



Original Notice

© 2021 Robotiq Inc.

Robotiq FT 300-S Force Torque
Sensor for Collaborative Robots



LEAN 
ROBOTICS
robotiq.com | leanrobotics.org

Table of Contents

Revisions	4
1. General Presentation	6
1.1. FT 300-S Force Torque Sensor	6
2. Safety	9
2.1. Warning	10
2.2. Intended Use	11
3. Installation	12
3.1. Scope of Delivery	12
3.2. Environmental and Operating Conditions	13
3.3. Mechanical Installation	14
3.4. Power Supply Specifications	15
3.5. Wiring	16
3.6. Calibration Procedure for Visual Demo Software (PC)	19
4. Software	20
4.1. Development Package	20
4.2. Visual Demo Software	24
4.3. Serial Communication	25
5. Specifications	31
5.1. Technical Dimensions	31
5.2. Mechanical Specifications	33
5.3. Signal Specifications	36
5.4. Electrical Ratings	37
5.5. Couplings	37
6. Maintenance	43
6.1. Maintenance Intervals	43
6.2. Cable replacement procedure	44
7. Spare Parts, Kits and Accessories	45
8. Troubleshooting	46
8.1. General troubleshooting	46



8.2. Troubleshooting on other platforms	47
9. Harmonized Standards, Declarations and Certificates	48
9.1. Original EU Declaration of Conformity	48
9.2. Applied standards	49
9.3. Ingress Protection Certification	50
10. Warranty	52
10.1. Exclusions	52
11. Contact	54



Revisions

Robotiq may modify this product without notice, when necessary, due to product improvements, modifications or changes in specifications. If such modification is made, the manual will also be revised, see revision information. See the latest version of this manual online at: support.robotiq.com.

2021-07-07

- Section 3 updated

2021-03-01

- Update of the FT 300 Torque Sensor which is now the **FT 300-S Torque Sensor** with a new design. Various sections of this instruction manual have been updated relatively to this mechanical change. For all information about the FT 300 Torque Sensor, please consult the Archives section at support.robotiq.com.

Revision 2019/06/21

Initial release



Copyright

© 2021 Robotiq Inc. All rights reserved.

This manual and the product it describes are protected by the Copyright Act of Canada, by laws of other countries, and by international treaties, and therefore may not be reproduced in whole or in part, whether for sale or not, without prior written consent from Robotiq. Under copyright law, copying includes translation into another language or format.

Information provided by Robotiq in this document is believed to be accurate and reliable. However, no responsibility is assumed by Robotiq for its use. There may be some differences between the manual and the product if the product has been modified after the edition date.

The information contained in this document is subject to change without notice.



1 General Presentation

The terms "Sensor", "Robotiq Sensor", "Force Sensor", "Torque Sensor", "FT 300-S Force Torque Sensor" used in the following manual refer to the Robotiq FT 300-S Force Torque Sensor unless specified. The Robotiq FT 300-S Force Torque Sensor is a robotic peripheral designed for force and torque data acquisition.

Info

The following manual uses the metric system. Unless specified, **all dimensions are in millimeters**.

11 FT 300-S Force Torque Sensor

Info

The following section presents key features of the Sensor, and must not be considered as being related to Sensor operation. Every feature is detailed in the applicable section of the manual. Safety guidelines must be read and understood before any operation is attempted with the Sensor.

The Force Torque Sensor is a robotic peripheral designed for force and torque data acquisition on robots. It is installed on the robot tool flange with a mechanical coupling. A sensor cable (not shown) is used for power and communications.

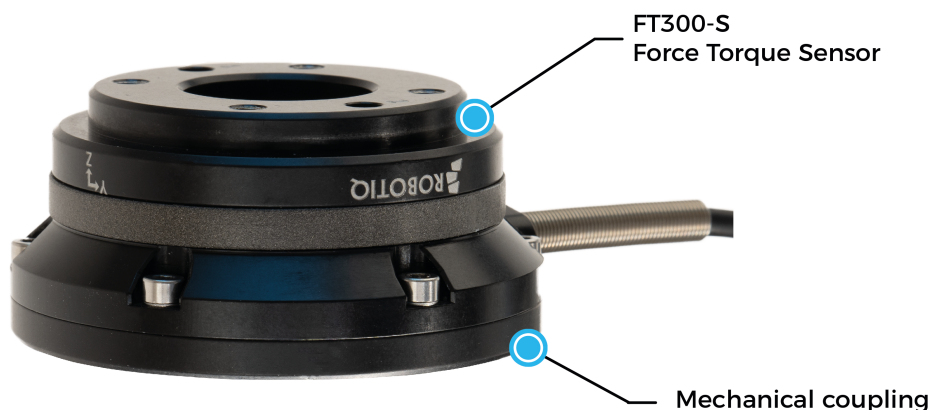


Fig. 1.1: FT 300-S Force Torque Sensor Nomenclature



111 Main features

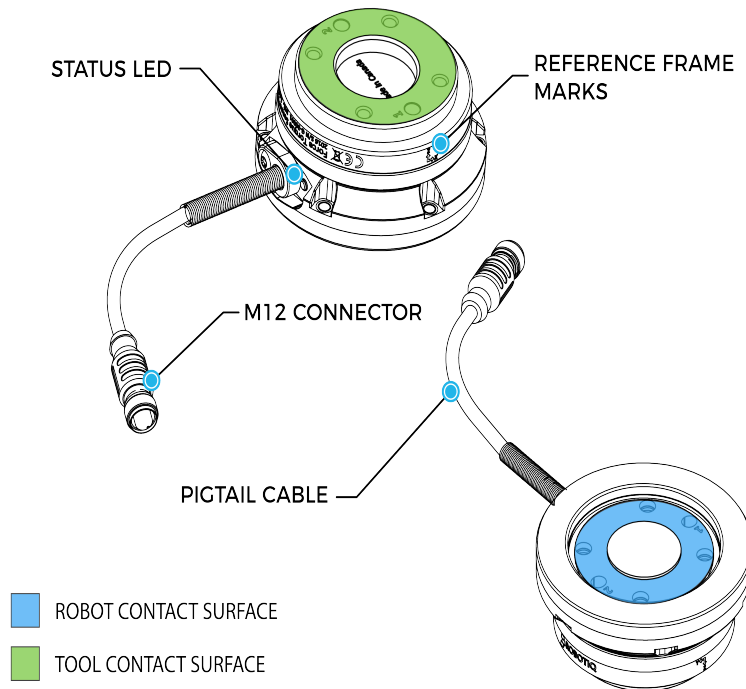


Fig. 1.2: Overview of the Robotiq Force Torque Sensors, with main features.

- The end-of-arm tool contact surface (in green) is the only point of contact allowed between the Sensor and the tool to ensure correct force and torque feedback.
- The robot contact surface (in blue) is the only contact point allowed between the Sensor and the robot for fastening the sensor to the robot. Note that the inside ring must not touch the robot.
- Tool Plate is not shown, but might be required when certain end-of-arm tools are mounted on the FT 300-S Force Torque Sensor.

Info

Details on the bolt pattern and indexing pin for the tool side and the robot side can be found in the **Specifications** section.

- M12 connector allows for both power and data transfer for the Sensor.
- Status LED provides visual information on the status of the Sensor, see **Installation** section.



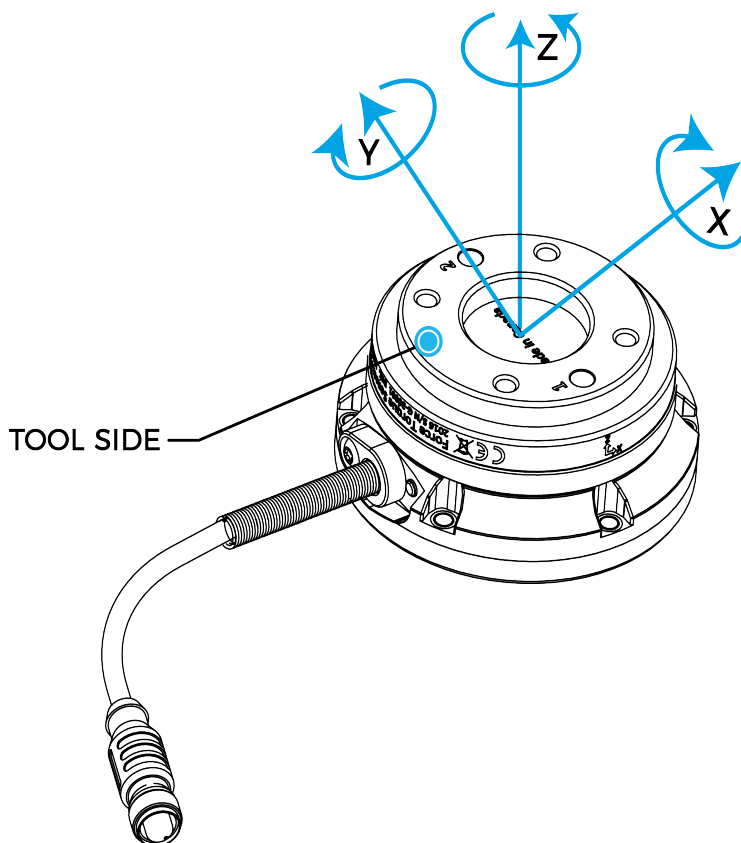


Fig. 1.3: FT 300-S Force Torque Sensor force and torque diagrams.

The figure above represents the various force and torques that the FT 300-S Force Torque Sensor can measure. Reference frame is centered on the Sensor as shown above and visual inscriptions are also represented on it.

- The Z axis passes through the center of the depression with positive direction in the tool direction.
- The X axis traces a symmetric line centered on the connector; the positive direction points the opposite way away from the connector.
- The Y axis uses the right hand thumb rule according to X-Z.

Tip

It is important to understand that the FT 300-S Force Torque Sensor can be used either as a Modbus RTU slave or as a streaming device. When use as a slave unit you will send status requests (read function) to get the force & moment values, while when in data stream mode the Sensor will continuously stream data without responding to a master request. Please refer to the **Serial Communication** section for details.



2. Safety

Warning

The operator must have read and understood all the instructions in this manual before handling the Robotiq Force Torque Sensor.

Info

The term "operator" refers to anyone responsible for:

Any of the following operations with the FT 300-S and the associated robot or tools:

- Installation
- Control
- Maintenance
- Inspection
- Decommissioning

This documentation explains the various components of the Force Torque Sensor, as well as general operations regarding the whole life-cycle of the product from installation to operation and decommissioning.

The drawings and photos in this documentation are representative examples and differences may exist between them and the delivered product.



2.1 Warning

Info

Any use of the Force Torque Sensor in noncompliance of these warnings is inappropriate and may cause injury or damage.

Warning

A force torque sensor used in human-robot collaboration must not be considered a complete safety measure, additional dedicated safety device(s) must be considered. Sensor failure can occur and result in danger for workers or machinery. See local or international safety measure for human-robot collaboration.

Warning

- The Sensor needs to be properly secured before operating the robot.
- Do not install or operate a Sensor that is damaged or lacking parts.
- Never supply the Sensor with an alternative current source.
- Make sure all cord sets are always secured at both ends, at the Sensor and at the robot.
- Always meet the recommended keying for electrical connections.
- Make sure no one is in the robot and/or Sensor path before initializing the robot's routine.
- Always meet the Sensor payload specifications.
- All local safety measures and/or laws on robot operation must be applied to the Sensor.
- Any use of the Sensor in noncompliance with these warnings is inappropriate and may cause injury or damage.



2.2. Intended Use

The Sensor is designed for data acquisition (force and torque sensing) for an end-of-arm tool on a robot.

The Sensor is intended for installation on a robot or other automated machinery or equipment.

The software is used for the implementation of a force torque sensor's operational commands in a user interface.

Info

Always comply with local and/or national laws, regulations and directives on automation safety and general machine safety.

The unit may be used only within the range of its technical specifications. Any other use of the product is deemed improper and unintended use. Robotiq will not be liable for any damages resulting from any improper or unintended use.



3. Installation

Warning

Be sure to read and understand the safety instructions related to the Robotiq Force Torque Sensor prior to installation.

3.1 Scope of Delivery

Standard delivery for an FT Sensor kit:

FTS-300-S-KIT-001
FT-300-S Basic Sensor Unit (FTS-300-S-SEN-001)
1 x 10m High-Flex Cable (straight connector) (CBL-COM-2073-10-HF)
1 x USB to RS485 Adapter (ACC-ADT-USB-RS485)
1X RS232 to RS485 adapter (ACC-ADT-RS232-RS485)

3.1.1 Options

- Couplings

Info

Coupling is mandatory for the FT 300-S.

- Adapter plates
- Tool plates

Info

The following are not included in delivery unless specified in the purchase:

- Options such as couplings and adapters for mounting on divers industrial robots.
- Hardware required for options; accessories or fixtures for the FT Sensor unless specified.
- Power supply units, power supply wiring or fuses.

Please refer to the **Spare Parts, Kits and Accessories** section for a list of available parts.



3.2. Environmental and Operating Conditions

The FT 300-S Force Torque Sensor is designed for industrial applications. Always respect the following specified storage, transport and operating environmental conditions:

CONDITION	VALUE
Minimum storage/transit temperature	-30°C
Maximum storage/transit temperature	70°C
Minimum operating temperature ¹	5°C
Maximum operating temperature ¹	40°C
Humidity (non-condensing)	20-80% RH
Maximum vibration (storage / transit)	5G
Maximum vibration (operating)	2G
IP rating	IP 652,3
Other	• Free from corrosive liquids or gases • Free from explosive liquids or gases • Free from powerful electromagnetic interference

¹Refer to the **Signal Specifications** section for details on temperature compensation range.

²Dust-tight and protected against water jets.

³IP Certification performed on the FT 300-S-UR-KIT, FT 300-S-OMRON-KIT, and FT 300-S-TM-KIT configurations only.



3.3. Mechanical Installation

You must use a coupling to attach the Sensor to a robot. Be sure to use the coupling related to your robot model. Our couplings are listed according to ISO 9409-1 and this covers most bolt patterns. If there is no coupling for your robot, you can modify a blank coupling. Some couplings may require an additional adapter plate. To create your own coupling or adapter plate you can refer to the **Technical Dimensions** section. To see available couplings and adapter plates and for details, refer to the **Spare Parts, Kits and Accessories** section.

Info

The FT 300-S coupling is mandatory, you can customize yours from a blank provided by Robotiq.

Here are the steps to follow for the installation of the Sensor (see figures below).

1. Place the provided dowel pin in the robot tool flange hole.
2. Mount the mechanical coupling on your robot arm. Align with the dowel pin.
3. Secure by inserting the supplied sealing screws. Lock them in place using medium strength threadlocker
4. Mount the Force Torque Sensor on the mechanical coupling.
5. Secure by inserting the M4 screws and the Belleville washers (with the convex side upward) in a cross pattern to properly compress the O-ring.

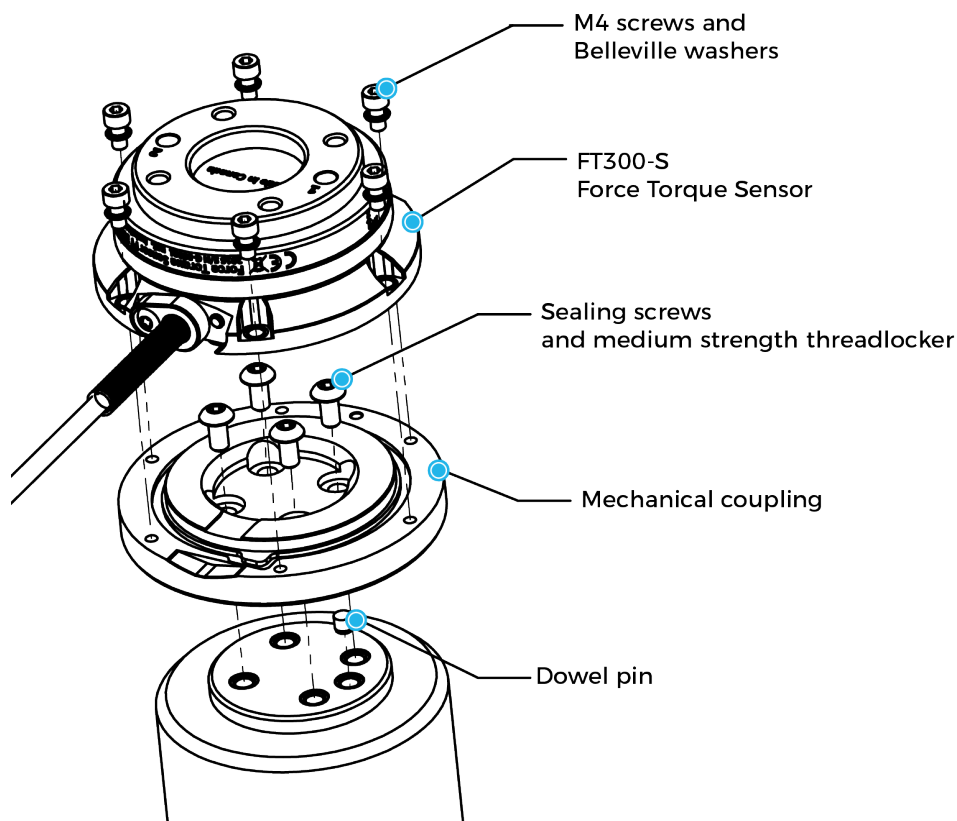


Fig. 3.1: Attaching the FT 300-S sensor to a robot arm using the mandatory coupling.



3.4. Power Supply Specifications

The Sensor needs to be supplied by a DC voltage source. This power supply is not included with the Sensor.

POWER SUPPLY SPECIFICATIONS	VALUE
Output voltage	5 to 24 V DC
Max power consumption	2 W
Overcurrent	1 A Fuse (Phoenix #0916604 (UT6-TMC M 1A))
Overvoltage protection	Warning Maximum output voltage tolerance is 10%, exceeding this limit, 26.4 V DC could damage the Sensor.

Info

Robotiq recommends the use of the following power supply:

TDK-Lambda DPP Series, 15W Single Output DIN Rail Mount Power Supply, **DPP15-24**



3.5. Wiring

Power and communications are established with the FT 300-S Force Torque Sensor via a single device cable. The FT 300-S has a pigtail cable.

The figure below represents the FT 300-S Force Torque Sensor receptacle (Sensor side) and connector (cable side) with associated pinout. The M12 - 5 pin A-coded connector is used in accordance with IEC 61076-2-101.

Warning

Use proper cabling management. Be sure to have enough forgiveness in the cabling to allow movement of the Gripper along all axes without pulling out the connectors. Always protect the controller side of the cable connection with a strain relief cable clamp.

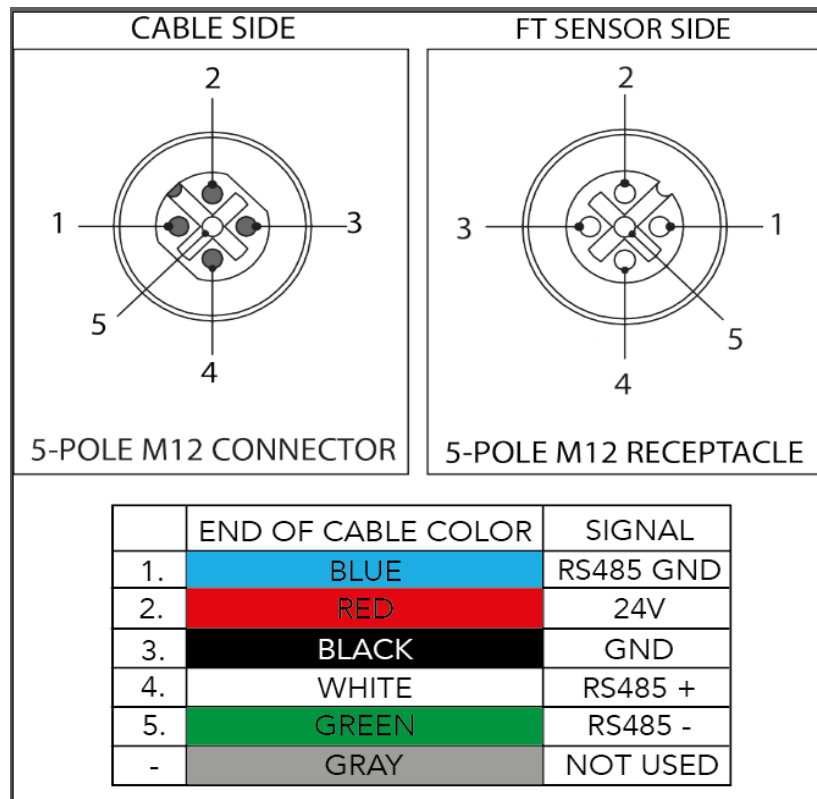


Fig. 3.2: Pinout of the Robotiq FT 300-S Force Torque Sensor and color code per cable type.

Info

Power pins 2 & 3 are connected to the specified power supply. Do not connect the gray cable.

Info

RS-485 signal pins 1, 4 & 5 are connected directly, to a RS-485 / USB converter or to a RS-485 / RS-232 converter.



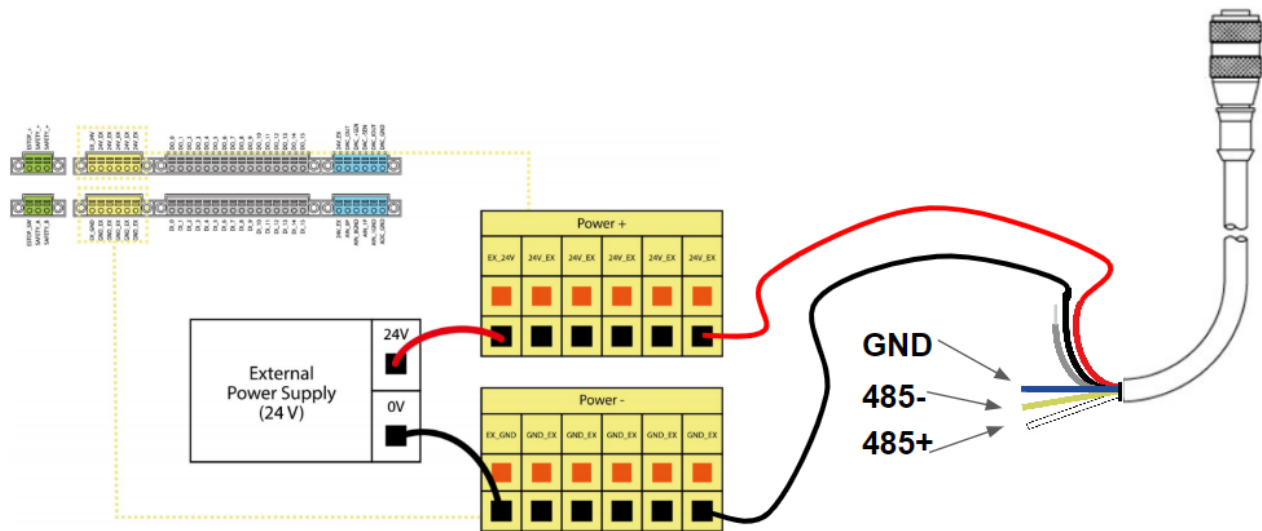


Fig. 3.3: FT300-S Cable to Terminal Connector on the Controller

3.5.1 Wiring with USB to RS485 Converter

When using a RS485 to USB converter (refer to the **Spare Parts, Kits and Accessories** section), the wiring must respect the figure below and subsequent directions. GND / 0V is wired to Sensor pin #1 as stated in the **Wiring** section.

The converter will provide you with a standard USB 2.0 male A connector.

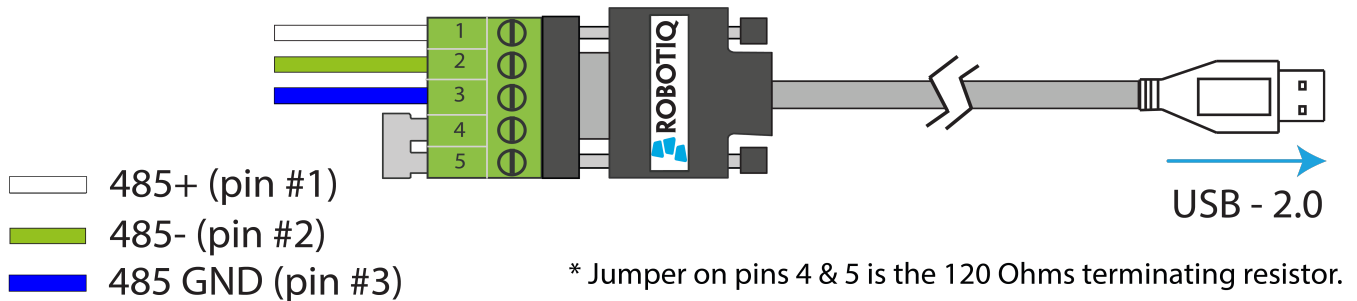


Fig. 3.4: Wiring diagram for the RS485 to USB converter

Warning

Power is not delivered via the USB, do not plug 24V into the USB.

3.5.2. Wiring with RS232 to RS485 Converter

When using a RS232 to RS485 converter (refer to the **Spare Parts, Kits and Accessories** section), the wiring must respect the figure below.



Warning

Do not wire converter pin #3 (5V) on the RS485.

The 24V power supply is NOT supplied via the converter.

The converted side will provide you with a standard DB - 9 female connector with signaling as shown in the figure below.

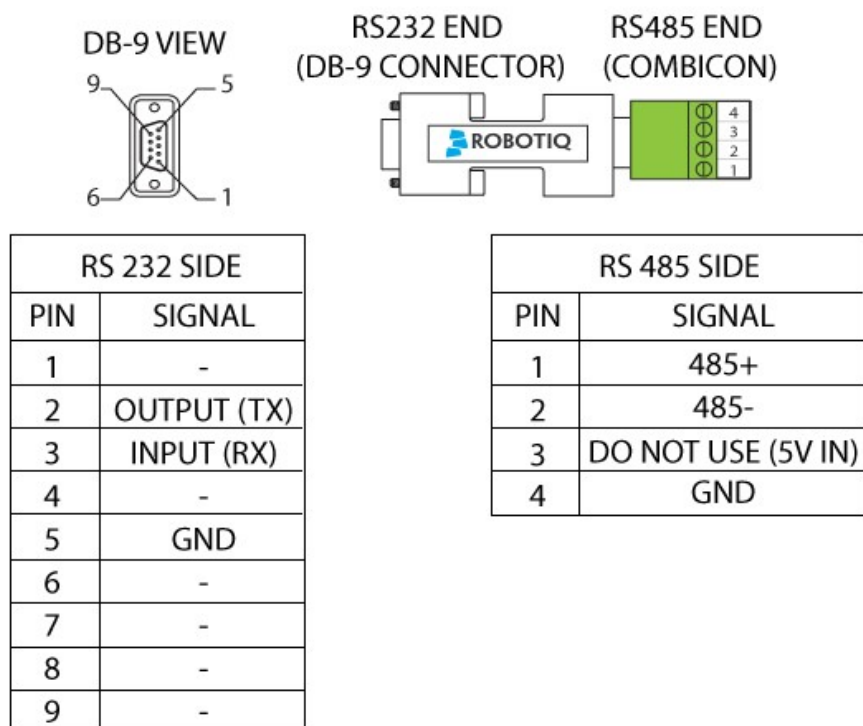


Fig. 3.5: Wiring diagram for RS232 to RS485 converter.



3.6. Calibration Procedure for Visual Demo Software (PC)

Info

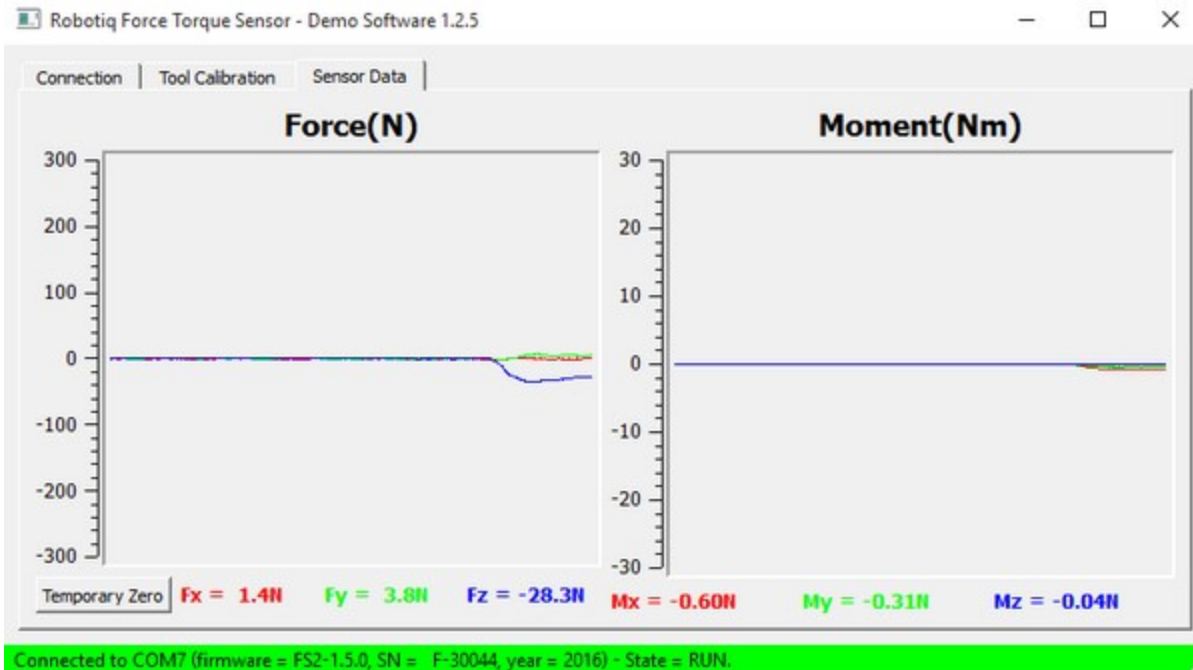
You need the Visual Demo Software installed first. Please refer to the **Visual Demo Software** section for download and installation.

To calibrate your FT 300-S Sensor:

- 1 Go to the "Tool Calibration" tab and follow the instructions.



- 2 Once completed, go to the "Sensor Data" tab.



4. Software

The following subsections provide instructions for the installation of the Force Copilot software package. This lets you receive input from a Force Torque Sensor.

- Section 4.1 and subsections detail the installation of an open source development package, which can be adapted according to the users' needs. It currently functions with Windows and Linux.
- Section 4.2 explains the Demo Software
- Section 4.3 will detail the use of serial communication in generic applications

4.1 Development Package

The Robotiq Force Torque Sensor development package can be downloaded at support.robotiq.com.

4.1.1 Distribution License

The development package is distributed under the New BSD license, which is a permissive free software license. In short, the provided code can be used in any project without any restriction regarding its use (commercial or not). If it is included in a software, this software does not need to be open-source. However, the code is provided "as is" without any liability from Robotiq and some restrictions apply regarding the distribution of the code and the use of the Robotiq name.

The terms of the license (included in each source file) are described here:

Software License Agreement (BSD License)

Copyright (c) 2014, Robotiq, Inc. All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- Neither the name of Robotiq, Inc. nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS



"AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

4.12. Linux

Package Files – Description

The development package is structured with the following files and directories architecture (non-Linux files and directories are ignored in this section):

- src: contains the source files common to all platforms
- obj: used during compilation for the object files related to the common sources
- Linux: contains Linux specific files
 - bin: contains the binary files
 - src: contains the source files common to all platforms
 - main.c : application source file which can be modified by the user
 - obj: contains all the object files after they are compiled
- Makefile: file containing the rules to compile the sensor driver using Make

Caution

When started, the provided software will scan all ports in the system (ttySx and ttyUSBx) to find a compatible Robotiq device. It uses the Linux utility "fuser" to determine if the port is already opened. This section of code can be modified by the user if necessary to avoid the scanning of ports (for example, if another device would become confused when receiving a message that it cannot understand).

Procedure to Compile and Test the Provided Source Code

This procedure explains how to compile the source code and verify that the sensor data is properly read.

1. Unzip the package in the home folder, for example in the folder ~/driver/
2. Open a terminal and enter the package directory using the following command:

```
rd@debian:~/$ cd driver
```



3. Use Make to compile the application:

```
rd@debian:~/ $ make linux
```

4. In order to have access to the virtual serial COM port, add the used username to the group dialout:

```
rd@debian:~/ $ sudo usermod -a -G dialout username
```

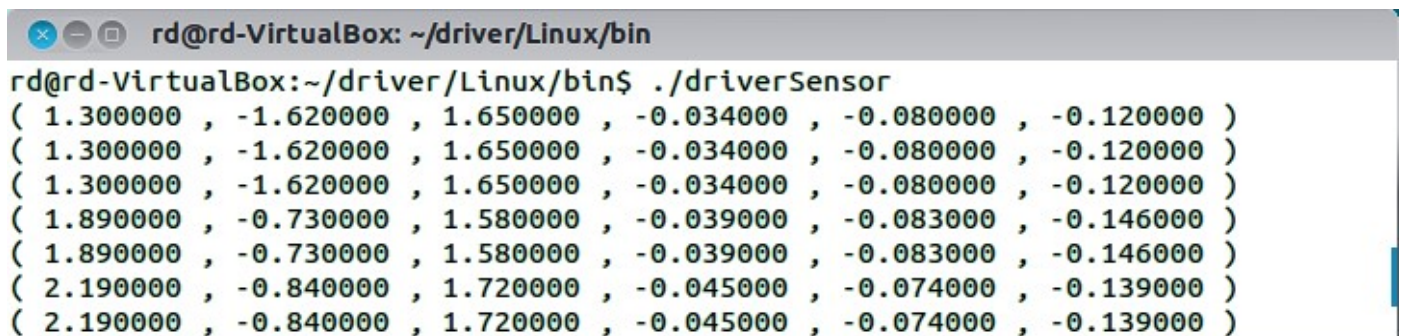
5. It is required to log out (or reboot) the session in order for the group change to become effective.
6. Make sure that the sensor is properly powered and that the data signals are connected to the development PC using the provided RS485 to USB converter. A new device named ttyUSBx should be present in /dev, which can be verified with the following command:

```
rd@debian:~/ $ ls -l /dev | grep ttyUSB
```

7. In a terminal, go to the ~/driver/Linux/bin folder and execute the demo application using the following command:

```
rd@debian:~/driver/Linux/bin/ $ ./driverSensor
```

8. After 1-2 seconds, the sensor data should start showing up in the terminal as a vector of 6 floats with data in the (Fx, Fy, Fz, Mx, My, Mz) format.



```
rd@rd-VirtualBox: ~/driver/Linux/bin
rd@rd-VirtualBox:~/driver/Linux/bin$ ./driverSensor
( 1.300000 , -1.620000 , 1.650000 , -0.034000 , -0.080000 , -0.120000 )
( 1.300000 , -1.620000 , 1.650000 , -0.034000 , -0.080000 , -0.120000 )
( 1.300000 , -1.620000 , 1.650000 , -0.034000 , -0.080000 , -0.120000 )
( 1.890000 , -0.730000 , 1.580000 , -0.039000 , -0.083000 , -0.146000 )
( 1.890000 , -0.730000 , 1.580000 , -0.039000 , -0.083000 , -0.146000 )
( 2.190000 , -0.840000 , 1.720000 , -0.045000 , -0.074000 , -0.139000 )
( 2.190000 , -0.840000 , 1.720000 , -0.045000 , -0.074000 , -0.139000 )
```

Fig. 4.1: Sensor Data Acquisition.

Adapt to a User Application

In practice, the provided source code will be adapted to either: be incorporated with a custom application or to communicate with one. At this point, the main.c file should be adapted according to the guideline comments inserted in the code.



Caution

Please note that Robotiq can only support our customers in making sure they can compile and test the provided code *as is*.

No support can be provided for the integration of the provided source code into a custom application.

4.13. Windows

Package Files – Description

The development package is structured with the following files and directories architecture (non-Windows files and directories are ignored in this section):

- src: contains the source files common to all platforms
- obj: used during compilation for the object files related to the common sources
- Windows: contains Windows specific files
 - bin: contains the binary files
 - src: contains the source files common to all platforms
 - main.c : application source file which can be modified by the user
 - obj: contains all object files after they are compiled
 - Data_logger: contains an application (and its source code) to log data from the sensor
 - compiler.bat: script which automates the settings for the environment variables and the compilation of the example application
- Makefile: file containing the rules to compile the sensor driver using Make

Procedure to Compile and Test the Provided Source Code

This procedure explains how to install MinGW, compile the provided source code and verify that the sensor data is properly read.

1. Unzip the package in the desired directory.
2. If it is not already installed, download MinGW at <http://www.mingw.org/>. Download the installer "mingw-get-setup.exe".
3. Install MinGW by running "mingw-get-setup.exe" and save the default installation path.
4. Open "MinGW installation manager".
5. Select "mingw-developer-toolkit" in the "Basic setup" tab and click "Mark for Installation".
6. Select "mingw32-binutils" in the "All packages" tab and click "Mark for Installation".
7. In the menu "Installation", click "Apply changes". This will install the required packages to compose the software using Make.
8. In the Windows directory, run the compiler.bat file. This will build your application.
9. Run the application "driverSensor" located in the "Windows/bin/" folder.
10. After 1-2 seconds, the sensor data should start showing up in the command window as a vector of 6 floats with data in the (Fx, Fy, Fz, Mx, My, Mz) format.



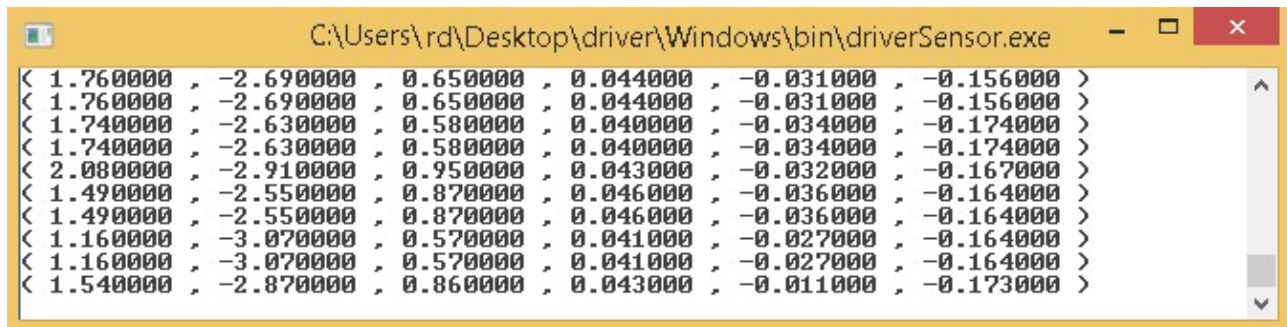


Fig. 4.2: Sensor Data Acquisition Under Windows.

Adapt to a User Application

In practice, the provided source code will be adapted to either: be incorporated with a custom application or to communicate with one. At this point, the main.c file should be adapted according to the suggested comments inserted in the code.

Caution

Please note that Robotiq can only support our customers in making sure they can compile and test the provided code as is.

No support can be provided for the integration of the provided source code into a custom application.

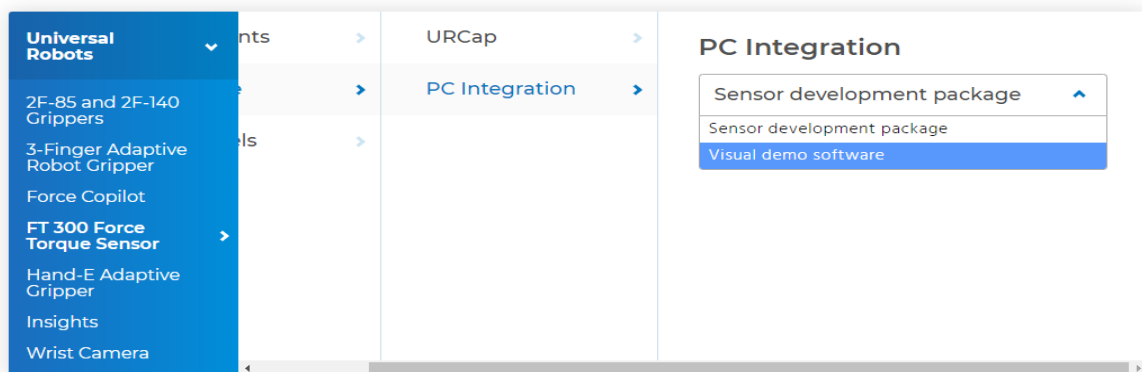
4.2. Visual Demo Software

The Visual Demo Software is used to demonstrate the ability of the FT Sensor to read force and moment. It is not intended to be used for programming or to save or use data. It can also be used to calibrate the Sensor. Please refer to the **Installation** section for the calibration procedure.

4.2.1 Software Package Installation

- 1 Make sure that you have the latest version of the Visual Demo Software, which can be found at support.robotiq.com.

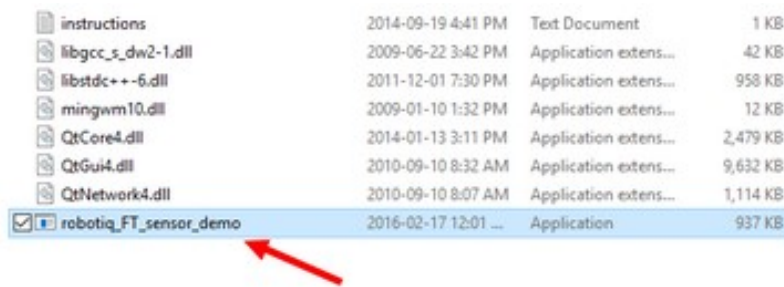
Support



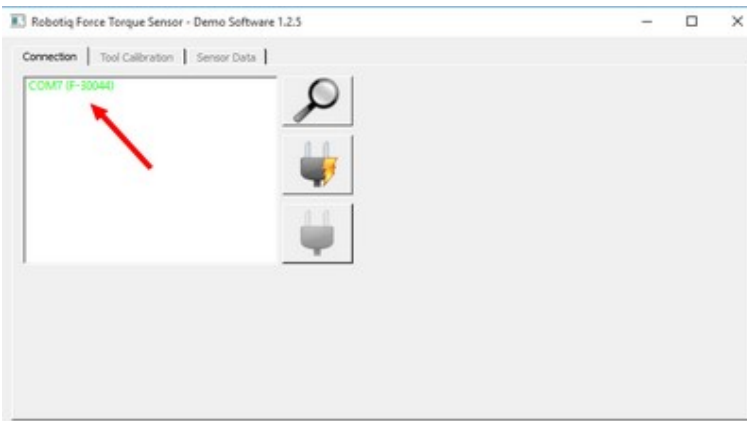
- 2 Copy all the files of this folder onto a PC.
- 3 Connect the USB connector to the converter attached to the PC. Important : The Sensor must NOT be powered at this time.
- 4 Wait while the driver(s) install. After all the drivers have been installed.



- 5 Plug the Sensor cable into the Sensor.
- 6 Connect the Sensor cable to the power supply.
- 7 Launch the demo application.



- 8 You should see a **COM** port in green with a serial number, showing the Sensor connected to the PC. Click on it.



By going into the **Sensor Data** tab, you can now see in real time the force and moment applied on the FT Sensor.

4.3. Serial Communication

The FT Sensor uses two communication modes, Modbus RTU and data stream. The Modbus RTU communication mode is used to obtain information on the Sensor, like its firmware version. The data stream mode is used to obtain data from the Sensor.

Info

It is recommended to use the FT Sensor data stream to obtain faster data acquisition.

Caution

Modbus RTU can be used to obtain data, but will result in a slower data acquisition frequency.

Info

In both modes, force and torque data from the Sensor will be in 16-bits signed integer format.



4.3.1 Modbus RTU

The FT Sensor can be controlled over USB using an ACC-ADT-USB-RS485 signal converter. This section is intended to provide guidelines for setting up a Modbus scanner that will adequately communicate with the Sensor.

For a general introduction to Modbus RTU and for details regarding the CRC algorithm, the reader is invited to read the Modbus over serial line specification and implementation guide available at : http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf.

For debugging purposes, the reader is also invited to download one of many free Modbus scanners such as the *CAS Modbus Scanner* from Chipkin Automation Systems available at: <http://www.store.chipkin.com/products/tools/cas-modbus-scanner>.

Info

Modbus RTU is a communication protocol based on Big Endian byte order. Therefore, the 16-bit register addresses are transmitted with the most significant byte first. However, the data port is, in the case of Robotiq products, based on the Little Endian byte order. As such, the data parts of Modbus RTU messages are sent with the less significant byte first.

Tip

Modbus RTU specification and details can be found at www.modbus.org



Connection Setup

The following table describes the connection requirements for controlling the Sensor using the Modbus RTU protocol:

Propriety	Value
Baudrate (bps)	19,200
Data bits	8
Stop bit	1
Parity	None
Supported Functions	Read Holding Register (FC03) Preset Multiple Register (FC16)
Slave ID	0x0009 (9)

In Modbus RTU you can obtain the following information:

Information	Register
Production year-	514
Serial number	510 to 513
Force X (N) = value / 100	180
Force Y (N) = value / 100	181
Force Z (N) = value / 100	182
Moment X (Nm) = value / 1000	183
Moment Y(Nm) = value / 1000	184
Moment Z (Nm) = value / 1000	185
Acceleration X (g) = value / 1000	190



Information	Register
Acceleration Y (g) = value / 1000	191
Acceleration Z (g) = value / 1000	192

Read Holding Register (FC03)

Function code 03 (FC03) is used to read the status of the Sensor (robot input). Examples of such data is the display of the current force and torque values.

Example of FC03 Read Function:

To get Fx, you need to read (03) the register 180 (00B4) in device ID 9 (09).

Request is: 09 03 00 B4 00 01 C5 64

Hex format: 0x09 0x03 0x00 0xB4 0x00 0x01 0xC5 0x64

Bits	Description
09	SlaveID
03	Function Code 03 (Read Holding Register)
00B4	Address of the first requested register
0001	Number of registers requested (1)
C564	Cycle Redundancy Check (CRC)

To get all 6 force/torque values at once, you need to read (03) six registers (0006), starting with register 180 (00B4) in device ID 9 (09).

Request is: 09 03 00 B4 00 06 04 A6

Hex format: 0x09 0x03 0x00 0xB4 0x00 0x06 0x84 0xA6

Bits	Description
09	SlaveID
03	Function Code 03 (Read Holding Register)
00B4	Address of the first requested register



Bits	Description
0006	Number of registers requested (6)
04A6	Cycle Redundancy Check (CRC)

4.3.2. Data Stream

Data stream mode is the recommended method of obtaining data from the Sensor. Once initiated, the Sensor will stream force and moment data continuously until communication is interrupted by the user.

Tip

To start the data stream, write 0x0200 in register 410.

To stop the data stream, communication must be interrupted by sending a series of 0xff characters to the Sensor. Sending for about 0.5s (50 times) will ensure that the Sensor stops the stream.

When the stream is started, 16 bytes messages are sent by the sensor at 100Hz using this format:

<0x20><0x4e><LSB_data1><MSB_data1> ... <LSB_data6><MSB_data6><LSB_crc><MSB_crc>

With dataX being a 16-bits signed integer defined as:

Data	Value meaning
data1	$F_x * 100 \text{ (N)}$
data2	$F_y * 100 \text{ (N)}$
data3	$F_z * 100 \text{ (N)}$
data4	$M_x * 1000 \text{ (Nm)}$
data5	$M_y * 1000 \text{ (Nm)}$
data6	$M_z * 1000 \text{ (Nm)}$

The CRC is computed using a standard 16-bits modbus CRC (see http://www.ccontrols.com/w/How_to_Compute_the_Modbus_RTU_Message_CRC).

Preset Multiple Registers (FC16)

Function code 16 (FC16) is used to activate functionalities of the Gripper (robot output). A common example is the initialization of data streaming.

Example of setting multiple registers (FC16):



To initialize the data stream, 0x0200 must be written with the function 16 (0x10) in register 410 (019A).

Request is: 09 10 01 9A 00 01 02 02 00 CD CA

Hex format: 0x09 0x10 0x01 0x9A 0x00 0x01 0x02 0x02 0x00 0xCD 0xCA

Bits	Description
09	SlaveID
10	Function Code 16 (Preset Multiple Registers)
019A	Address of the first register
0001	Number of registers requested (1)
02	Number of data bytes to follow (1 registers x 2 bytes/register = 2 bytes)
0200	Value written to register 0x019A
CDCA	Cycle Redundancy Check (CRC)



5. Specifications

The following sections provide data on the various specifications of the Robotiq Force Torque Sensor.

- Section 5.1 details the technical dimensions of the sensor.
- Section 5.2 details the mechanical specifications.
- Section 5.3 covers signal specifications (data acquisition).
- Section 5.4 specifies electrical rating.
- Section 5.5 covers the technical dimensions of the sensor coupling options.

5.1 Technical Dimensions

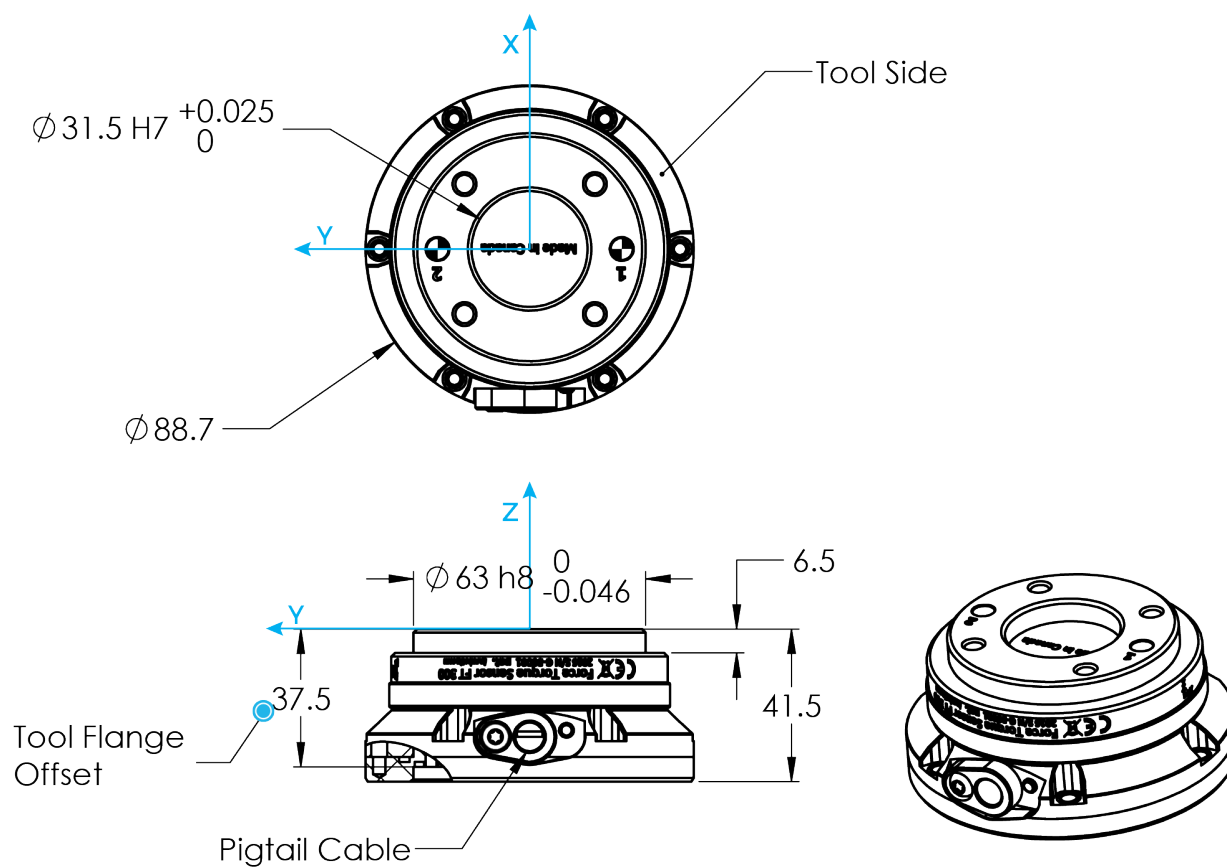


Fig. 5.1: Robotiq FT 300-S Sensor general technical dimensions.

Info

Reminder: Measures are in millimeters.



5.11 Tool Side Bolt Pattern

The figure below illustrates the bolt pattern used for tool fixation on the FT 300-S Sensor.

- Bolt pattern diameter is 50 mm
- Mounting holes are M6 thread, 6 mm deep.
- Dowel pin holes for M6 dowel pin has a tight fit (H7) and 6 mm deep.

Info

FT 300-S tool side bolt pattern matches ISO-9409-1-50-4M6. A second dowel pin hole is present to allow sensor axes to reflect those of the robot, depending on the robot brand used.

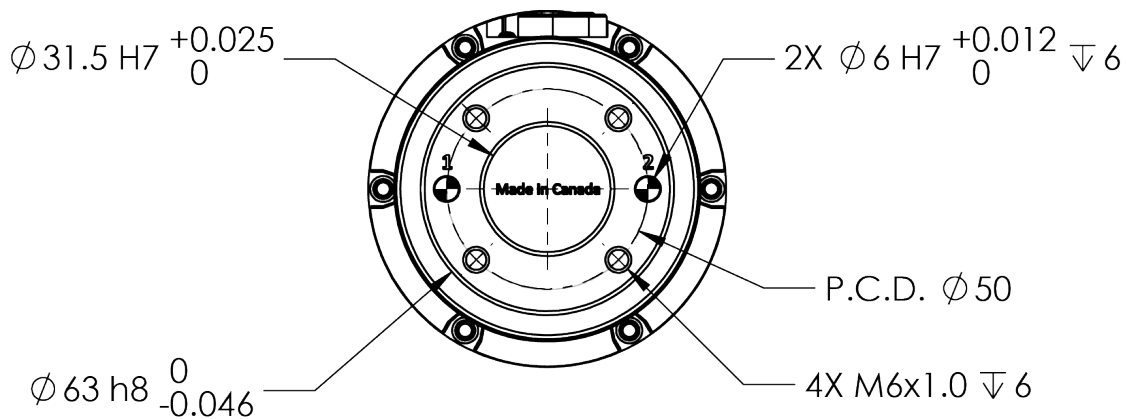


Fig. 5.2: FT 300-S Sensor tool side bolt pattern.

5.2. Mechanical Specifications

Info

Reminder: all units are within the metric measurement system.

SPECIFICATION		VALUE
Approximate weight		442 g
Overload capacity		A combined load exceeding 500% of the measuring range will permanently damage the Force Torque Sensor ($F_x/300 + F_y/300 + F_z/300 + M_x/30 + M_y/30 + M_z/30 < 500\%$)
Outside diameter		Ø 89 mm (Robot side) Ø 75 mm (Tool side)
Thickness		41.5 mm (Overall) 37.5 mm (from robot flange)
Stiffness	F_x, F_y	$35 \times 10^6 \text{ N/m}$
	F_z	$30 \times 10^6 \text{ N/m}$
	M_x, M_y	10,000 Nm/rad
	M_z	20,000 Nm/rad



5.2.1 Moment of Inertia and Center of Mass

The coordinate system used for calculating the moment of inertia and center of mass for the FT Sensor is shown in the matrix and the table below:

Info

All values are approximate. Actual coordinates may vary according to various options present on the Sensor.

- Here is the approximate moment of inertia matrix for the FT Sensor, taken at the coordinate system origin:

$$I = \begin{bmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{yx} & I_{yy} & I_{yz} \\ I_{zx} & I_{zy} & I_{zz} \end{bmatrix} = \begin{bmatrix} 316 & -1 & -2 \\ -1 & 611 & 0 \\ -2 & 0 & 671 \end{bmatrix} kg * mm^2$$

Fig. 5.3: Moment of inertia of the FT 300-S Sensor.

- Here is the approximate position of the center of mass for the FT Sensor:

Sensor	x (mm)	y (mm)	z (mm)	Mass (g)
FT 300-S	-6.00	0	13.5	410*

*Cable mass is not completely considered.

- Here is the Tool Center Point (TCP) table for the FT 300-S Sensor:

Sensor	x (mm)	y (mm)	z (mm)
FT 300-S	0	0	37.5

Info

For TCP and center of mass of the FT 300-S with Gripper combinations, please consult the specific table provided on our [support website](#).



5.2.2. Overload Capacity

The FT 300-S sensors have overload capacities, the overload capacity specification includes load and torque values in all 3 axes.

Info

For loads between the measuring range and the overload capacity, the signal will be saturated. The sensor will not undergo permanent damage if the overload capacity is not reached.

Warning

Exceeding the overload capacity will permanently damage the sensor.

Sensor	Measuring range	Overload capacity ¹
FT 300-S	+/- 300 N	1500 N (500%) ²

¹Overload capacity with all axes combined.

²Maximum load expressed in % of measuring range.

The overload capacity given includes forces and torques in all 3 axes. To get an approximation of the total load, these formulas must be used:

- For the FT 300-S

$$F_x/300 + F_y/300 + F_z/300 + M_x/30 + M_y/30 + M_z/30 < 500\%$$



5.3. Signal Specifications

SPECIFICATION		FT 300-S
Measuring range	Force	± 300 N
	Torque	± 30 Nm
Signal noise ¹	Fx, Fy	0.1 N
	Fz	0.1 N
	Mx, My	0.005 Nm
	Mz	0.003 Nm
Recommended threshold when mounted on a robot	Fx, Fy	1 N
	Fz	1 N
	Mx, My	0.02 Nm
	Mz	0.01 Nm
Data output rate		100 Hz
Temperature compensation		15 to 35°C

¹Signal noise is the standard deviation of the signal measured over a period of one (1) second.

²Specifications included in the **Signal Specifications** section may vary outside of the temperature compensation range.

Table 5 - 1: Signal Specifications

Warning

Sensor data may be slightly affected by strong electromagnetic fields.

Caution

For more details on minimum/maximum operating temperatures, please refer to the **Environmental and Operating Conditions** section.

³Specifications included in the **Signal Specifications** section may vary outside of the temperature compensation range.



Caution

The recommended threshold represents the smallest variations that can be detected by the sensor.

The signal noise is the limiting factor for the Sensor's precision. For the FT 300-S, the signal noise defined in the signal specifications is the standard deviation of each data (Fx, Fy, Fz, Mx, My, Mz) over 1 second. In order to use that signal noise information, three times the standard deviation given must be used. According to the normal distribution, three times the standard deviation will cover almost all values possible (99.7%).

Info

Noise is an unwanted and unpredictable alteration to a signal. It may come from electrical or electromagnetic sources and degrades the quality of the Sensor's signal.

5.4. Electrical Ratings

SPECIFICATION	VALUE
Input voltage	5 to 24 VDC $\pm$ 10%
Max power consumption	2 W
Communication electrical interface	RS-485
Recommended fuse	Phoenix #0916604 (UT6-TMC M 1 A)
Recommended power supply	TDK-Lambda DPP Series 15W Single Output DIN Rail Mount Power Supply, DPP15-24

5.5. Couplings

For a detailed list of available couplings and adapter plates, please refer to the **Spare Parts, Kits and Accessories** section.

The following subsections contain data required for custom couplings or creating couplings from blanks.

Info

All Robotiq couplings and adapter plates are provided with necessary hardware for fixation on the Robotiq device side.

Caution

Unless identified for specific packages only, **robot side screws and dowel pins are not provided**.



5.5.1 Blank Coupling

Below are the dimensions of the blank coupling, FTS-300-S-CPL-BLANK (please refer to the Spare Parts, Kits and Accessories section), available to create a custom bolt pattern. The blue section can be fully customized to a depth of 5mm. The orange section can be fully customized on the entire height, just make sure to leave a 2mm minimal thickness at the screw connection. The screws head must not contact the PCB cover, make sure to use low head screws or to machined in order not to make contact with the cover.

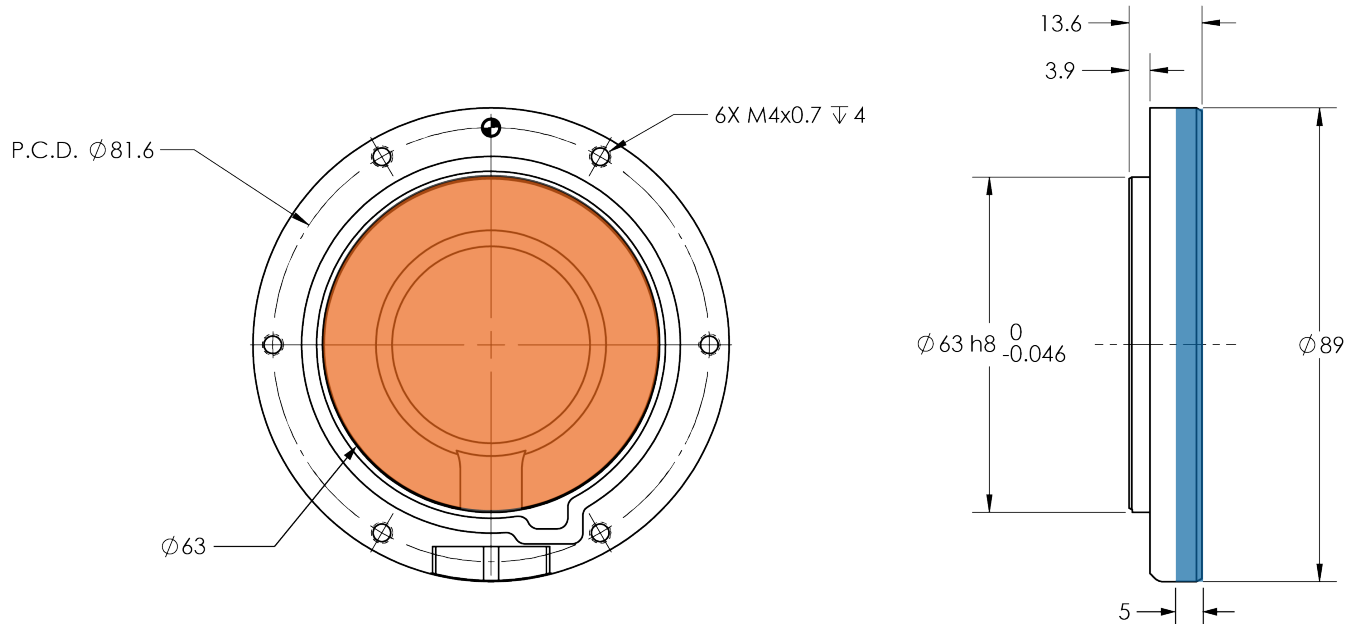


Fig. 5.4: Workable area dimensions of blank coupling FTS-300-S-CPL-BLANK

5.5.2. Coupling for ISO 9409-1-50-4-M6

Bolt pattern for coupling FTS-300-S-CPL-014 (please refer to the Spare Parts, Kits and Accessories section) is compatible with:

- 50 mm pitch circle diameter:
 - (4) M6-1.0 button head socket cap screw clearance
 - (1) M6 dowel pin
 - ISO 9409-1 standard 50-4-M6

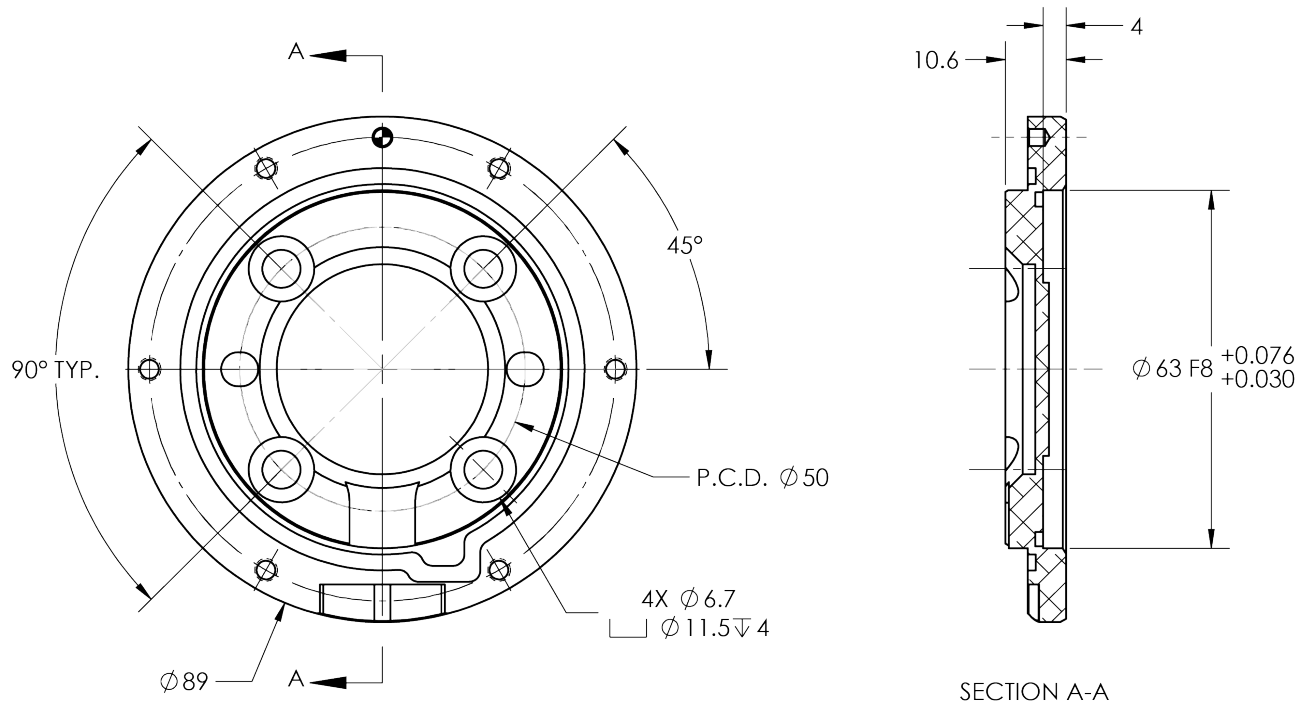


Fig. 5.5: Coupling for ISO 9409-1-50-4-M6

5.5.3. Coupling for ISO 9409-1-315-4-M5

Bolt pattern for coupling FTS-300-S-CPL-029 (please refer to the Spare Parts, Kits and Accessories section) is compatible with: I

- 31.5 mm pitch circle diameter:
 - (4) M5-0.8 button head socket cap screw clearance
 - (1) M5 dowel pin
 - ISO 9409-1 standard 31.5-4-M5

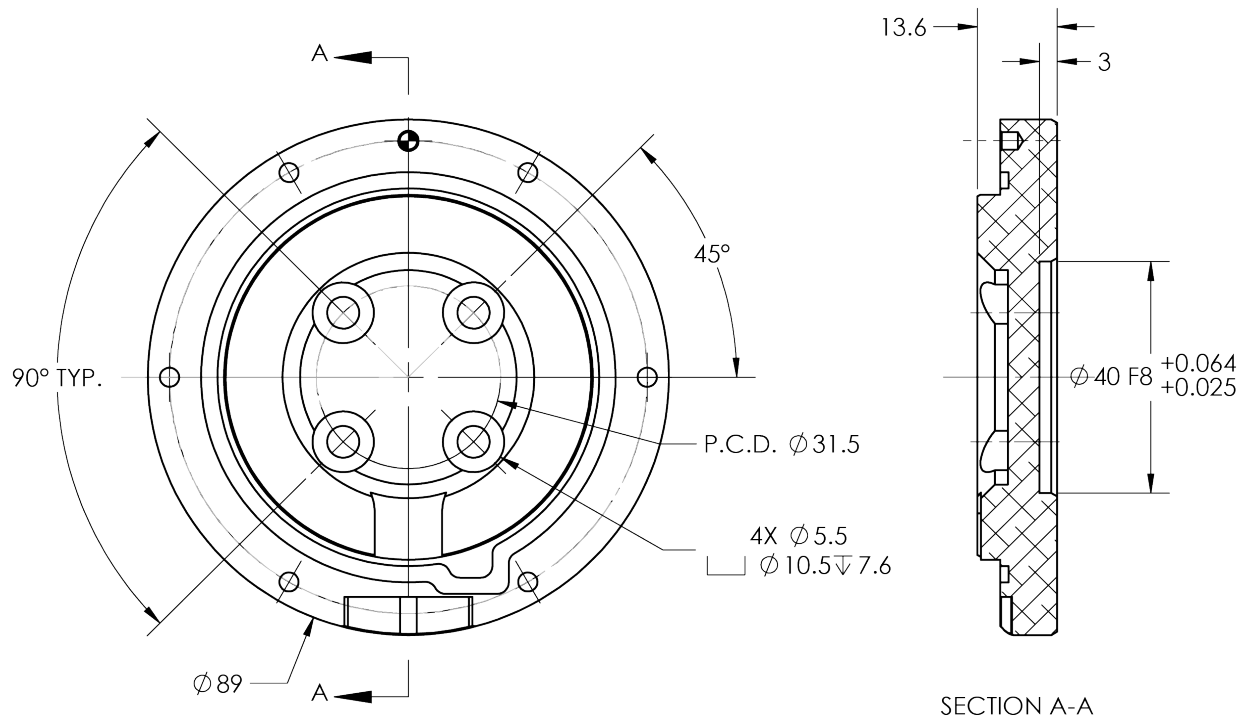


Fig. 5.6: Coupling for ISO 9409-1-40-4-M6

5.5.4. Coupling for ISO 9409-1-40-4-M6

Bolt pattern for coupling FTS-300-S-CPL-030 (please refer to the Spare Parts, Kits and Accessories section) is compatible with:

- 40 mm pitch circle diameter:
 - (4) M6-1.0 button head socket cap screw clearance
 - (1) M6 dowel pin
 - ISO 9409-1 standard 40-4-M6

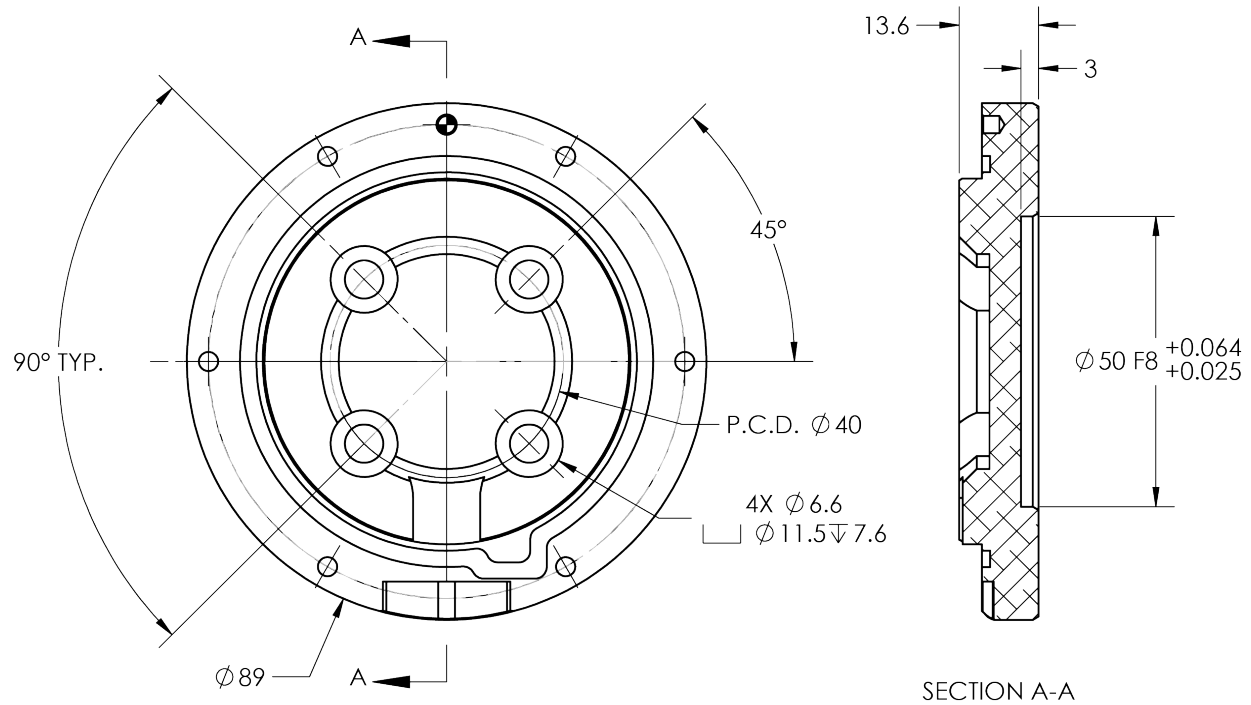


Fig. 5.7: Coupling for ISO 9409-1-31.5-4-M5.

5.5.5. Coupling for P.C.D. 39 and 8 x M3

Bolt pattern for coupling FTS-300-S-CPL-031 (please refer to the Spare Parts, Kits and Accessories section) is compatible with:

- 39 mm pitch circle diameter:
 - (8) M3-0.5 button head socket cap screw clearance
 - (1) M3 dowel pin

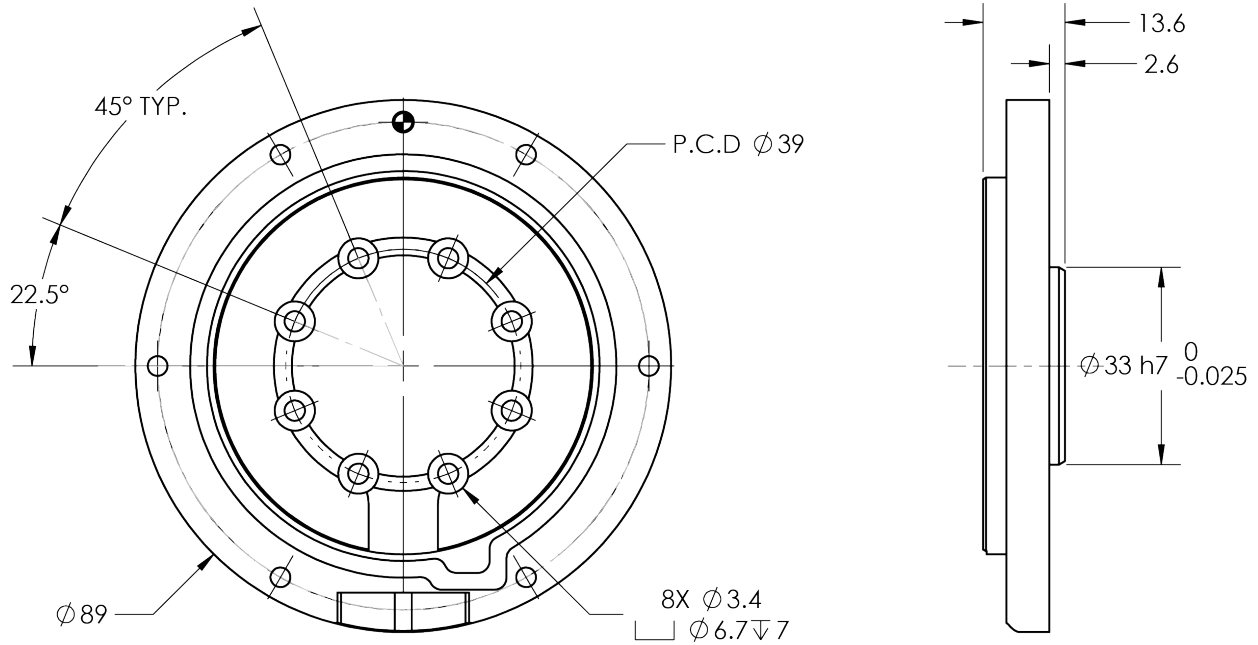


Fig. 5.8: Coupling for ISO 9409-1-50-4-M6

6. Maintenance

The Robotiq Force Torque Sensor requires only external maintenance with limited downtime.

Maintenance of the Sensor is required after specified usage, measured in time (normal 40h week). Respecting the maintenance interval will ensure:

- Correct functioning of your Sensor.
- Validity of your warranty.
- Proper lifetime for your Sensor.

Please visit support.robotiq.com for details on the maintenance operation.

Warning

Unless otherwise specified, any repairs done on the FT 300-S Force Torque Sensor will be done by Robotiq.

6.1 Maintenance Intervals

Operation	Daily	Weekly	Semiannually
Zero calibration	X ¹		
Sensor cleaning	Dirty conditions	Normal conditions	
Periodic inspection			X ²

¹Zero calibration should be integrated into the program routine. This will compensate for the tool weight (for its current orientation), the effect of the attachment mechanisms on the Sensor and any other factors which could affect the readings. It is recommended to add this instruction when the robot is not applying force on its environment and when the tool is in the same orientation as when the readings will be used (for example at the beginning of the program or just before picking up an object or applying force).

²If there is any visible damage to the Sensor, contact support@robotiq.com.



6.2. Cable replacement procedure

Caution

Make sure the Force Torque Sensor is mounted on the robot when repairing the cable. This allows the o-ring to be well compressed.

1. Unplug M12 connector between 1m pigtail cable and the 10m cable.
2. Unscrew the sensor cable with a T20 screwdriver (not provided).
3. Clean the contact surface with a dry cloth.
4. Spread the paste supplied on the gasket of the new connector and on the contact surface of the sensor.
5. Insert the cable connector into the sensor.

Tip

You may need to apply light pressure for the connector to seat fully.

6. Secure the connector with the provided screw and tooth lock washer.
7. Wipe off excess paste.



7. Spare Parts, Kits and Accessories

Caution

The following list is up to date at print time and is subject to change, check online for updates.

Info

Unless specified, screws, dowel pins and other hardware are included only for the Sensor side, never for the robot side.

Info

For Spare Parts and kits before the update of FT 300-S Torque Sensor, please consult the instruction manual available in the **Archives** section of our [support website](#).

Item	Description	Ordering Number
FT 300-S Sensor Standard Kit	Robotiq Force Torque Sensor , includes cable and USB converter.	FTS-300-S-KIT-001
Sensor	Replacement sensor, sensor alone.	FTS-300-S-SEN-001
Blank coupling	Blank coupling with FT bolt pattern on one side and the other side clear.	FTS-300-S-CPL-BLANK
Coupling for ISO 9409-1-50-4-M6	Coupling for 50 mm PCD ¹ (4) M6 thread and (1) 6 mm M6 dowel pin. To be used on UR, TM and Omron robots.	FTS-300-S-CPL-014
Coupling for ISO 9409-1-31.5-4-M5	Coupling for 31.5 mm PCD ¹ (4) M5 thread and (1) 5 mm M5 dowel pin.	FTS-300-S-CPL-029
Coupling for ISO 9409-1-40-4-M6	Coupling for 40 mm PCD ¹ (4) M6 thread and (1) 6 mm M6 dowel pin.	FTS-300-S-CPL-030
Coupling for P.C.D. 39 and 8 x M3	Coupling for 39 mm PCD ¹ (8) M3 thread and (1) 3 mm M3 dowel pin.	FTS-300-S-CPL-031
Robotiq Device Cable	10 m cable for power and communication with the FT Sensor	CBL-COM-2073-10-HF

¹Pitch Circle Diameter



8. Troubleshooting

The following are some common troubleshooting hints, if you need further assistance please contact support@robotiq.com.

8.1 General troubleshooting

8.11 An offset has appeared in the Sensor data

- Changes in ambient conditions can cause an offset in the sensor signals.
- An offset can also be caused if the sealing o-rings are displaced during an overload.
- These offsets do not account for a de-calibration of the Sensor as they are in fact recognized as effort applied to the Sensor. Any additional force applied on the tool side of the Sensor will be read normally.
- In all cases, it is recommended to have a software offset which compensates for these variations in addition to the effort caused by the tool weight for a given orientation. It is preferable to set the software offset before starting to use the sensor data such that the robot software uses a proper and consistent reference.

8.12. Procedure to determine if the Sensor is functional

- Verify that the Sensor is connected according to the Installation section of this manual.
- Power-off the Sensor and then connect the provided USB/RS485 converter to a USB port of a Windows PC.
 - In the Windows PC, open the Device Manager.
 - You should see a USB Serial Port device in the Ports (COM & LPT) category. If not, it is possible that the converter drivers have not installed automatically. You can download the drivers from the ftdichip.com website.
- Power the Sensor with the recommended voltage.
- Download the simple data logger application at support.robotiq.com
- Run the data logger application. Enter 100 for the number of data per 10 seconds and any file name (for example "test.csv").
- Verify that the sensor data is displayed in the Windows console application.



8.2. Troubleshooting on other platforms

8.2.1 USB converter detected as a mouse by Windows

- In Windows, the USB converter is sometimes detected as a mouse, making the cursor move. This a well know problem in Windows: <http://support.microsoft.com/kb/819036>
- A simple workaround is to plug in the USB converter before powering the Sensor. Once the USB driver is initialized in Windows, the Sensor can be powered and used without a problem.

8.2.2. Data frequency under 100 Hz in Windows

- By default, the USB to RS485 converter has a latency setting of 16 ms in Windows (1 ms in Linux), which will prevent the application software from receiving new messages at 100 Hz (it will often read two sensor messages in the buffer at the same time).
- In the Windows Device Manager, right click on the virtual COM port for the Sensor and select **Properties**. In the **Port settings** tab, click on **Advanced**. Adjust the latency timer to **9 ms** (it is not recommended to lower it too much in Windows since other connectivity issues may arise), then click **OK**.

8.2.3. In Linux, the serial port cannot be opened

- By default, a user does not have access to the serial ports.
- It is possible to provide this access by adding the user to the dialout group with the following command:

```
rd@debian:~/$ sudo usermod -a -G dialout username
```



9. Harmonized Standards, Declarations and Certificates

9.1 Original EU Declaration of Conformity



EU Declaration of Conformity (Original)

We, the manufacturer:

Robotiq Inc.
966 Chemin Olivier, Suite 500
Lévis, Québec, Canada, G7A 2N1

hereby declares, under sole responsibility, that the product:

FT 300-S
All serial number
(and accessories)

is in conformity with the relevant Union harmonisation legislation, namely complies with the following European Directives and harmonised standards:

- 2014/30/EU (EMC Directive)
 - EN 61000-6-2:2016
 - EN 61000-6-4:2007 + A1:2011
- 2011/65/EU + 2015/863 (RoHS Directive)
 - EN 50581:2012
- 2012/19/EU (WEEE Directive)
 - EN 50419:2005.

The manufacturer also declares the use of these other technical standards, as far as applicable:

ISO 9409-1:2004.

Name and address of the person authorised to compile the relevant technical documentation:

Nicolas Tremblay, CEP, see manufacturer address.

The relevant technical documentation is compiled in accordance with Annex II of Directive 2014/30/EU and will be presented electronically by the manufacturer to competent national authorities, if required with a substantiated reason.

Signed in Lévis on March 1st, 2021

Louis-Alexis Allen Demers, ing., Eng., Ph. D.
Hardware Director



9.2. Applied standards

This section describes all applied harmonized standards for the design and production of the Robotiq FT 300-S Force Torque Sensor. Standards are applied where applicable, some points may not be applied if not applicable to this specific product. Conformity is not enforced by any laws, it is self-applied and the aim is to define normal safety and performance requirements for similar products.

Info

Conformity of the product is only met if all instructions of the following manual are followed. Among others; installation, safety measure and normal usage must be respected.

The following standards have been applied:

EN 61000-6-2	2016	Generic standards – Immunity standard for industrial environments
EN 61000-6-4	2007 + A1: 2011	Generic standards – Emission standard for industrial environments
ISO 9409-1	2004	Manipulating industrial robots – Mechanical interfaces – Part 1: Plates



9.3. Ingress Protection Certification



National Technical Systems Canada Inc.

2425 Boulevard Industriel

Chambly, QC

J3L 4W3, Canada

Phone: 450-868-0360

Fax: 450-868-0351

TEST CERTIFICATE

Product Name: Force Torque Sensor FT-300

Manufacturer: Robotiq

Part No.: FT-300-S

Serial Number: G-P3203

Applicant: Robotiq

We, National Technical Systems Canada Inc. declare that the product above has been tested in our facility and found compliance with the applicable essential requirements of standards herein specified.

Note:

- Tests were performed on November 9th, 10th & 13th 2020.
- No modifications have been incorporated in the product during the qualification tests.
- All information's about the qualification tests are presented in the test report **FTR0555597**.
- This test certificate do not in any situation, supersede official test report **FTR0555597**.

Test Certificate: TC-0555597
Issued: 01/20/2021

F-050 R02



Test Name Standards	Test Specifications	Results
Ingress protection against access to hazardous parts – Rod Standard IEC 60259:2013	Code IP6X	PASS
Ingress protection against solid foreign objects – Dust Standard IEC 60259:2013	Code IP6X	PASS
Ingress protection against water Standard IEC 60259:2013	Code IPX4	PASS
Ingress protection against water Standard IEC 60259:2013	Code IPX5	PASS



Alexandre Beausoleil

Digitally signed by
Alexandre Beausoleil
Date: 2021.01.20
11:39:41 -05'00'

Alexandre Beausoleil / ENV & DYN Lab. Manager

Test Certificate: TC-0555597
Issued: 01/20/2021

F-050 R02



10. Warranty

Robotiq warrants the FT 300-S Force Torque Sensor against defects in material and workmanship for a period of one year from the date of reception when utilized as intended with the specified maintenance. Robotiq also warrants that this equipment will meet applicable specifications under normal use.

Caution

Warranty applies under the following conditions:

- Usage respects the operating, transporting and storage conditions specified in the **Environmental and Operating Conditions** section
- Usage under normal one-shift operation (40h a week)
- Usage respects maintenance specified in the **Maintenance** section

During the warranty period, Robotiq will repair or replace any defective product, as well as verify and adjust the product free of charge if the equipment should need to be repaired or if the original adjustment is erroneous. If the equipment is sent back for verification during the warranty period and found to meet all published specifications, Robotiq will charge standard verification fees.

The unit is considered defective when at least one of the following conditions occurs :

- The Sensor feedback is not accessible;
- Sensor signal noise is over twice the specified limit.

Caution

The warranty will become null and void if the :

- Unit has been tampered with, repaired or worked on by unauthorized individuals.
- Warranty sticker has been removed.
- Screws, other than as explained in this guide, have been removed.
- Unit has been opened.
- Unit serial number has been altered, erased, or removed.
- Unit has been misused, neglected, or damaged by accident.

This warranty is in lieu of all other warranties expressed, implied, or statutory, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event shall Robotiq be liable for special, incidental, or consequential damages.

Robotiq shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

10.1 Exclusions

Robotiq reserves the right to make changes in the design or construction of any of its products at any time without incurring an obligation to make any changes whatsoever on units already purchased.



This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond Robotiq's control. It also excludes all consumable parts, such as suction cups, and their normal wear.



11 Contact

www.robotiq.com

Contact Us

Phone

1-888-ROBOTIQ (762-6847)

(+1) 418-380-2788 Outside US and Canada

Technical Support

Option 3

Sales

Option 2

Head Office

Robotiq
966, chemin Olivier
Suite 500
Lévis, Québec
G7A 2N1
Canada



Where automation Pros come to share their know-how and get answers.

dof.robotiq.com



