ROBOTICS

Product manual

Force Control Package

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Product manual
Force Control Package

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Original instructions.

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Overview of this manual

About this manual

This manual contains information about the Force Control Package, which is used together with software RW Force Control options for robot systems running on an OmniCore controller.

> **Note**
>
> It is the responsibility of the integrator to provide safety and user guides for the robot system.

Usage

This manual should be used during installation and maintenance of the hardware components in the Force Control Package.

> **Note**
>
> Before any work on or with the robot is performed, the safety information in the product manual for the controller and manipulator must be read.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel

Prerequisites

A maintenance/repair/installation craftsman working with an ABB Robot 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.

References

Documentation referred to in the manual, is listed in the table below.

Reference	Document ID
Operating manual - OmniCore	*3HAC065036-001*
Operating manual - Integrator's guide OmniCore	*3HAC065037-001*
Product manual - OmniCore C30	*3HAC060860-001*
Product manual - OmniCore C30 Type A	*3HAC089064-001*
Product manual - OmniCore C90XT	*3HAC073706-001*
Product manual - OmniCore V250XT Type B	*3HAC087112-001*
Product manual - OmniCore V400XT	*3HAC081697-001*
Operating manual - RobotStudio	*3HAC032104-001*
Technical reference manual - RAPID Overview	*3HAC065040-001*

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Reference	Document ID
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC065038-001*
Technical reference manual - System parameters	*3HAC065041-001*
Application manual - Force control with software and hardware	*3HAC070206-001*

Revisions

Revision	Description
A	First edition.
B	Published in release 24C. The following updates are made in this revision: • Updated the spare part list, see *Spare parts on page 55*. • Reference to OmniCore product manuals added in *Installation on page 39*. • Updated option requirements for working with force control, see *Required Controller & RobotWare options on page 11*.
C	Published in release 24D. The following updates are made in this revision: • Updated the information about periodic calibration. • Added a new adapt plate S21 for IRB 1300 and IRB 1600, and updated related information about adapter unit type B. • Updated tightening torque of screws used for mounting the force sensors.

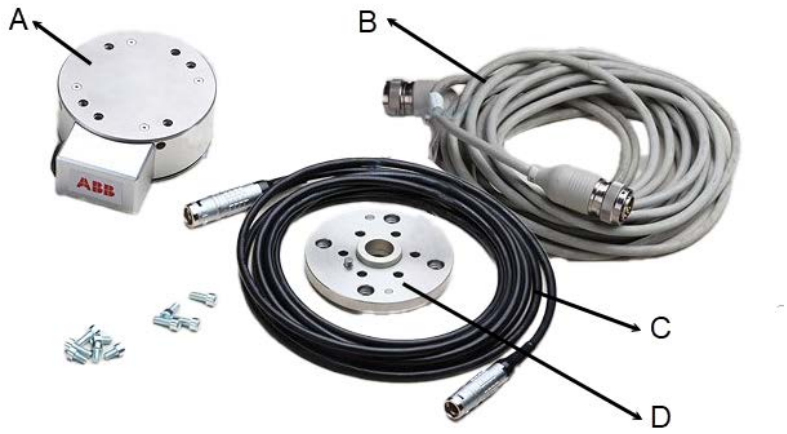
1 Introduction

1.1 Overview

About ABB Force Control

ABB Force Control products contains all the required hardware and software to run the robot in force control mode, in which, hardware contains both the hardware components in Force Control Package and floor cables.

Following illustration shows the hardware required for force control applications.



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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 12*.
B	Floor cable	Control cable connecting the sensor cable to the controller cabinet. For detailed information about the floor cable, see *Cables on page 36*.
C	Sensor cable	Cable connecting the force sensor to the floor cable. For detailed information about the sensor cable, see *Cables on page 36*.
D	Adapter unit	Includes adapter plates(s), screws and pins that are used to mount the force sensor onto the robot wrist. For detailed information about the adapter unit, see *Adapter unit on page 19*.

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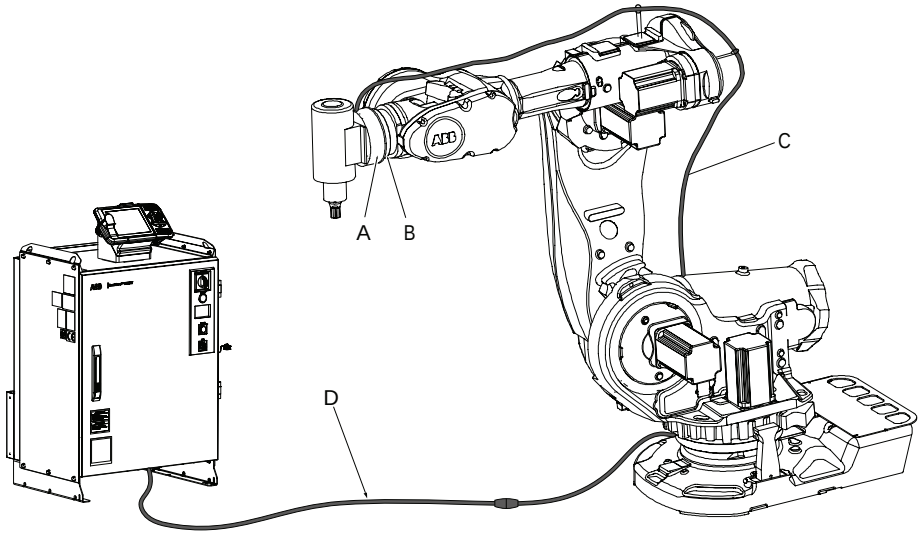
Application example

ABB Force Control products are commonly used in robot machining application and robot assembly application. The following figure shows a hardware connection example in machining application.



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A	ABB force sensor
B	Adapter unit
C	Sensor cable
D	Floor cable

1.2 Delivery

Hardware components

Please check if the delivered packages contain all the hardware components that ordered. Following components are delivered by default:

- ABB force sensor. For detailed information, see *ABB force sensor on page 12*.
- Sensor cable. For detailed information, see *Cables on page 36*.
- Adapter unit. For detailed information about the adapter unit, see *Adapter unit on page 19*.
- Floor cable. For detailed information, see *Cables on page 36*.

Required Controller & RobotWare options

Force Control are options that contain the RAPID instructions required to run force control. According to the application demands, choose the options *Force Control* as required:

- 3415-1 Force Control Standard

The Force Control Package also requires ABB robots with OmniCore controllers to work. Following options are necessary for force control.

Category	Option	Note
Controller variant	One of followings: • 3000-210 OmniCore C90XT • 3000-310 OmniCore V250XT • 3000-410 OmniCore V400XT	
Additional logic 24V power	3015-2 24V 4Amps	
Ethernet & signal interfaces	3050-1 Cable grommet	Required when 3000-310 OmniCore V250XT or 3000-410 OmniCore V400XT is selected.

Tip

ABB Force Control products have integrated the functions of machining application and assembly application. For information about how to use ABB Force Control products in machining and assembly applications, see *Application manual - Force control with software and hardware*.

1.3 ABB force sensor

Specification

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.

Force sensors follow the definitions defined in SAE J2570-2000. For detailed description of sensor specifications, refer to SAE J2570-2000. Contact ABB if any additional specification is required.

General

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
Weight	1.4 kg	1.41 kg	6 kg
Outside diameter x height (unit: mm)	104x40	104x40	168x62
Orientation	Aligned with tool coordination system of robot	Aligned with tool coordination system of robot	Aligned with tool coordination system of robot

Force and torque range

Specification type	Small force sensor	Medium force sensor	Large force sensor
Force measurement range	Fx/Fy: 165 N; Fz: 495 N	Fx/Fy: 660 N; Fz: 1980 N	Fx/Fy: 2500 N; Fz: 6250 N
Force measurement resolution	Fx/Fy: 0.03 N; Fz: 0.11 N	Fx/Fy: 0.09 N; Fz: 0.33 N	Fx/Fy: 0.33 N; Fz: 1.0 N
Torque measurement range	Mx/My/Mz: 15 Nm	Mx/My/Mz: 60 Nm	Mx/My/Mz: 400 Nm
Torque measurement resolution	Mx/My/Mz: 0.003 Nm	Mx/My/Mz: 0.008 Nm	Mx/My/Mz: 0.053 Nm
Uncertainty	Fx/Fy/Fz: 1.71% Mx/My: 1.9%; Mz: 2.1%	Fx/Fy/Fz: 1.8% Mx/My: 1.92%; Mz: 2.4%	Fx/Fy/Fz: 1.98% Mx/My: 2.1%; Mz: 2.1%

Environment condition

Specification type	Small force sensor	Medium force sensor	Large force sensor
Operating temperature (℃)	0 ˚C- 52˚C	0 ˚C- 52˚C	0 ˚C- 52˚C
Storage temperature (℃)	-40˚C - +70˚C	-40˚C - +70˚C	-40˚C - +70˚C
Calibration temperature (℃)	20˚C-25˚C	20˚C-25˚C	20˚C-25˚C
Temperature compensation	Yes	Yes	Yes
Compensated temperature range (℃)	10 to 70	10 to 70	10 to 70

Performance

Specification type	Small force sensor	Medium force sensor	Large force sensor
Power supply (V)	24 V (15-30 V)	24 V (15-30 V)	24 V (15-30 V)
Current (mA) nominal (24V power)	140	140	140

Continues on next page

Specification type	Small force sensor	Medium force sensor	Large force sensor
Current (mA) peak (24V power)	200	200	200
Overload capacity (%F.S.)	1000	1000	1000
Lowest free air resonant frequency (HZ)	700	1200	1400
Non-linearity (%F.S.)	0.5	0.5	0.5
Hysteresis (%F.S.)	0.5	0.5	0.5
Crosstalk (%F.S.)	2.5	2.5	2.5
Zero offset (%F.S.)	10	10	10
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	700	1200	1400
Output	EtherCAT	EtherCAT	EtherCAT
Overload protection [i]	10 times	10 times	10 times

[i] Overload capacity of the force sensor is not the same as typical capacity and could not be treated as the same definition. Overload capacity is designed for accidental usage scenarios when mishandling occurs. It is not recommended to use the overload range of the sensor; otherwise, lifetime of the force sensor will shorten as a consequence of misuse.

Note

In most cases, torque applied to the force sensor will limit the force sensor capability, especially if tool with long leverage is used. TuneMaster can be used to monitor the force and torque values. For details about TuneMaster, see the section "TuneMaster" in *Application manual - Force control with software and hardware* and *Application manual - TuneMaster*.

To protect the force sensor, do not accelerate or decelerate the robot greatly in linear and rotation motions.

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Type mapping

Force sensor type	Robot type[i]	Adapter unit (qty.)	Adapter unit type	Adapter plate type	Sensor cable length	Floor cable length [option 3211-X]
Small force sensor	IRB 1100	Single	A	S1	5 m	3 m / 7 m / 15 m
	IRB 1200					
	IRB 1300	Double	B	S2 & S21		
	IRB 1600					
	IRB 2400	Single	C	S3		
	IRB 2600					
	IRB 4400L/10				10 m	
	IRB 4600 - 20/2.50					
Medium force sensor	IRB 2400				5 m	
	IRB 2600					
	IRB 4400L/10				10 m	
	IRB 4600-20/2.50					
	IRB 4400/60	Double	D	M1 & M2		
	IRB 4600-40/2.55 IRB 4600-45/2.05 IRB 4600-60/2.05					
	IRB 5710-90/2.3 LID IRB 5710-70/2.7 LID					
Large force sensor	IRB 4400/60		E	M3 & M4		
	IRB 4600-40/2.55 IRB 4600-45/2.05 IRB 4600-60/2.05					
	IRB 5710		F	L1 & L2		
	IRB 5720					
	IRB 6710					
	IRB 6650S		G	L3 & L4		
	IRB 6660					
	IRB 6700/6720/6730/6740					

[i] Unless otherwise specified, all the variants of the listed robots supports the corresponding force sensor.

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Note

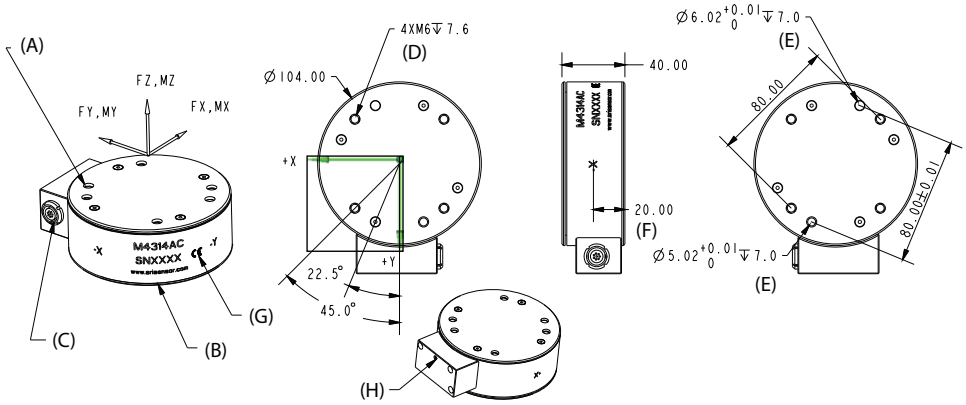
ABB force sensor can be substituted by ATI Axia series Force/Torque sensors in ABB force control applications. Contact your local ATI support for the proper model in Axia series that is applicable to your robot and force control application.

See *https://www.ati-ia.com/* for more information.

For detailed information about how to configure ATI force sensor,see *Application manual - Force control Standard*.

Dimension

Small force sensor



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A	Mounting tool to this side
B	Mounting robot arm to this side
C	LEMO connector EEG.IT.308.CLL MAIING connector FGG.IT.308.CYCC60Z
D	90° equal space on Φ80.00 BC, both sides
E	On Φ80.00 BC, both sides
F	Neutral axis
G	CE mark
H	LED

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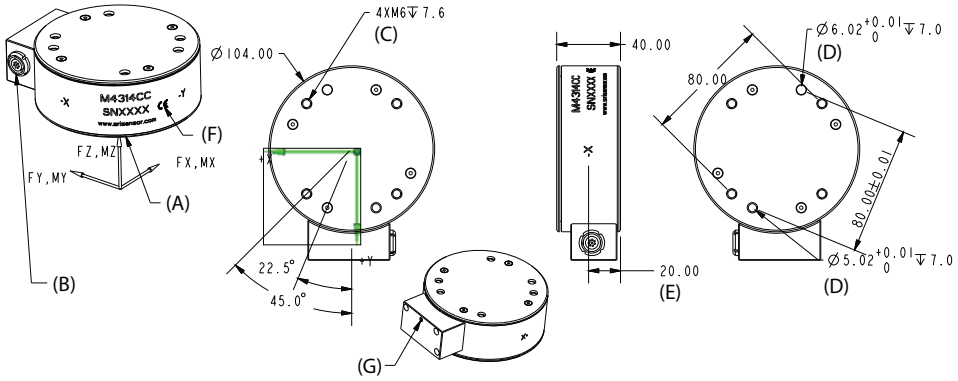
1.3 ABB force sensor

Continued

Medium force sensor



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A	Mounting robot arm to this side
B	LEMO connector EEG.IT.308.CLL MAIING connector FGG.IT.308.CYCC60Z
C	90° equal space on Φ80.00 BC, both sides
D	On Φ80.00 BC, both sides
E	Neutral axis
F	CE mark
G	LED

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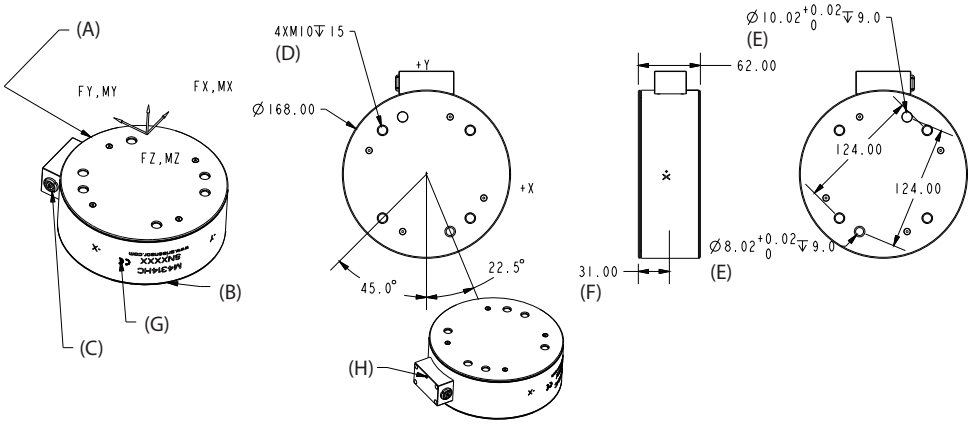
Large force sensor



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A	Mounting tool to this side
B	Mounting robot arm to this side
C	LEMO connector EEG.IT.308.CLL MAIING connector FGG.IT.308.CYCC60Z
D	90° equal space on Φ124.00 BC, both side
E	On Φ124.00 BC, both side
F	Neutral axis
G	CE mark
H	LED

Sensor connector

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Pin	Description	Pin	Description
1	+24V+	5	RDP
2	GND	6	RDN
3	TDP	7	RX
4	TDN	8	TX

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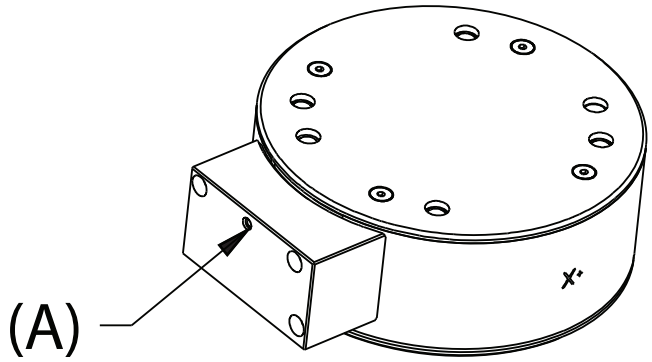
LED light



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A	LED

LED status	Sensor status
Off	Power off
Flashing	Work properly
On (solid)	Abnormal

CE Conformity

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

CAUTION

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.

1.4 Adapter unit

1.4.1 Overview

Overview introduction

There are seven types of adapter unit which contains following components by standard:

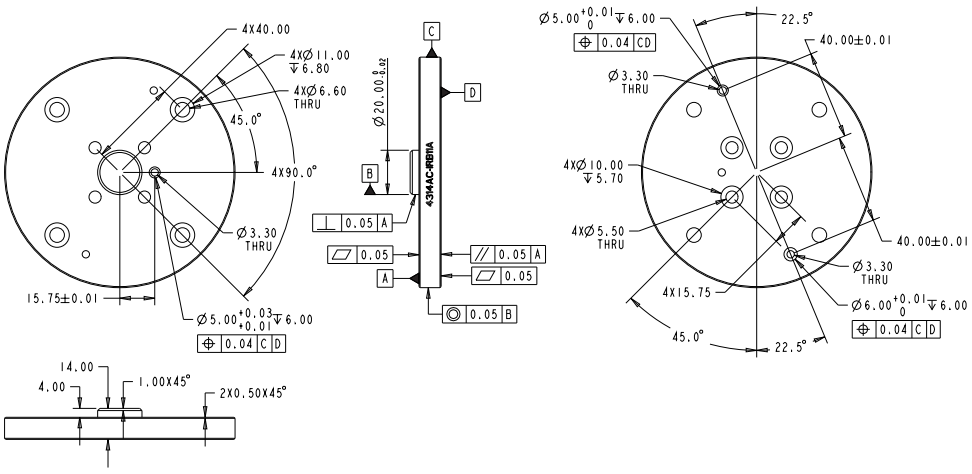
- Adapter plate to mount the force sensor on the robot flange. Adapter plates are classified into 7 adapter units based on the plate types and quantity. There are 11 adapter plate types, 3 of which are used alone and 8 of which are used in pair.

  For detailed information about what types of and how many adapter plates are needed for each robot type, see *Type mapping on page 14*.
- Mounting screws. Used to mount the sensor to the robot by adapter plates and mount the cable bracket on the adapter plate of the sensor.
- Positioning pins. Used for easy and accurate positioning during the installation.

Adapter flange dimension

The force sensor should be mounted on the tool flange of robot axis by ABB specific adapter plate. Detailed flange dimensions are listed below.

Adapter plate S1



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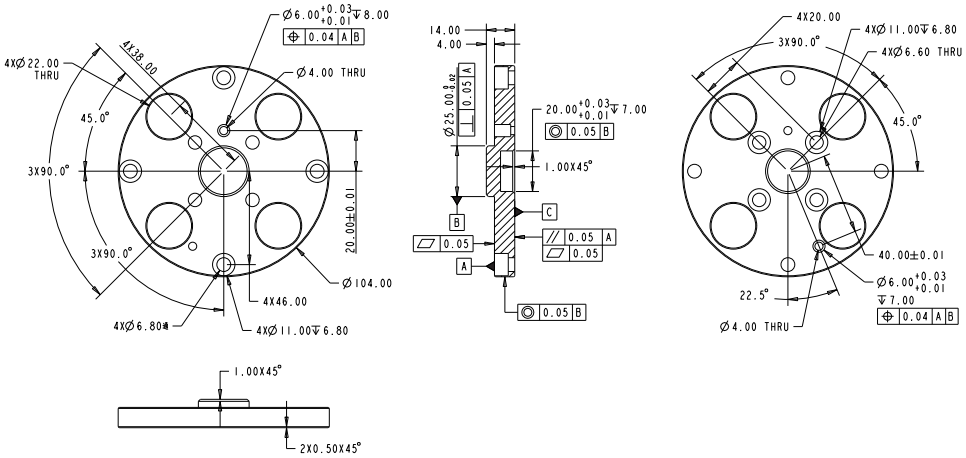
1.4.1 Overview
Continued

Adapter plates S2 and S21

Adapter plates S2 and S21 are used in pair. Adapter plate S2 is mounted to the robot tool flange, and plate S21 is mounted between plate S2 and force sensor.

Following figure shows the dimension of adapter plate S2.



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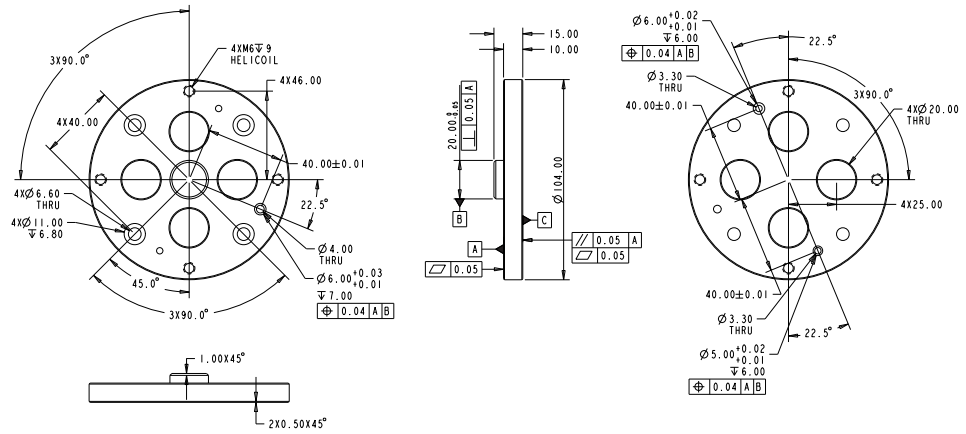
Following figure shows the dimension of adapter plate S21.



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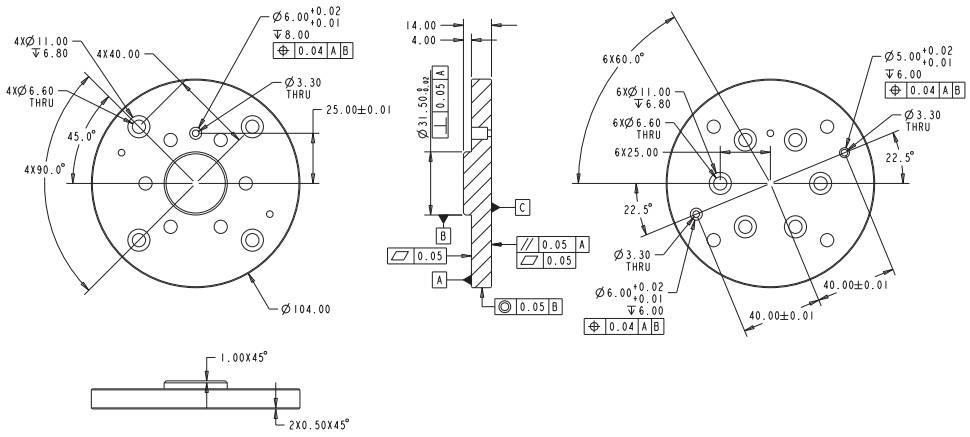
Adapter plate S3



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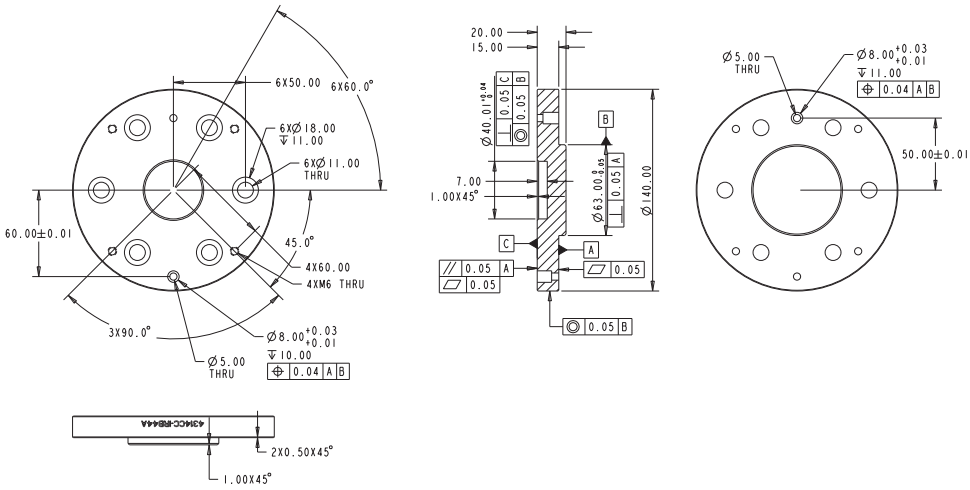
Adapter plates M1 and M2

Adapter plates M1 and M2 are used in pair. Adapter plate M1 is mounted to the robot tool flange, and plate M2 is mounted between plate M1 and force sensor.

Following figure shows the dimension of adapter plate M1.



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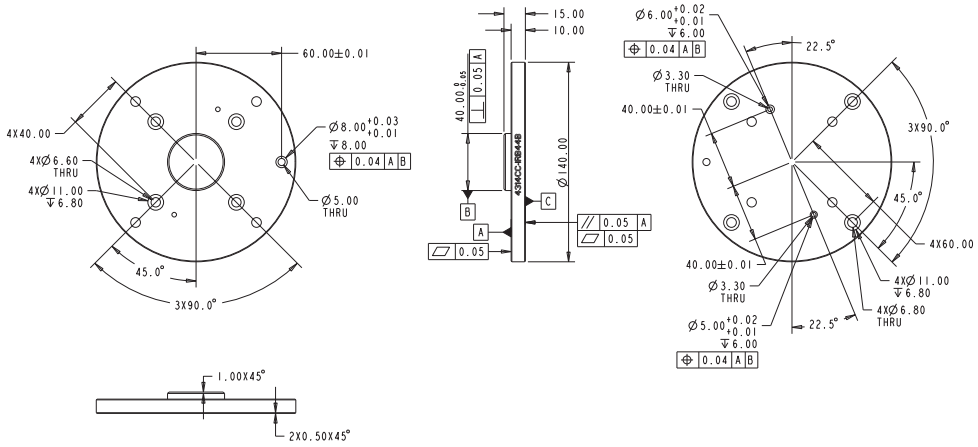
1.4.1 Overview
Continued

Following figure shows the dimension of adapter plate M2.



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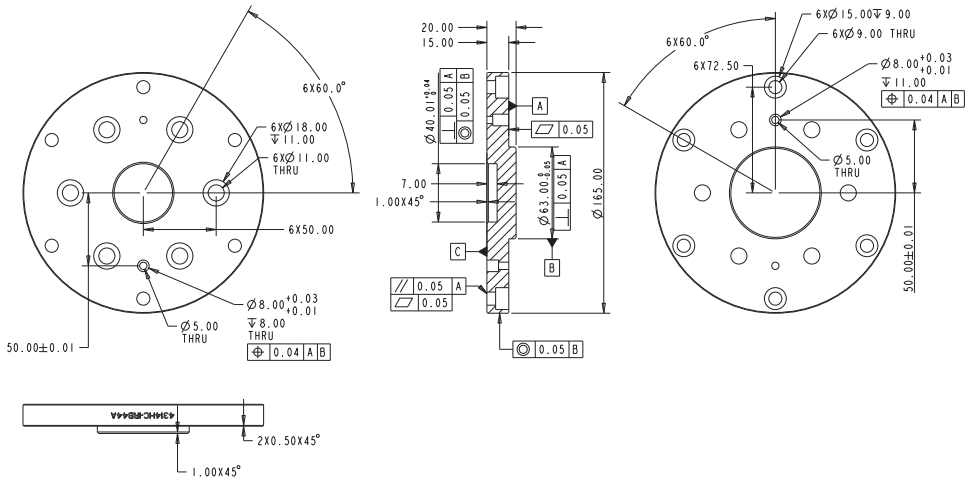
Adapter plates M3 and M4

Adapter plates M3 and M4 are used in pair. Plate M3 is mounted to the robot tool flange, and plate M4 is mounted between plate M3 and force sensor.

Following figure shows the dimension of adapter plate M3.



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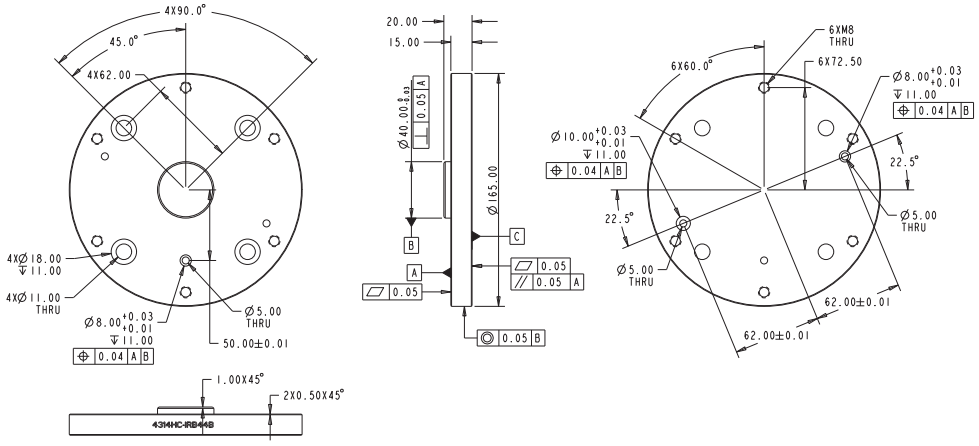
Following figure shows the dimension of adapter plate M4.



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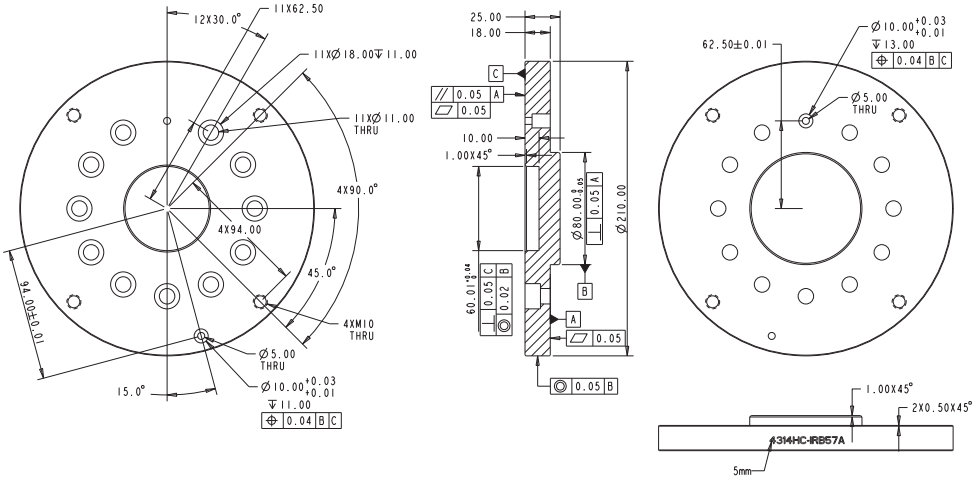
Adapter plates L1 and L2

Adapter plates L1 and L2 are used in pair. Plate L1 is mounted to the robot tool flange, and plate L2 is mounted between plate L1 and force sensor.

Following figure shows the dimension of adapter plate L1.



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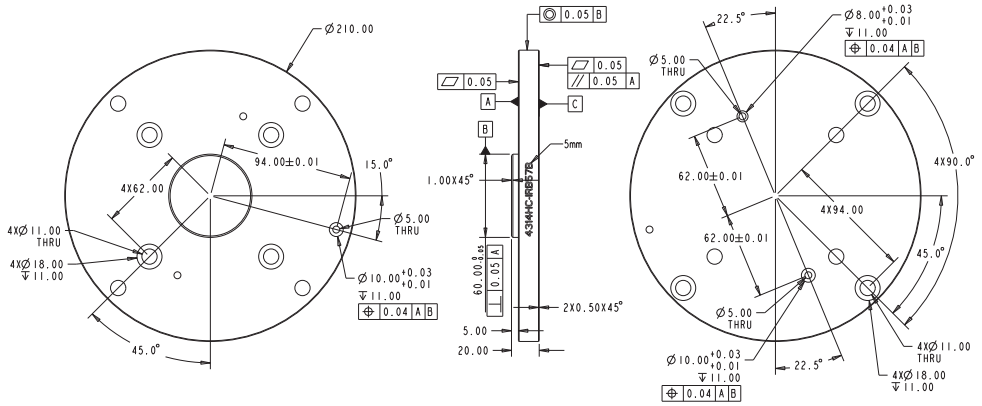
1.4.1 Overview
Continued

Following figure shows the dimension of adapter plate L2.



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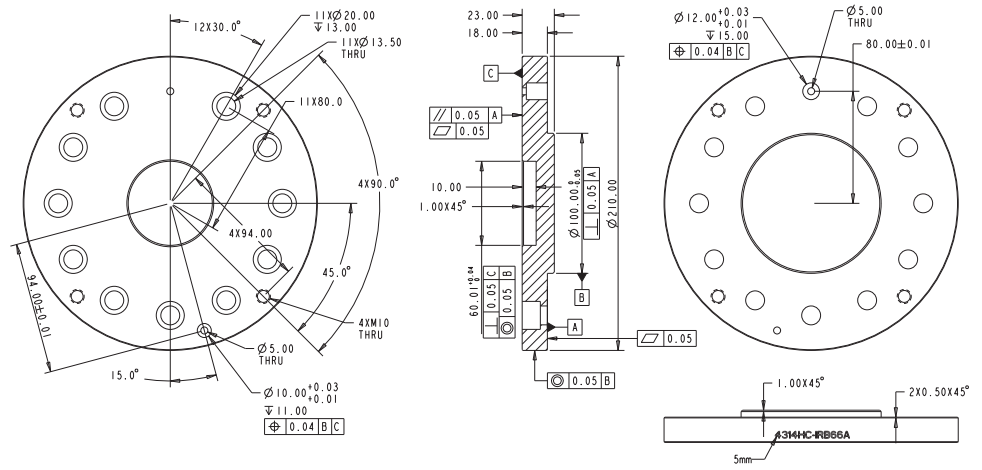
Adapter plates L3 and L4

Adapter plates L3 and L4 are used in pair. Plate L3 is mounted to the robot tool flange, and plate L4 is mounted between plate L3 and force sensor.

Following figure shows the dimension of adapter plate L3.



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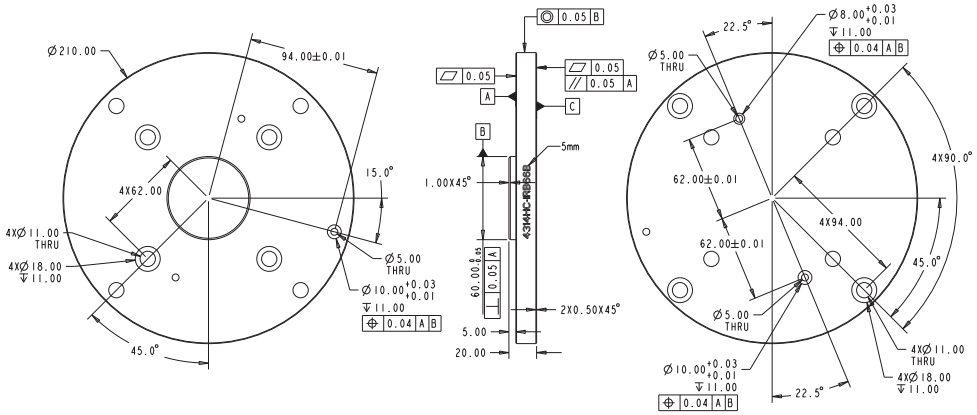
Following figure shows the dimension of adapter plate L4.



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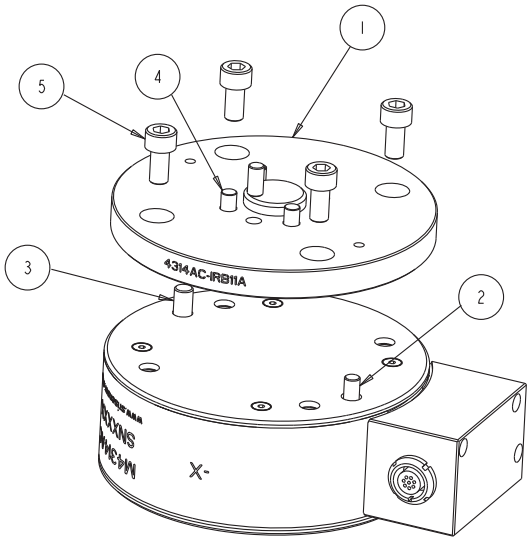
1.4.2 Adapter unit type A

Component

Component of adapter unit type A are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



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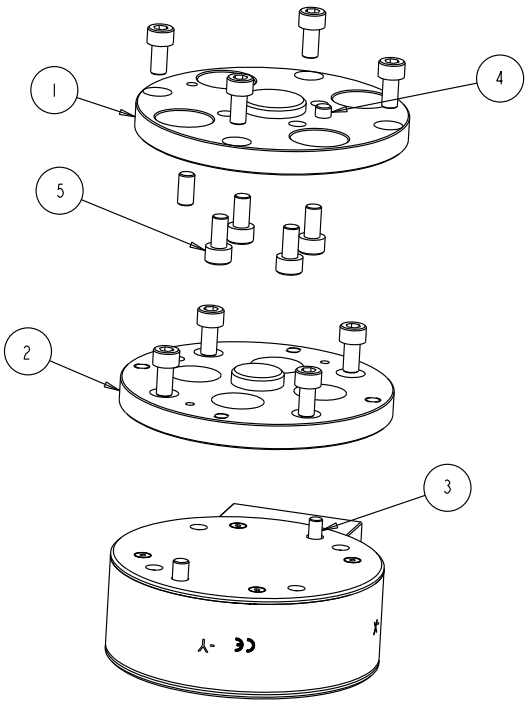
No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	S1	3HAC090710-001	1	Mounted to the robot tool flange.
2	Positioning pin	Φ5x10	3HAC090872-001	2	One is to position the adapter plate to the robot tool flange; the other is to position the adapter plate to the force sensor.
3	Positioning pin	Φ6x12	3HAC090873-001	1	To position the adapter plate to the force sensor.
4	Hexagon socket head cap screws	M5x10	3HAC090863-001	4	To fix the adapter plate to the robot tool flange.
5	Hexagon socket head cap screws	M6x12	3HAC090864-001	4	To fix the adapter plate to the force sensor.

1.4.3 Adapter unit type B

Component

Component of adapter unit type B are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



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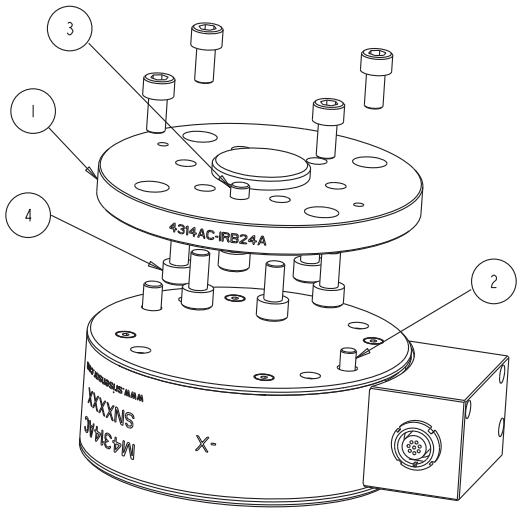
No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	S2	3HAC090712-001	1	Mounted to the robot tool flange.
2	Adapt plate	S21	3HAC093543-001	1	Mounted between adapter plate S2 and force sensor.
3	Positioning pin	Φ5x10	3HAC090872-001	1	To position the adapter plate S21 to the force sensor.
4	Positioning pin	Φ6x12	3HAC090873-001	3	One is to position adapter plate S2 to the robot tool flange; another is to position adapter plate S21 to adapter plate S2; and the third is to position adapter plate S21 to the force sensor.
5	Hexagon socket head cap screws	M6x12	3HAC090864-001	12	Four are to fix the adapter plate S2 to the robot tool flange; four are to fix the adapter plate S21 to the force sensor; the others are to fix adapter plate S21 to adapter plate S2.

1.4.4 Adapter unit type C

Component

Component of adapter unit type C are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



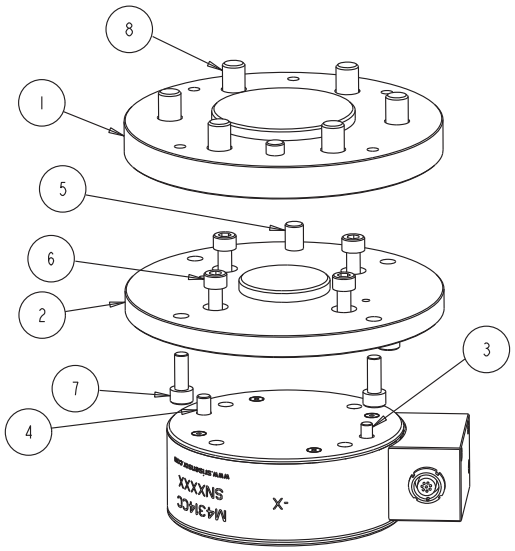
xx2400000861

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	S3	3HAC090713-001	1	Mounted to the robot tool flange.
2	Positioning pin	Φ5x10	3HAC090872-001	1	To position the adapter plate to the force sensor.
3	Positioning pin	Φ6x12	3HAC090873-001	2	One is to position the adapter plate to the robot tool flange; the other is to position the adapter plate to the force sensor.
4	Hexagon socket head cap screws	M6x12	3HAC090864-001	10	Six are to fix the adapter plate to the robot tool flange; the others are to fix the adapter plate to the force sensor.

1.4.5 Adapter unit type D

Component

Component of adapter unit type D are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



xx2400000862

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	M1	3HAC090714-001	1	Mounted to the robot tool flange.
2	Adapt plate	M2	3HAC090715-001	1	Mounted between adapter plate M1 and force sensor.
3	Positioning pin	Φ5x10	3HAC090872-001	1	To position adapter plate M2 to the force sensor.
4	Positioning pin	Φ6x12	3HAC090873-001	1	To position adapter plate M2 to the force sensor.
5	Positioning pin	Φ8x16	3HAC090874-001	2	One is to position adapter plate M1 to the robot tool flange; the other is to position adapter plate M2 to adapter plate M1.
6	Hexagon socket head cap screws	M6x12	3HAC090864-001	4	To fix adapter plate M2 to the force sensor.
7	Hexagon socket head cap screws	M6x16	3HAC090866-001	4	To fix adapter plate M2 to adapter plate M1.

Continues on next page

1.4.5 Adapter unit type D

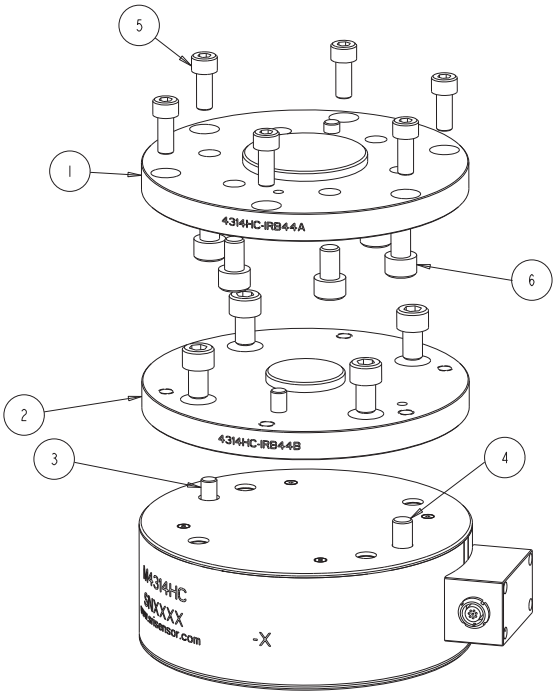
Continued

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
8	Hexagon socket head cap screws	M10x16	3HAC090870-001	6	To fix adapter plate M1 to the robot tool flange.

1.4.6 Adapter unit type E

Component

Component of adapter unit type E are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



xx2400000863

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	M3	3HAC090716-001	1	Mounted to the robot tool flange.
2	Adapt plate	M4	3HAC090717-001	1	Mounted between adapter plate M3 and force sensor.
3	Positioning pin	Φ8x16	3HAC090874-001	3	One is to position adapter plate M3 to the robot tool flange; another is to position adapter plate M4 to adapter plate M3; and the third is to position adapter plate M4 to the force sensor.
4	Positioning pin	Φ10x20	3HAC090875-001	1	To position adapter plate M4 to the force sensor.
5	Hexagon socket head cap screws	M8x20	3HAC090867-001	6	To fix adapter plate M3 to adapter plate M4.

Continues on next page

1.4.6 Adapter unit type E

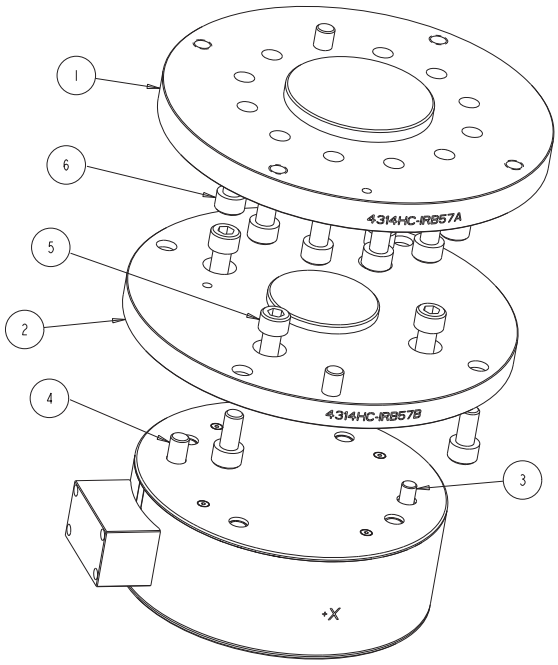
Continued

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
6	Hexagon socket head cap screws	M10x16	3HAC090868-001	10	Six are to fix adapter plate M3 to the robot tool flange; the others are to fix adapter plate M4 to the force sensor.

1.4.7 Adapter unit type F

Component

Component of adapter unit type F are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



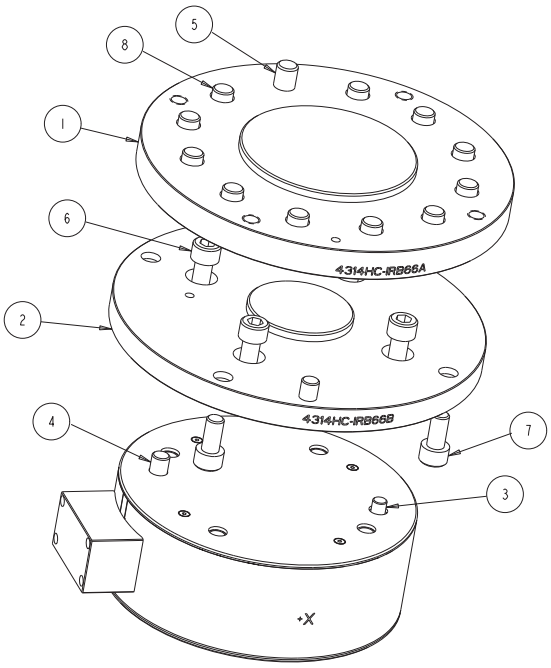
xx2400000864

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	L1	3HAC090718-001	1	Mounted to the robot tool flange.
2	Adapt plate	L2	3HAC090719-001	1	Mounted between adapter plate L1 and force sensor.
3	Positioning pin	Φ8x16	3HAC090874-001	1	To position adapter plate L2 to the force sensor.
4	Positioning pin	Φ10x20	3HAC090875-001	3	One is to position adapter plate L1 to the robot tool flange; another is to position adapter plate L2 to adapter plate L1; and the third is to position adapter plate L2 to the force sensor.
5	Hexagon socket head cap screws	M10x16	3HAC090868-001	4	To fix adapter plate L2 to the force sensor.
6	Hexagon socket head cap screws	M10x20	3HAC090870-001	15	Eleven are to fix adapter plate L1 to the robot tool flange; the others are to fix adapter plate L2 to adapter plate L1.

1.4.8 Adapter unit type G

Component

Component of adapter unit type G are listed in the following table. For detailed adapter plate dimension information, see *Adapter flange dimension on page 19*.



xx2400000865

No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
1	Adapt plate	L3	3HAC090720-001	1	Mounted to the robot tool flange.
2	Adapt plate	L4	3HAC090721-001	1	Mounted between adapter plate L3 and force sensor.
3	Positioning pin	Φ8x16	3HAC090874-001	1	To position adapter plate L4 to the force sensor.
4	Positioning pin	Φ10x20	3HAC090875-001	2	One is to position adapter plate L4 to adapter plate L3; the other is to position adapter plate L4 to the force sensor.
5	Positioning pin	Φ12x20	3HAC090876-001	1	To position adapter plate L3 to the robot tool flange.
6	Hexagon socket head cap screws	M10x16	3HAC090868-001	4	To fix adapter plate L4 to the force sensor.
7	Hexagon socket head cap screws	M10x20	3HAC090870-001	4	To fix adapter plate L4 to adapter L3.

Continues on next page

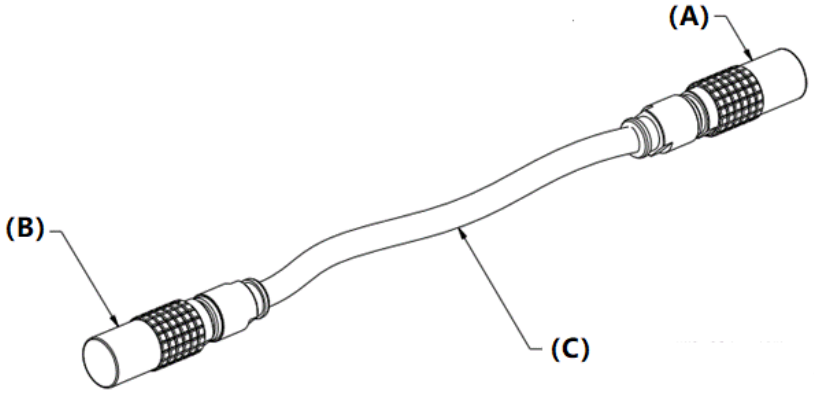
No.	Name	Specification/Model	Reference no.	Quantity(Unit:piece)	Description/Note
8	Hexagon socket head cap screws	M12x20	3HAC090871-001	11	To fix adapter plate L3 to the robot tool flange.

1.5 Cables

Overview

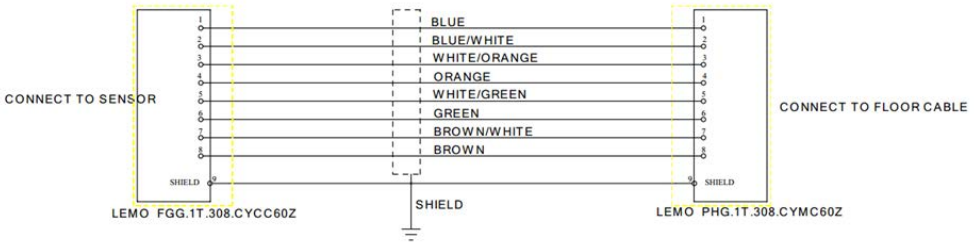
The cables are high flexible, well shielded and should be grounded.

Wiring - sensor cable



xx2400000899

A	PHG.IB.308.CLLD62Z, connector to sensor
B	PHG.IB.308.CLLD62Z, connector to floor cable
C	Ethercat cable CAT.5e



xx2400000900

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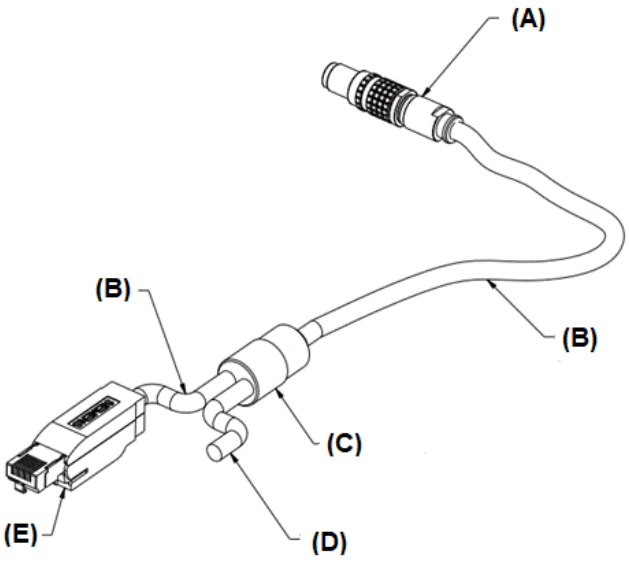
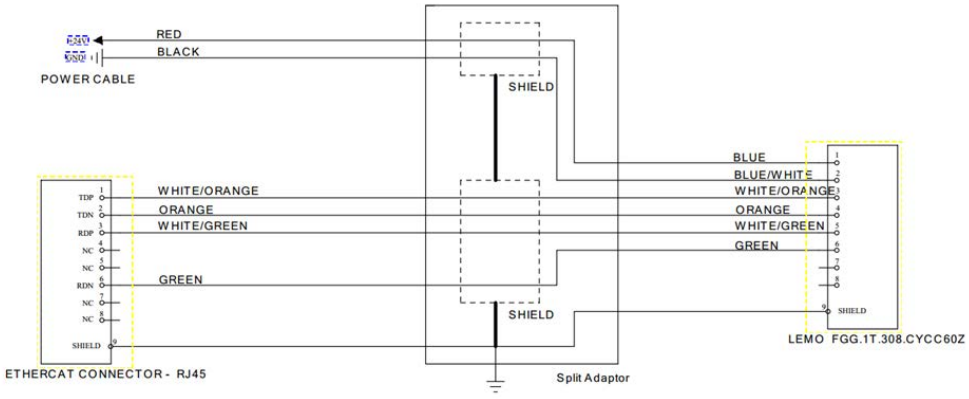
Wiring - floor cable



xx2400000901

A	FGG.IT.308.CLAC65Z
B	Ethercat cable CAT.5e
C	Split adaptor
D	Power cable, free end
E	Ethercat connector, RJ45



xx2400000902

Cable specification

Item	Description
Sensor cable length	5 m, 10 m [i]
Floor cable length	3 m, 7 m, 15 m [i]
Sensor cable lifetime	3 million times of bending

[i] See *Type mapping on page 14* for the robot type and sensor type that each cable length is applicable to.

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2 Installation

Hardware installation

Tools

This table lists tools to be used when mounting the force sensor on the robot.

No.	Description	Small force sensor	Medium force sensor	Large force sensor	Quantity
1	M5 screw driver	X			1
2	M6 screw driver	X	X		1
3	M8 screw driver			X	1
4	M10 Screw driver		X	X	1
5	M12 Screw driver			X	1
6	M5 torque wrench	X			1
7	M6 torque wrench	X	X		1
8	M8 torque wrench			X	1
9	M10 Torque wrench		X	X	1
10	M12 Torque wrench			X	1
11	Rubber hammer	X	X	X	1

The following table lists the tightening torque of screws.

Dimension	Tightening torque (Nm)	Class
M5	6	12.9
M6	Used with adpater plates S1, S2, S21 and S3: 10 Used with adpater plates M1 and M2: 16	12.9
M8	40	12.9
M10	79	12.9
M12	130	12.9

Installation procedure

Use the following procedure to install a force sensor to a robot, in which the IRB 6700 with a large ABB force sensor is used as an example.

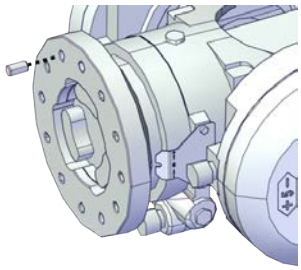
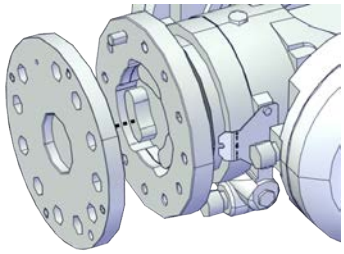
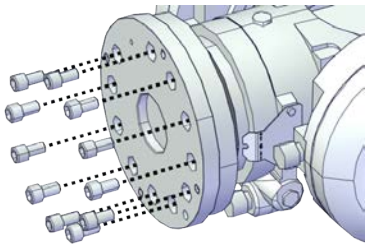
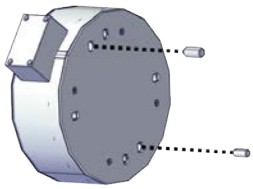
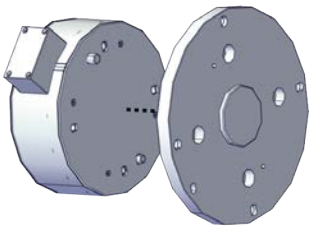
Note

Installation procedures of other force sensor types differ slightly because the screws and positioning pins used for mounting vary according to the adapter unit types and robot types. Refer to *Adapter unit on page 19* for the specification and quantity of screws and positioning pins that are applicable to your application.

	Description	Illustration/Note
1	Jog the robot to the home position.	

Continues on next page

Continued

	Description	Illustration/Note
2	Insert a Φ12x20 positioning pin in the positioning hole of the robot tool flange.	 xx2400000849
3	Mount adapter plate L3 on the robot tool flange with positioning pin aligned to the positioning hole of the adapter plate.	 xx2400000850
4	Fix adapter plate L3 to the robot tool flange with eleven M12x20 fixing screws.	 xx2400000851
5	Insert a Φ10x20 positioning pin and a Φ8x16 positioning pin in the positioning holes on the robot arm side of the force sensor. **Note** Do not mix the two sides of the force sensor. Refer to the force sensor drawings in *Dimension on page 15* for the sensor sides.	 xx2400000852
6	Mount adapter plate L4 on the robot arm side of the force sensor with positioning pins aligned to the corresponding positioning holes of the adapter plate.	 xx2400000853

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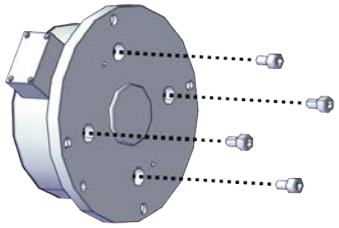
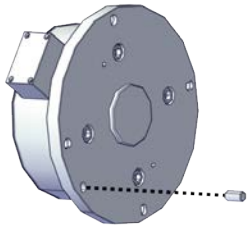
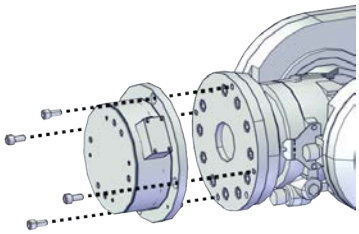
Continued

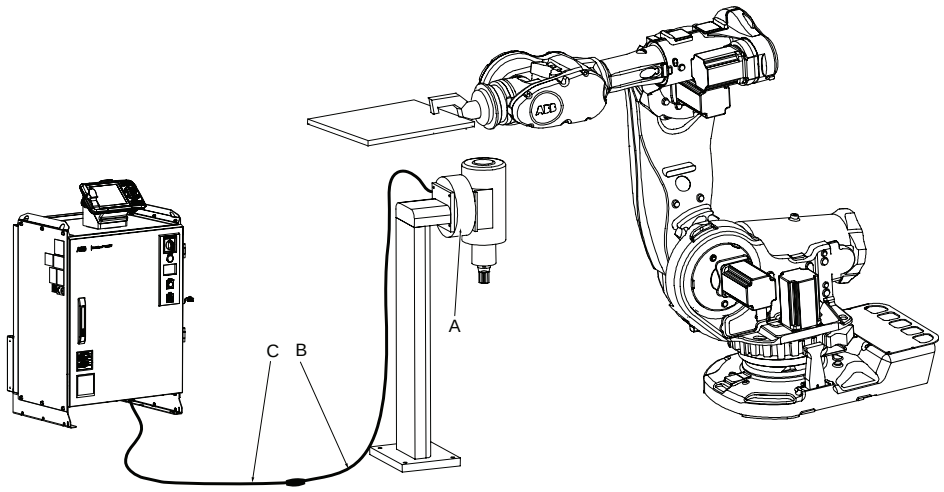
	Description	Illustration/Note
7	Fix adapter plate L4 to the force sensor with four M10x16 fixing screws.	 xx2400000854
8	Insert a Φ10x20 positioning pin in the positioning hole on adapter plate L4.	 xx2400000855
9	Mount the force sensor to the robot by aligning adapter plate L4 to adapter plate L3 and securing with four M10x20 fixing screws. **Note** When mounting adapter plates M1/M2, L1/L2 and L3/L4, the fixing screws must be mounted from the force sensor side. For other adapter plates, the fixing screws are mounted from the robot side.	 xx2400000856
10	Connect the sensor cable between the force sensor and floor cable.	
11	Connect the floor cable to the controller.	See the product manual for the respective OmniCore controller.

Continues on next page

Continued

Note

The procedure to fix the ABB force sensor in the room is the same as that to fix ABB force sensor to the robot except that the adapter plate is not needed. The following figure illustrate a mounting example of room fixed sensor.



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Software installation

	Description	Illustration/Note
1	Connect a PC with RobotStudio and RobotWare to the robot controller.	See *Operating manual - RobotStudio*.
2	Modify the system in RobotStudio. Force Control parameters are set in the configuration topic *Motion*.	
3	Right click the *Configuration* node in RobotStudio, select **Load Parameters** and then **Load parameters and replace duplicates**.	See *Application manual - Force control with software and hardware*.
4	Now that the system is configured the last step is to program the application. To get started more easily there are some basic code examples on how to use Force control. There is also a RAPID component overview for easy usage.	

Note

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

Continues on next page

Note

Software RW Force Control options of ABB Force Control Package has been installed and configured in robot system 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** > **Configuration** -> **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 Standard*.

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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 `FCLoadId` function, along with its optional argument `\LoadIdErr`, can be used for the annual sensor check. The identified load values and `LoadIdErr` should closely align with the initial values from the first installation of the sensor and tool.

The tolerance for this check may vary depending on factors like cable condition, application reorientation requirement, and other variables. If the `FCLoadId` measurement deviates by more than 2% and the performance is affected, it is recommended to contact ABB service for recalibration.

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4 Decommissioning

4.1 Introduction to decommissioning

Introduction

This section contains information to consider when taking a product, robot or controller, out of operation.

It deals with how to handle potentially dangerous components and potentially hazardous materials.

> **Note**
>
> The decommissioning process shall be preceded by a risk assessment.

Disposal of materials used in the robot

All used grease/oils and dead batteries **must** be disposed of in accordance with the current legislation of the country in which the robot and the control unit are installed.

If the robot or the control unit is partially or completely disposed of, the various parts **must** be grouped together according to their nature (which 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 robot and control unit are installed.

See also *Environmental information on page 48*.

Transportation

Prepare the robot or parts before transport, this to avoid hazards.

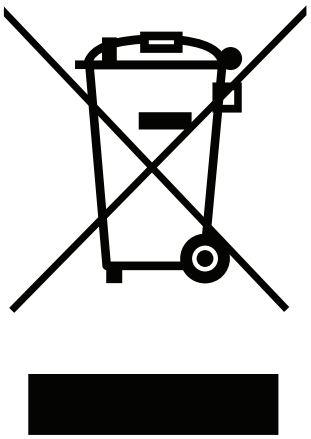
4.2 Environmental information

Introduction

ABB robots contain components in different materials. During decommissioning, all materials shall be dismantled, recycled, or reused responsibly, according to the relevant laws and industrial standards. Robots or parts that can be reused or upcycled helps to reduce the usage of natural resources.

Disposal symbol

The following symbol indicates that the product must not be disposed of as common garbage. Handle each product according to local regulations for the respective content (see table below).



xx1800000058

Materials used in the product

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

Dispose components properly according to local regulations to prevent health or environmental hazards.

Material	Example application
Copper	Cables
Plastic/rubber	Cables, connectors, etc.

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.

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 TuneMaster output.

Possible cause

- Loose connector connection
- Damaged cable
- Loose sensor attachment
- Disturbance of surrounding equipment

Continues on next page

5.1 Sensor related
Continued

- 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 with software and hardware*.
- 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.

Continues on next page

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. 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.

Continues on next page

- 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 Force Control Package.

Item	ABB Reference no.	Description
1	3HAC090880-001	Assembly kits for IRB 1100&1200
2	3HAC090881-001	Assembly kits for IRB 1300&1600
3	3HAC090882-001	Assembly kits for IRB 2400&2600
4	3HAC090883-001	Assembly kits for IRB 4400-L10&4600-20
5	3HAC090884-001	Assembly kits for IRB 4400-60&4600-40/45/60&5710-90/70LID - Medium
6	3HAC090885-001	Assembly kits for IRB 4400-60&4600-40/45/60&5710-90/70LID - Large
7	3HAC090886-001	Assembly kits for IRB 5710-110 /90 LID&5720-180 /155 LID/125 /90 LID&6710
8	3HAC090887-001	Assembly kits for IRB 6650S&6660&6700&6720&6730&6740
9	3HAC090877-001	Small ABB force sensor
10	3HAC090878-001	Medium ABB force sensor
11	3HAC090879-001	Large ABB force sensor
12	3HAC090857-001	Sensor cable 5m
13	3HAC090890-001	Sensor cable 10m
14	3HAC090858-001	Control cable signal 3m
15	3HAC090859-001	Control cable signal 7m
16	3HAC090860-001	Control cable signal 15m

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7 Reference information

7.1 ATI Force sensor

About ATI force sensor

The ATI Axia series Force/Torque sensors are compatible alternative to ABB force sensors. Contact your local ATI support for the proper model in Axia series that is applicable to your robot and force control application.

See *https://www.ati-ia.com/* for more information.

7.2 Tightening torque

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	1,150

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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

7.3 Unit conversion

Converter table

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	

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