determine whether a **standard** tightening torque or **special** torque is to be applied. The **standard torques** are specified in the following tables. Any **special torques** are specified in the repair, maintenance or installation procedure descriptions. **Any special torque specified overrides the standard torque!**

- Use the *correct tightening torque* for each type of screw joint.

- Only use *correctly calibrated* torque keys.

- Always *tighten the joint by hand,* and never use pneumatic tools.

- Use the *correct tightening technique*, that is *do not* jerk. Tighten the screw in a slow, flowing motion.

- Maximum allowed total deviation from the specified value is **10%**!

Oil-lubricated screws with slotted or cross-recess head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *slotted or cross-recess head screws.*

Dimension	Tightening torque (Nm) Class 4.8, oil-lubricated
M2.5	0.25
M3	0.5
M4	1.2
M5	2.5
M6	5.0

Oil-lubricated screws with allen head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *allen head screws.*

Dimension	Tightening torque (Nm) Class 8.8, oil-lubricated	Tightening torque (Nm) Class 10.9, oil-lubricated	Tightening torque (Nm) Class 12.9, oil-lubricated
M5	6	-	-
M6	10	-	-
M8	24	34	40
M10	47	67	80
M12	82	115	140
M16	200	290	340
M20	400	560	670
M24	680	960	1150

Lubricated screws (Molycote, Gleitmo or equivalent) with allen head screws

The following table specifies the recommended standard tightening torque for *screws lubricated with Molycote 1000, Gleitmo 603 or equivalent* with *allen head screws.*

Dimension	Tightening torque (Nm) Class 10.9, lubricated [i]	Tightening torque (Nm) Class 12.9, lubricated [i]
M8	28	35
M10	55	70
M12	96	120
M16	235	280
M20	460	550
M24	790	950

[i]   Lubricated with Molycote 1000, Gleitmo 603 or equivalent

Water and air connectors

The following table specifies the recommended standard tightening torque for *water and air connectors* when *one* or *both* connectors are made of *brass.*

Dimension	Tightening torque Nm - Nominal	Tightening torque Nm - Min.	Tightening torque Nm - Max.
1/8	12	8	15
1/4	15	10	20
3/8	20	15	25
1/2	40	30	50
3/4	70	55	90

Unit convert

Use the following table to convert units used in this manual.

Quantity	Units		
Length	1 m	3.28 ft.	39.37 in
Weight	1 kg	2.21 lb.	
Weight	1 g	0.035 ounces	
Pressure	1 bar	100 kPa	14.5 psi
Force	1 N	0.225 lbf	
Moment	1 Nm	0.738 lbf-ft	
Volume	1 L	0.264 US gal	

ATI Force sensor

The ABB alternative 6 DOF sensors are ATI Force/Torque sensors of model Delta, Theta and Omega. See http://ati-ia.com/ for more information.

The following items need to be ordered from ATI in order to complete the Force Control installation:

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ATI provides the following Sensor product range adapted to ABB Force Control.

Items to complete the Force Control install-ation	Description
Sensor including adapter plate for ABB robot	See details of part number below.
Connection cable	See details of part number below.
ABB data disk	9030-05-1005

ATI Sensor Type, including adapter plate for ABB tool flange

Robot	Proposed sensor type
IRB 120	Mini45
IRB 140, IRB 2400L IRB 1600 IRB 2400-10/-16 IRB 2600	Delta
IRB 4400 IRB 4600	Theta Omega160
IRB 66XX	Omega160, Omega190, Omega250
IRB 7600	Omega250

These sensors and adapter plates are only recommendations. For correct selection depending on robot type, ATI should be consulted

ATI IP-environment protection

Sensors are available in the following protection classes: IP60, Dust protection, IP65, Wet spray protection, IP65V, with Viton seals for applications with exposure to solvents and aggressive oils and IP68 for underwater protection (10m).

ATI Sensor Part number

The part number shall be:

Part number	Description
9105-TIF-Type-IPxx	Where: Type is equal to "sensor type" choice according to table above. IPxx has to be chosen IP60, IP65 or IP65V15yy, chosen according table above

ATI Cable Part number

The part number shall be:

Part number	Description
9105-C-Lx-AM-yy	Where:Lx has to be chosen L for IP60, IP65 and IP68, LV for IP65V yy will be chosen according cable length in meters that is required (from measuring board to sensor). Standard lengths available are 12, 17, 20, 25, 27, 32, 35 and 40 m (robot floor cable + 5 meter for small robots and 10 meters for large robots). Other lengths are available on request.

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