ROBOTICS

# Product manual

## Integrated Force Control

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# Product manual

# Integrated Force Control

RobotWare 6.15.04

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Revision: J

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Original instructions.

# Table of contents

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# Overview of this manual

## About this manual

This manual contains information about the option Force Control package.

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

## 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.

> **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

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

## References

IRC5

| 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 Instructions, Functions and Data types* | *3HAC050917-001* |
| *Technical reference manual - RAPID Overview* | *3HAC050947-001* |
| *Technical reference manual - System parameters* | *3HAC050948-001* |
| *Application manual - Force Control* | *3HAC050377-001* |

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### OmniCore

| Reference | Document ID |
|---|---|
| *Operating manual - OmniCore* | *3HAC065036-001* |
| *Operating manual - RobotStudio* | *3HAC032104-001* |
| Product manuals for OmniCore controller | |
| *Technical reference manual - RAPID Overview* | *3HAC065040-001* |
| *Technical reference manual - RAPID Instructions, Functions and Data types* | *3HAC065038-001* |
| *Technical reference manual - System parameters* | *3HAC065041-001* |
| *Application manual - Product.ProductName* | *Document.ID-1* |

## Revisions

| Revision | Description |
|---|---|
| - | First edition |
| A | Corrected reference number for control cables in *Spare parts on page 55*. |
| B | Released with RobotWare 6.04:<br>• Minor corrections. |
| C | Released with RobotWare 6.06:<br>• Added specification about Force measurement resolution and Torque measurement resolution. |
| D | Released with RobotWare 6.08:<br>• Updated force sensor dimension figures and adapter flange dimension figures.<br>• Updated force sensor output voltage scope.<br>• Added sensor validation procedure.<br>• Added note to configuration.<br>• Updated tools used for force sensor installation.<br>• Added note to force sensor specifications. |
| E | Released with RobotWare 6.09:<br>• Updated force sensor output voltage scope. |
| F | Released with RobotWare 6.10:<br>• Updated force measurement resolution and weight for large force sensor. |
| G | Released with RobotWare 6.12:<br>• Added uncertainty specifications. |
| H | Released with RobotWare 6.13:<br>• Updated force sensor specifications. |
| J | Released with RobotWare 6.15.04:<br>• Updated adapter flange dimension figures for large size force sensor used with IRB 66XX and IRB 6700. |

# 1 Installation

## 1.1 Introduction

### 1.1.1 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.


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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 | VMB, voltage measurement box | Voltage measurement box. For detailed information about VMB, see *Voltage measurement box on page 17*. |
| C | Control cable | Cable between the VMB box and IRC5 control cabinet. For detailed information about the control cable, see *Cables on page 20*. |
| D | Sensor cable | Cable between the force sensor and the VMB box.For detailed information about the sensor cable, see *Cables on page 20*. |
| 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 25*. |

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1.1.1 Overview
*Continued*

**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.

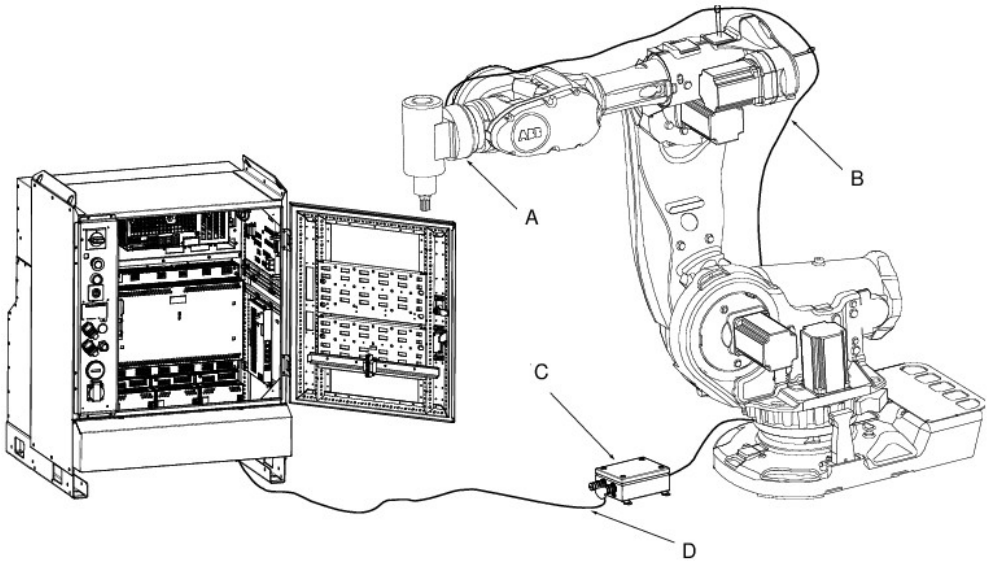



ABB force sensor

Cable between the force sensor and VMB box

VMB(Voltage measurement box)

Cable between VMB box and the robot controller

## 1.1.2 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 12*.
- Sensor cable. For detailed information, see *Cables on page 20*.
- VMB box. For detailed information, see *Voltage measurement box on page 17*.
- Control cable. For detailed information, see *Cables on page 20*.
- Adapter unit. For detailed information about the adapter unit, see *Adapter unit on page 25*.
- 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*.

## 1.1.3 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.

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.

| 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: 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 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%<br>Mx/My: 1.9%; Mz: 2.1% | Fx/Fy/Fz: 1.8%<br>Mx/My: 1.92%; Mz: 2.4% | Fx/Fy/Fz: 1.98%<br>Mx/My: 2.1%; Mz: 2.1% |
| Weight[i] | 1.6 kg | 1.7 kg | 7.2 kg |
| Outside diameter x height (unit: mm) | 104x40 | 104x40 | 168x62 |
| Non-linearity | 1.0% | 1.0% | 1.0% |
| Hysteresis | 1.0% | 1.0% | 1.0% |
| Crosstalk with adjustment | 2.5% | 2.5% | 2% |
| Zero offset | 10%FS | 10%FS | 10%FS |
| Stiffness | F>3.0*E+7N/m;<br>T>3.0*E+3Nm/rad | F>3.0*E+7N/m;<br>T>3.0*E+3Nm/rad | F>6.0*E+7N/m;<br>T>6.0*E+3Nm/rad |
| Resonance frequency | >1000 | >1000 | >1000 |
| Output FS | 4.9-5.1 V | | |
| Sensitivity (outputFS) | Sensitivity = Output at full scale / Full scale | | |
| Overload protection[ii] | 10 times | 10 times | 10 times |
| Temperature compensation | Yes | Yes | Yes |

*Continues on next page*

| Specification type | Small force sensor | Medium force sensor | Large force sensor |
|---|---|---|---|
| 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 |

i Sensors delivered before May 2021 may have a different weight. Always read the datasheet enclosed in sensor package for the actual weight before implementing applications. Contact ABB for more information.

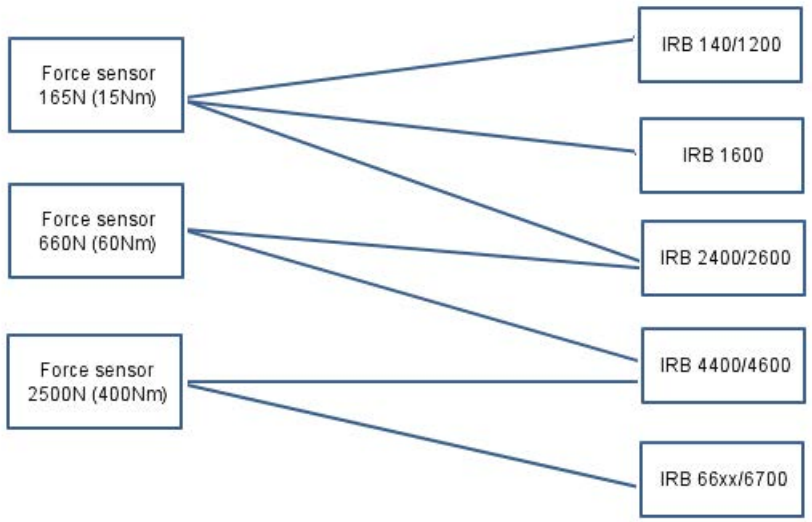
ii Overload capacity of the force sensor is not the same as typical capacity and could not be treated as the same definition. Overload capacity is designed for accidental usage scenarios when mishandling occurs. It is not recommended to use the overload range of the sensor; otherwise, lifetime of the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

**Note**

Make sure the force and torque applied to the force sensor are not exceed the preceding listed measurement range during the whole program. Refer to the section "Test Signal Viewer" in *Application manual - Force Control* and use the TSV to monitor the force and torque values.

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

### Force sensor and robot type mapping




**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*.

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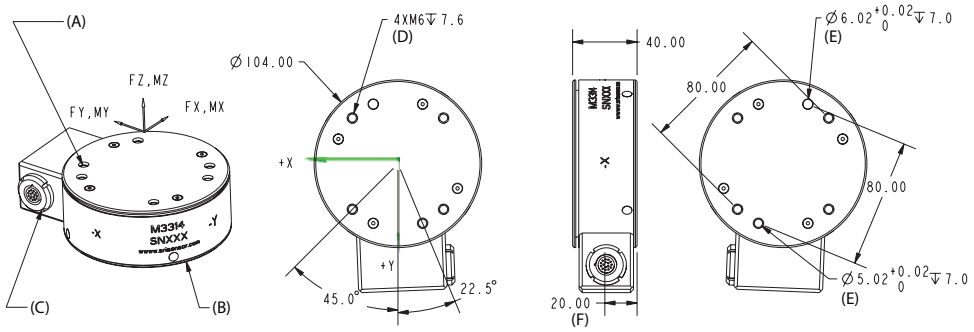
### 1.1.3 ABB force sensor
*Continued*

## ABB Force sensor dimension

### Small & medium ABB force sensor

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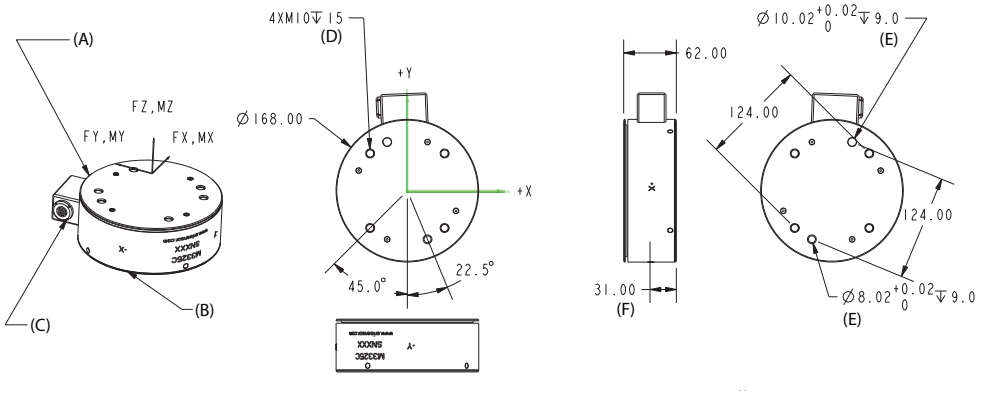
| | |
|---|---|
| A | Mounting tool to this side |
| B | Mounting robot arm to this side |
| C | LEMO connector EEG.2K.316.CLL MAIING connector FGG.2K.316.CLAD52Z |
| D | 90° equal space on Φ80.00 BC, both side |
| E | On Φ80.00 BC, both side |
| F | Neutral axis |

### Large ABB force sensor

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| | |
|---|---|
| A | Mounting tool to this side |
| B | Mounting robot arm to this side |
| C | LEMO connector EEG.2K.316.CLL MAIING connector FGG.2K.316.CLAD52Z |
| D | 90° equal space on Φ124.00 BC, both side |
| E | On Φ124.00 BC, both side |
| F | Neutral axis |

## 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 | 5 | 5 | 5 | 5 | 5 | 5 |

*Continues on next page*

| Sensor type | Fx(unit:V) | Fy(unit:V) | Fz(unit:V) | Mx(unit:V) | My(unit:V) | Mz(unit:V) |
|---|---|---|---|---|---|---|
| Medium force sensor | 5 | 5 | 5 | 5 | 5 | 5 |
| Large force sensor | 5 | 5 | 5 | 5 | 5 | 5 |

## I/O pin configuration

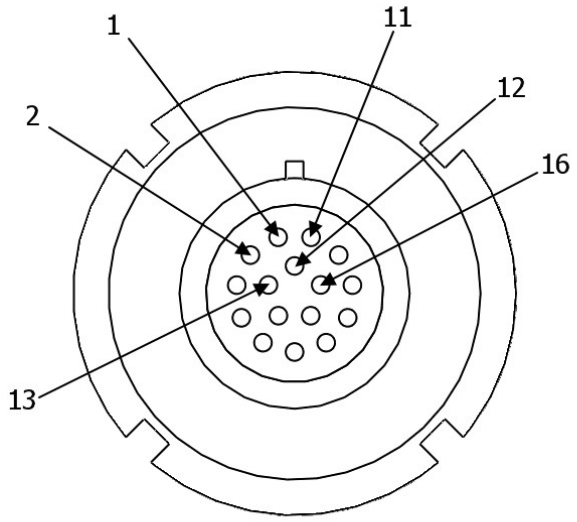


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*Figure 1.1: Connector*

| 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 |

## 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.

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1.1.3 ABB force sensor
*Continued*

**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.

## 1.1.4 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

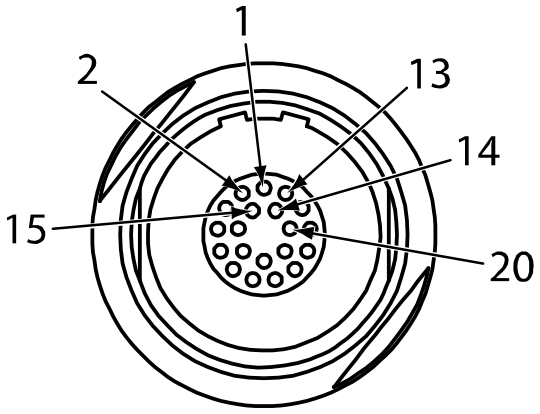
| Voltage description | Maximum value |
|---|---|
| Differential input voltage (for example between $U_0$+ and $U_0$-) | +/- 10 V |
| Input voltage (relative to 0 V Common) | +/- 10 V |

### 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.

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| 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 |

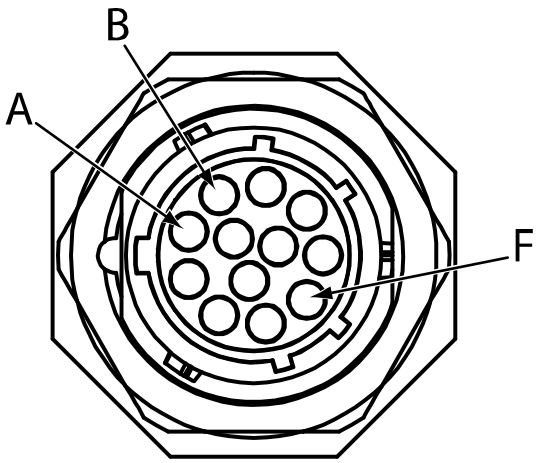
*Continues on next page*

1.1.4 Voltage measurement box
*Continued*

| Pin | Description | Pin | Description |
|---|---|---|---|
| 10 | $U_4$- | 20 | +15V |

Connector X1

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

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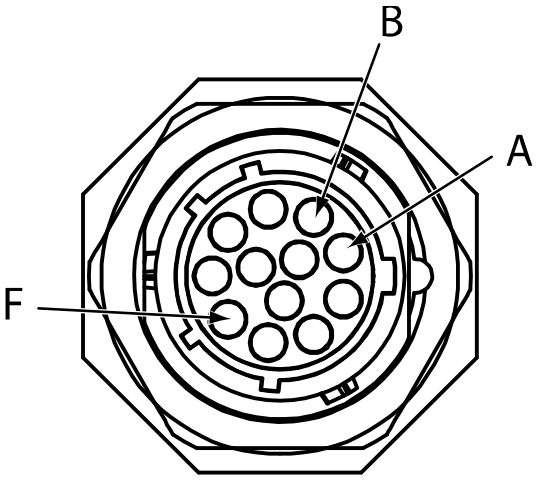
| Pin | Description | Pin | Description |
|---|---|---|---|
| A | SDI_AXC_P | D | SDO_AXC_N |
| B | SDI_AXC _N | E | 0V |
| C | SDO_AXC_P | F | 24V |

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.

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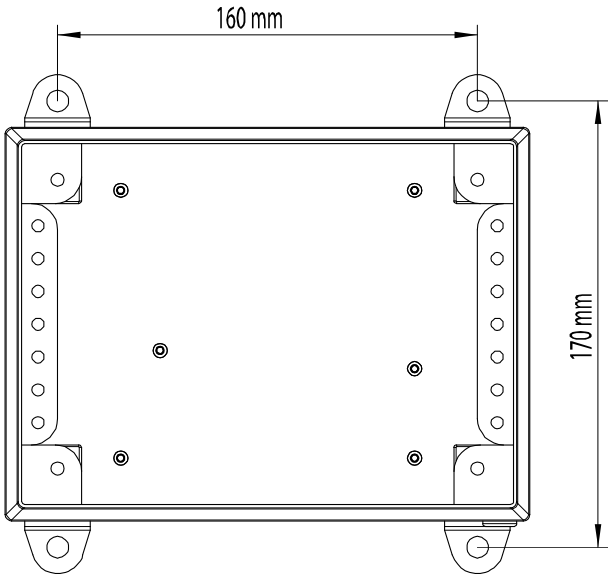
| Pin | Description | Pin | Description |
|---|---|---|---|
| A | SDO_SMB_P | D | SDI_SMB_N |
| B | SDO_SMB _N | E | 0V |

*Continues on next page*

| Pin | Description | Pin | Description |
|---|---|---|---|
| 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:

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## Protection class

The voltage measurement box has protection class IP66.

## 1.1.5 Cables

**Overview**

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

**I/O pin configuration for sensor cable**

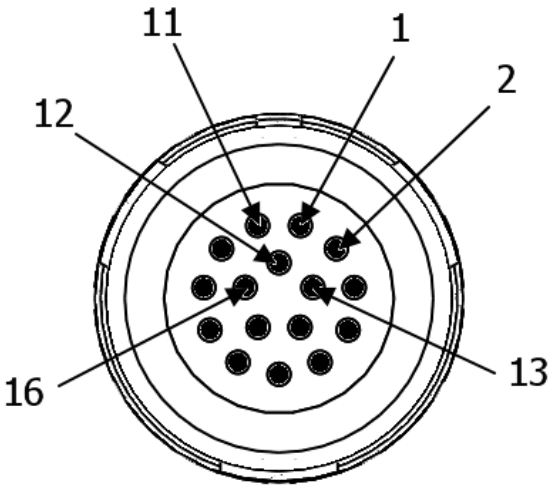


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*Figure 1.2: Sensor side connector*

| 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 |

*Continues on next page*

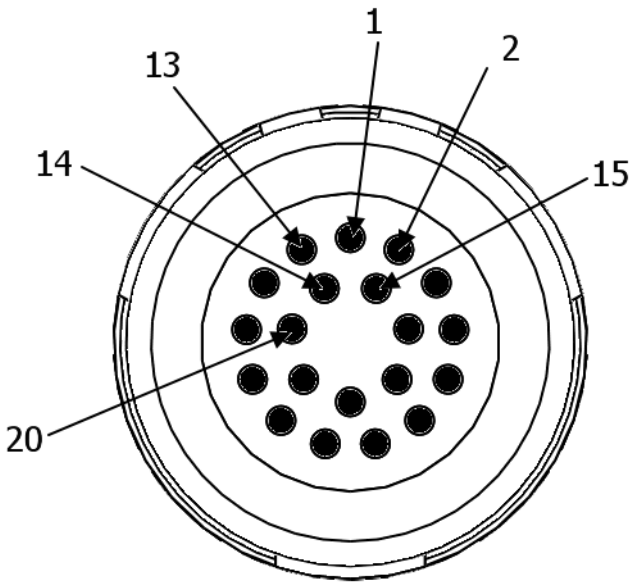


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*Figure 1.3: VMB side connector*

| 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 |

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1.1.5 Cables
*Continued*

**I/O pin configuration for control cable**

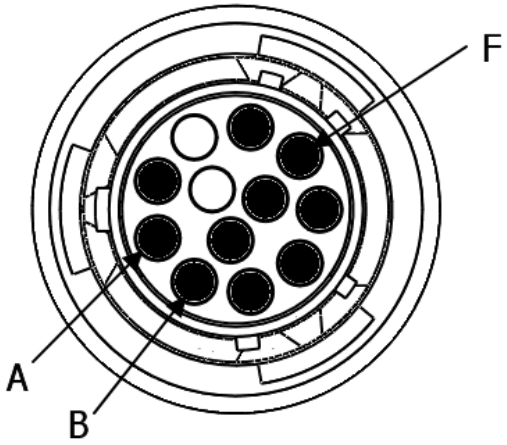


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*Figure 1.4: VMB side connector*

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

*Continues on next page*

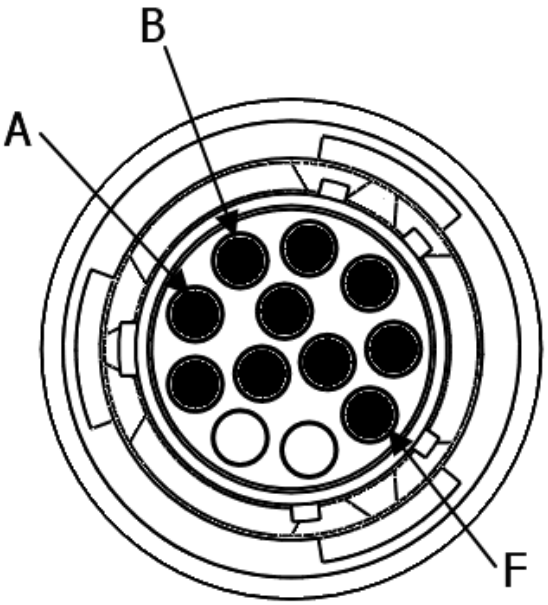


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*Figure 1.5: IRC5 side connector*

| 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 |

*Continues on next page*

1.1.5 Cables
*Continued*

**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.

## 1.1.6 Adapter unit

### 1.1.6.1 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 25*.
- 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 29*.
- 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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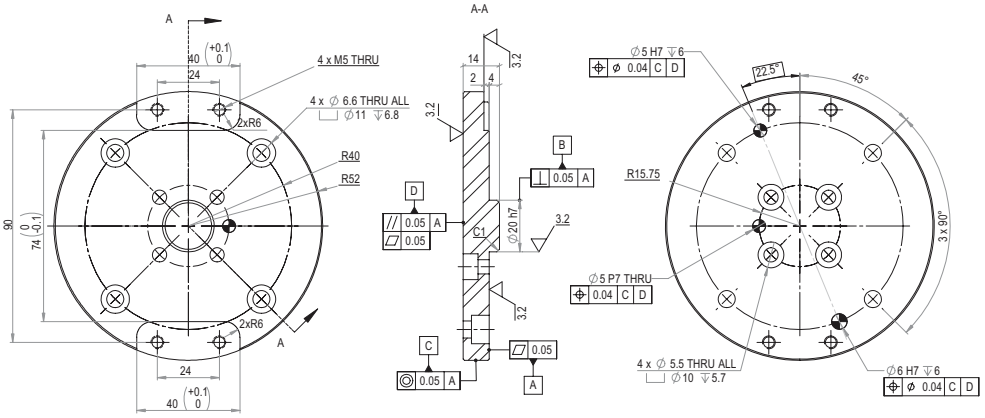
### 1.1.6.1 Overview
*Continued*

**Their detailed dimension information is listed below.**

**Small force sensor used with IRB1200**

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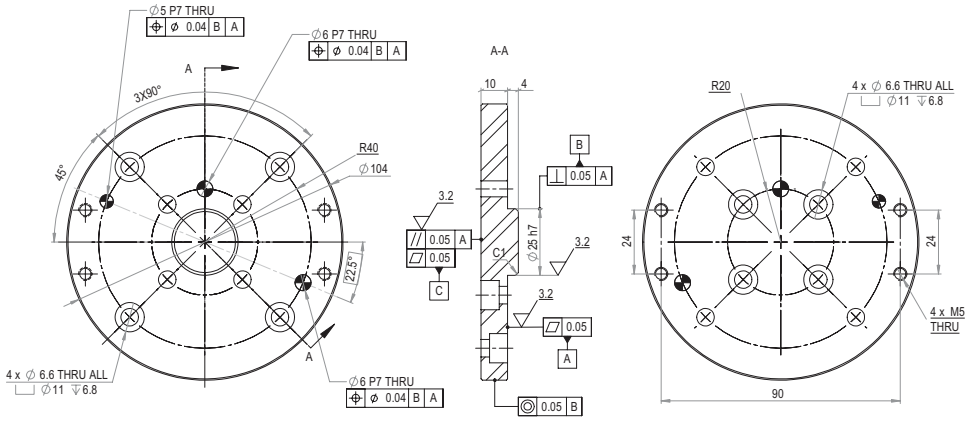
**Small force sensor used with IRB140 & IRB1600**

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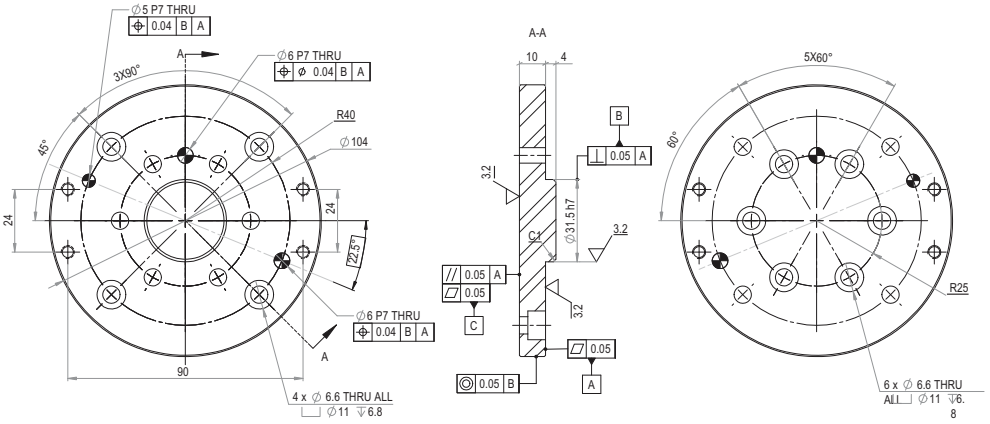
**Small/medium force sensor used with IRB2400 & IRB2600**

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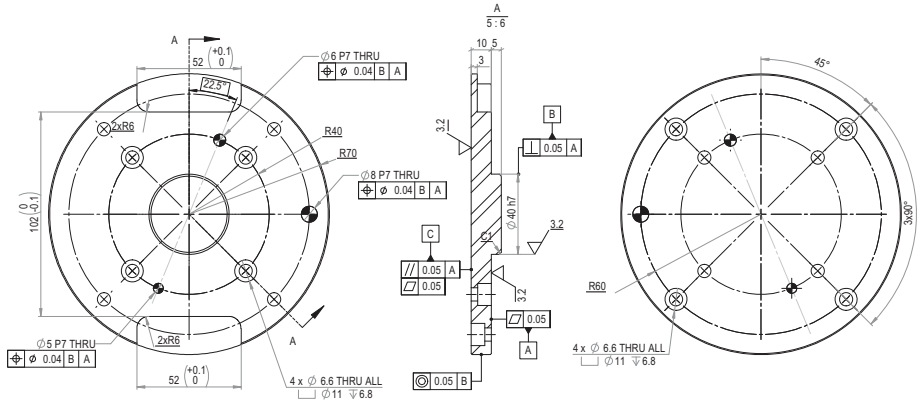
Medium force sensor used with IRB4400 & IRB4600

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.

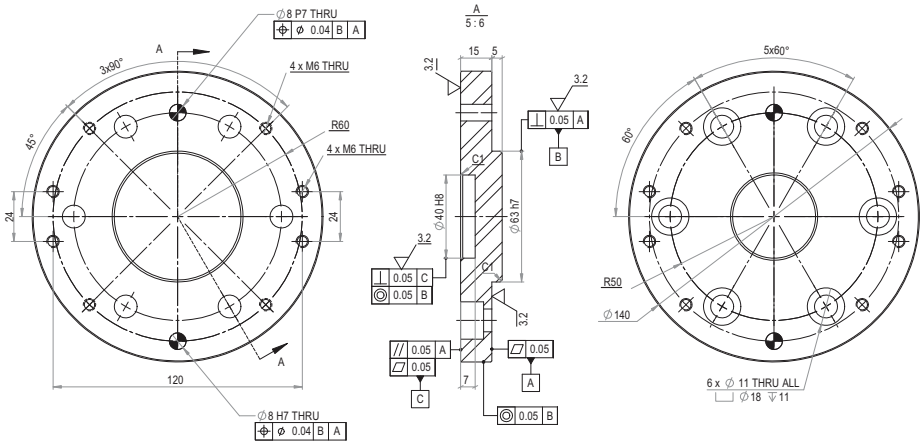
When the middle size force sensor is used, the adapter flanges' dimensions are as follows.

- Sensor side adapter flange




xx1300002366

- Robot side adapter flange

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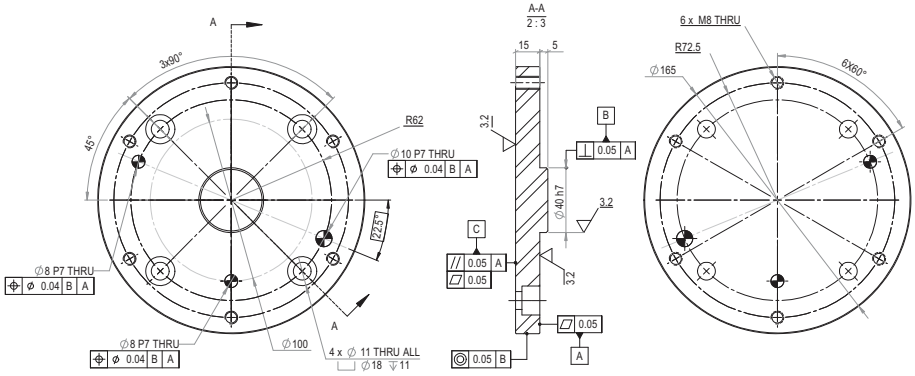
### 1.1.6.1 Overview

*Continued*

**Large force sensor used with IRB4400 & IRB4600**

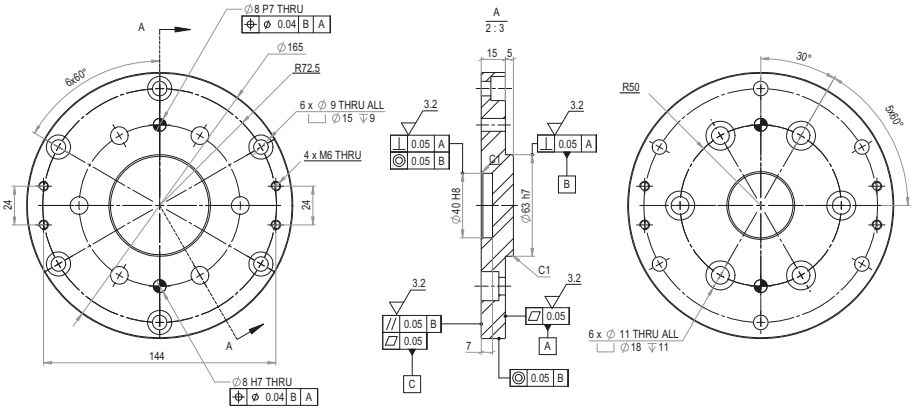
**When the large size force sensor is used, the adapter flanges' dimensions are as follows.**

- **Sensor side adapter flange**




xx1300002362

- **Robot side adapter flange**




xx1300002361

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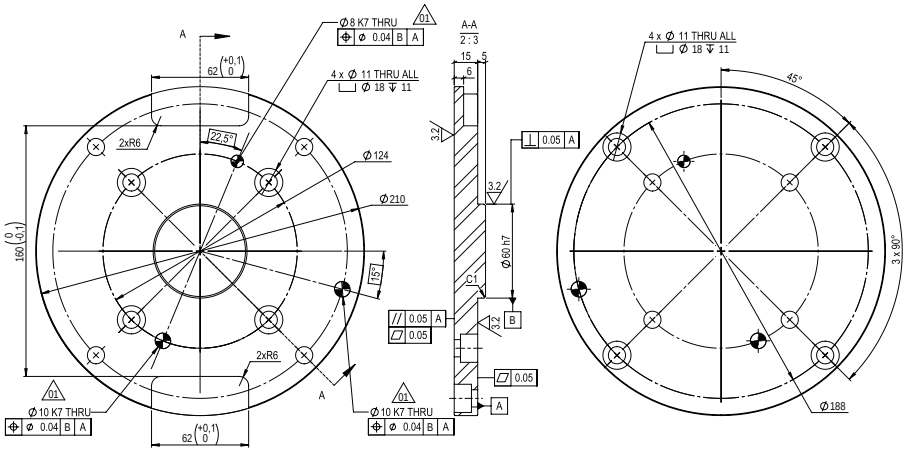
### Large force sensor used with IRB66XX & IRB6700

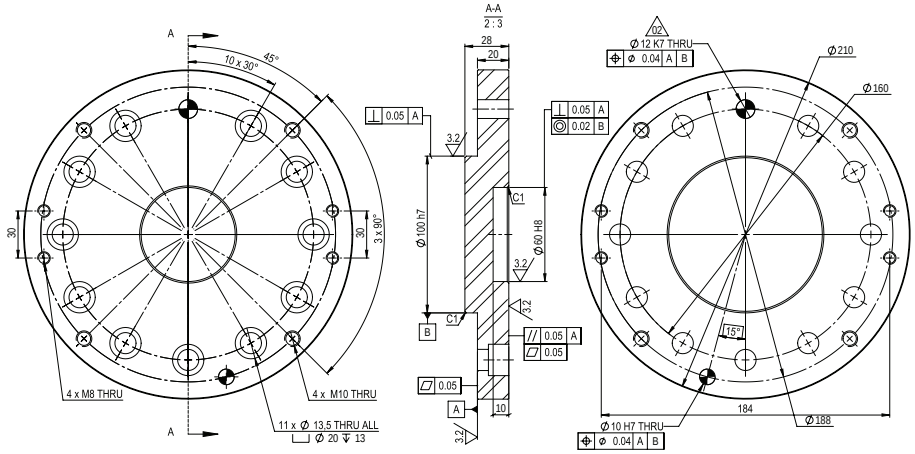
**When the large size force sensor is used, the adapter flanges' dimensions are as follows.**

- **Sensor side adapter flange**




xx1300002363

- **Robot side adapter flange**




xx1300002364

## Extending plate

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

## 1.1.6.2 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | A | 3HAC048938-001 | 1 | SS 304 | |
| 2 | Extending plate | a | 3HAC047797-001 | 1 | Al 6063 | |
| 3 | Positioning pin | Φ5x12 | 9ABA108-24 | 1 | Stainless steel A1-50 | To position the sensor side adapter flange to the sensor. |
| 4 | Positioning pin | Φ6x12 | 9ABA108-33 | 1 | Stainless steel A1-50 | To position the sensor side adapter flange to the sensor. |
| 5 | Positioning pin | Φ5x16 | 9ABA108-25 | 1 | Stainless steel A1-50 | To position the robot side adapter flange to the robot. |
| 6 | Hexagon socket head cap screws | M5x8 | 9ADA183-11 | 4 | Steel 8.8 | To fix the robot side adapter flange to the robot. |
| 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 countersunk head screws | M5x12 | 9ADA625-44 | 2 | Stainless Steel A2-70 | To fix the extending plate to the robot side adapter flange. |

## 1.1.6.3 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | B | 3HAC047790-001 | 1 | SS 304 | |
| 2 | Extending plate | a | 3HAC047791-001 | 1 | Al 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 | 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 countersunk head screws | M5x12 | 9ADA625-44 | 2 | Stainless steel A2-70 | To fix the extending plate to the robot side adapter flange. |

## 1.1.6.4 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | C | 3HAC048926-001 | 1 | SS 304 | |
| 2 | Extending plate | a | 3HAC047791-001 | 1 | Al 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. |

## 1.1.6.5 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | D | 3HAC048927-001; 3HAC048928-001 | 2 | SS 304 | |
| 2 | Extending plate | b | 3HAC048988-001 | 1 | Al 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 robot 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 countersunk head screws | M6x16 | 9ADA625-56 | 2 | Stainless Steel A2-70 | To fix the extending plate to the robot side adapter flange. |

## 1.1.6.6 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | E | 3HAC048929-001; 3HAC048930-001 | 2 | SS 304 | |
| 2 | Extending plate | b | 3HAC048988-001 | 1 | Al 6063 | |
| 3 | Postioning pin | Φ8x20 | 9ABA108-45 | 3 | Stainless Steel A1-50 | To position the sensor side adapter flange to the sensor;<br>To position the robot side adapter flange to the robot;<br>To position the robot 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 adapter flange. |
| 8 | Hexagon socket countersunk head screws | M6x16 | 9ADA625-56 | 2 | Stainless Steel A2-70 | To fix the extending plate to the robot side adapter flange. |

## 1.1.6.7 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 25* and *Extending plate on page 29* .

| No. | Name | Specification/Model | Reference no. | Quantity(Unit:piece) | Material | Description/Note |
|---|---|---|---|---|---|---|
| 1 | Adapt flange | F | 3HAC048931-001; 3HAC048932-001 | 2 | SS 304 | |
| 2 | Extending plate | c | 3HAC048989-001 | 1 | Al 6063 | |
| 3 | Postioning pin | Φ8x20 | 9ABA108-45 | 1 | Stainless Steel A1-50 | To position the sensor side adapter flange to the sensor; |
| 4 | Postioning pin | Φ10x20 | 9ABA108-56 | 1 | Stainless Steel A1-50 | To position the sensor side adapter flange to the sensor; |
| 5 | Postioning pin | Φ10x24 | 9ABA108-57 | 1 | Stainless Steel A1-50 | To position the robot side adapter flange to the sensor side adapter flange. |
| 6 | Postioning pin | Φ12x24 | 9ABA108-69 | 1 | Stainless Steel A1-50 | To position the robot 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 countersunk head screws | M8x20 | 9ADA625-67 | 2 | Stainless Steel A2-70 | To fix the extending plate to the robot side adapter flange. |

## 1.2 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 | M6 screw driver | X | X | | 1 |
| 2 | M10 Screw driver | | | X | 1 |
| 3 | M6 torque wrench | X | X | | |
| 4 | M10 Torque wrench | | | X | |
| 5 | Rubber hammer | X | X | X | 1 |

The following table lists the tightening torque of screws.

| Dimension | Tightening torque (Nm) | Class |
|---|---|---|
| M6 | 10 | 8.8 |
| M10 | 49 | 8.8 |

Sensor validation

Before installing the force sensor to the robot, use the following procedure to verify the effectiveness of the force sensor:

1. Place the sensor on the ground and connect it to the VBM box and robot controller.
2. Power on the controller.
3. Use the TSV to check the values of voltages U0 to U5 for the force sensor.

The channel definition in the TSV is as follows.

| Signal number | Voltage | Sensor parameter |
|---|---|---|
| 1001 | U0 | Fx |
| 1002 | U1 | Fy |
| 1003 | U2 | Fz |
| 1004 | U3 | Tx |
| 1005 | U4 | Ty |
| 1006 | U5 | Tz |

For small force sensors, the value of each channel voltage must be less than 0.65. If the value is larger than 0.65, contact ABB.

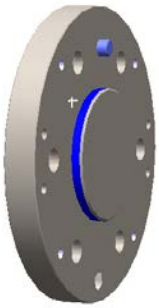
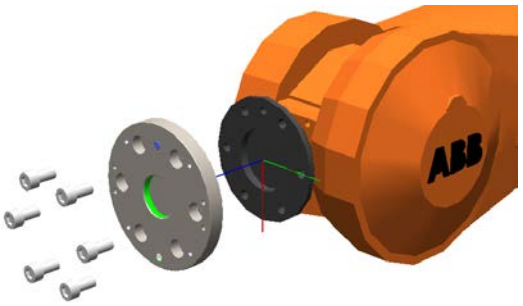
For medium force sensors, the value of each channel voltage must be less than 0.9. If the value is larger than 0.9, contact ABB.

For large force sensors, the value of each channel voltage must be less than 0.8. If the value is larger than 0.8, contact ABB.

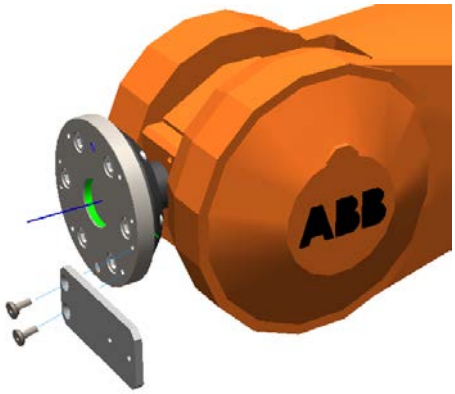
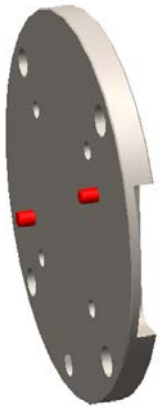
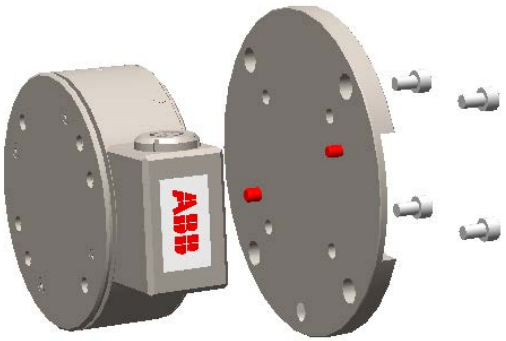
*Continues on next page*

## 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 9*.

| | Description | Illustration/Note |
|---|---|---|
| 1 | Jog the robot to the home position. | |
| 2 | Insert the 8x20 positioning pin into the robot side adapter flange.<br>**Note**<br>For IRB 1200, IRB 140, IRB 1600, IRB 2400, IRB 2600, there is only one adapter flange. |  |
| 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.<br>**Tip**<br>Force sensor frame and mounting information:<br>  <br>A: Mount the tool to this side<br>B: LEMO connector: EEG.2K.316.CLL; Mating connector: FGG.2K.316.CLAD52Z<br>C: The robot arm is at this side |  <br>**Note**<br>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 25*. |

*Continues on next page*

| | Description | Illustration/Note |
|---|---|---|
| 4 | Use two 6x16 class 8.8 hexagon socket head cap screws to fix the cable bracket on the robot side adapter flange. Torque: 12 Nm. |  |
| 5 | Insert a 6x16 positioning pin and a 5x16 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 6x16 positioning pin and the 5x16 positioning pin also inserted into the corresponding positioning holes on the sensor. Torque: 12 Nm.<br>**Note**<br>For IRB 1200, IRB 140, IRB 1600, IRB 2400, IRB 2600, this step is skipped because the force sensor is mounted directly on the robot side adapter flange. |  |

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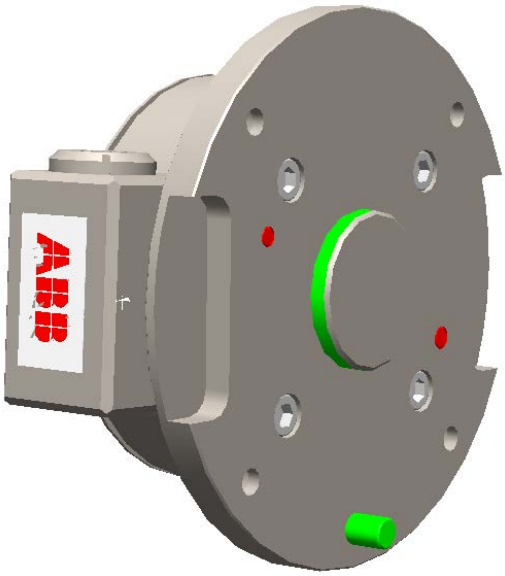
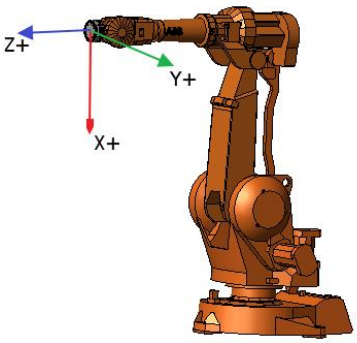
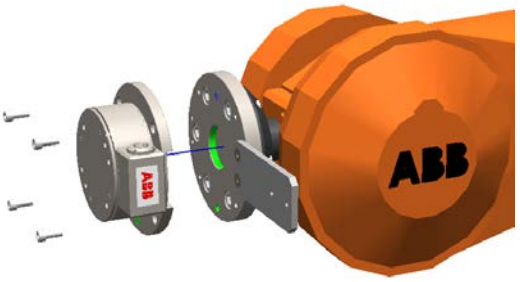
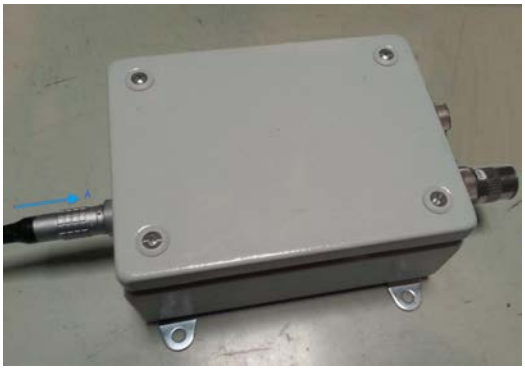
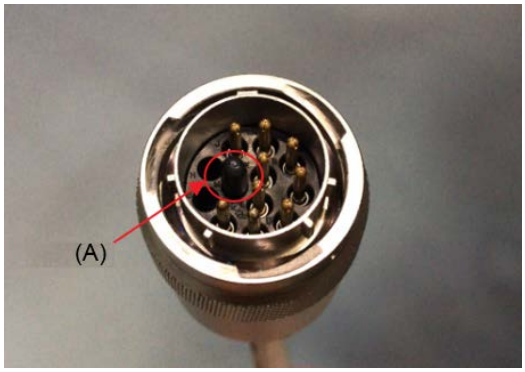
| | Description | Illustration/Note |
|---|---|---|
| 7 | Insert the 8x20 positioning pin into the corresponding positioning hole in the sensor side adapter flange or directly in the sensor (if only one adapter flange is needed). |  |
| 8 | Mount the unit containing the sensor and the adapter flange (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 8x20 positioning pin inserted into the corresponding positioning hole in the robot side adapter flange.<br>**Note**<br>Make sure the adapter is tightly fixed.<br>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.<br>X+,Y+,Z+ direction of the TCP of axis 6:<br>  |  <br>**Note**<br>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. |

*Continues on next page*

| | Description | Illustration/Note |
|---|---|---|
| 9 | Plug the cable connecting the sensor and VMB to the sensor with red marks on the sensor and the cable connector aligned. |  |
| 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. |  <br>xx1300002259<br>A: Connecting the force sensor to VMB<br>  <br>xx1300002260 |

*Continues on next page*

| | Description | Illustration/Note |
|---|---|---|
| 11 | Plug the cable connecting the VMB and the control cabinet to the VMB. |  <br>xx1300002261<br>A: Connect VMB to IRC5 control cabinet |
| 12 | Plug the other end of the cable to the Serial Measurement Link2 on IRC5 Control Cabinet.<br>**Note**<br>The black plastic plug must be pulled out from the connector of the SMC cable first. |  <br>xx1800002232<br>A: Black plastic plug |

**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

| | Description | Illustration/Note |
|---|---|---|
| 1 | Install RobotStudio and RobotWare on a PC. | |
| 2 | Create a new system in RobotStudio. Select the RobotWare option **Force Control Base**. | |
| 3 | Configure the system using RobotStudio. Force Control parameter are set in the configuration topic *Motion*. | See *Configuration on page 42*. |

*Continues on next page*

| | Description | Illustration/Note |
|---|---|---|
| 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.

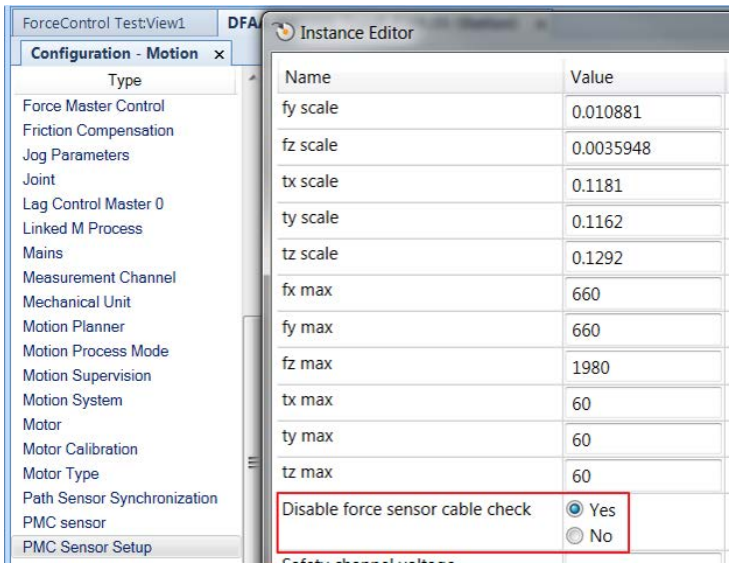
*Continues on next page*

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

**Note**

After loading the sensor configuration file to the controller, make sure that the parameter **Disable check of saturation** is always set to **No** to proect the force sensor hardware.

The parameter value can be checked using the RobotStudio.

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

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# 2 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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# 3 Decommissioning

## 3.1 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.

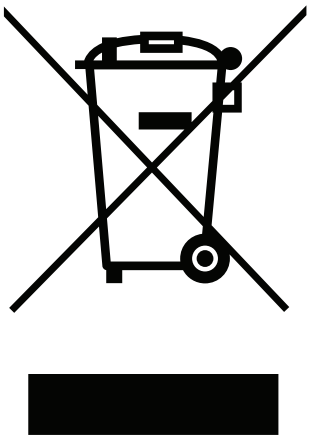
## 3.2 Environmental information

### Introduction

ABB robots contain components in different materials. During decommissioning, all materials should 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.

### 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).



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

# 4 Troubleshooting

## 4.1 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

*Continues on next page*

- 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.

## 4.2 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.

*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 (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.

*Continues on next page*

- 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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# 5 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 | 3HAC068916-001 | Control cable signal 3m |
| 14 | 3HAC068917-001 | Control cable signal 7m |
| 15 | 3HAC068918-001 | Control cable signal 15m |
| 16 | 3HAC068919-001 | Control cable signal 22m |
| 17 | 3HAC068920-001 | Control cable signal 30m |

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# 6 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)<br>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)<br>Class 8.8, oil-lubricated | Tightening torque (Nm)<br>Class 10.9, oil-lubricated | Tightening torque (Nm)<br>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 |

*Continues on next page*

*Continued*

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 |

## 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:

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

| Items to complete the Force Control installation | 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 |

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| Robot | Proposed sensor type |
|---|---|
| IRB 140<br>IRB 2400L<br>IRB 1600<br>IRB 2400-10/-16<br>IRB 2600 | Delta |
| IRB 4400<br>IRB 4600 | Theta<br>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:<br>Type is equal to “sensor type” choice according to table above.<br>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<br>yy will be chosen according cable length in meters that is required (from measuring board to sensor).<br>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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# 6.1 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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