



Original Notice

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**Robotiq FT 300 Force Torque Sensor  
for OMRON TM Series Robots**



LEAN   
**ROBOTICS**  
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# Revisions

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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](https://support.robotiq.com).

**Revision 2019/04/30**

Initial release



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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 Force Torque Sensor" used in the following manual refer to the Robotiq Force Torque Sensor FT 300 unless specified. The Robotiq FT 300 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.

## Info

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

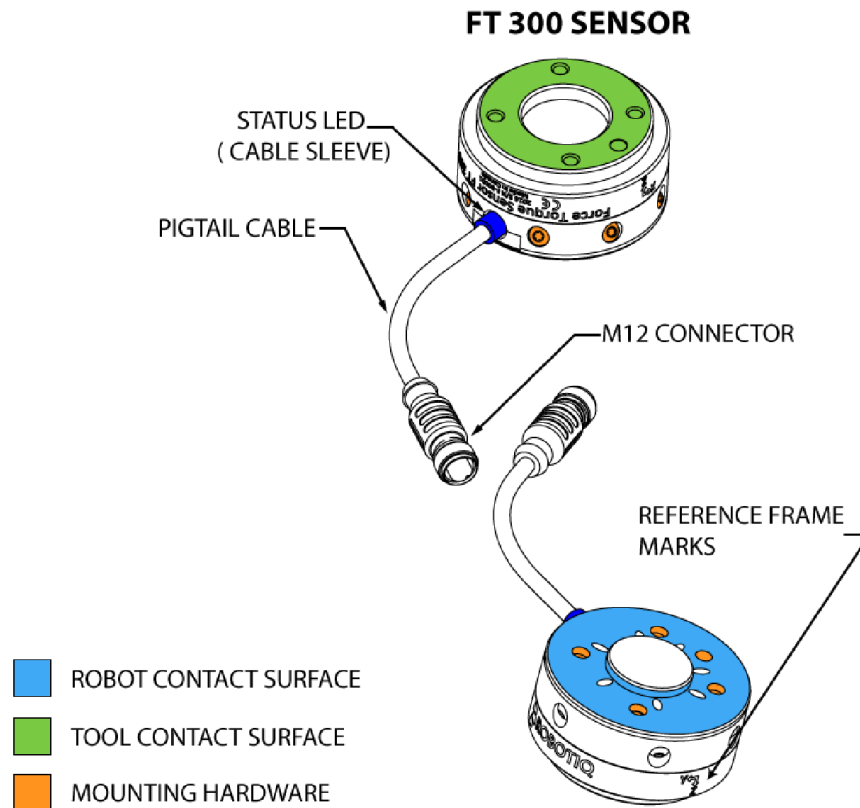


Fig. 1.1: General presentation of the Robotiq Force Torque Sensors with main features.



## 1.1. Main features

### 1.1.1. FT 300 Force Torque Sensor

- 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.

#### Info

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

- The screw positioning for the coupling and the robot mountings are shown in orange. See the Spare Parts section for a list of available Couplings.
- M12 connector (pigtail or mounted) allows for both power and data transfer for the Sensor.
- Status LED provides visual information on the status of the Sensor, see Section 3.7 for details.

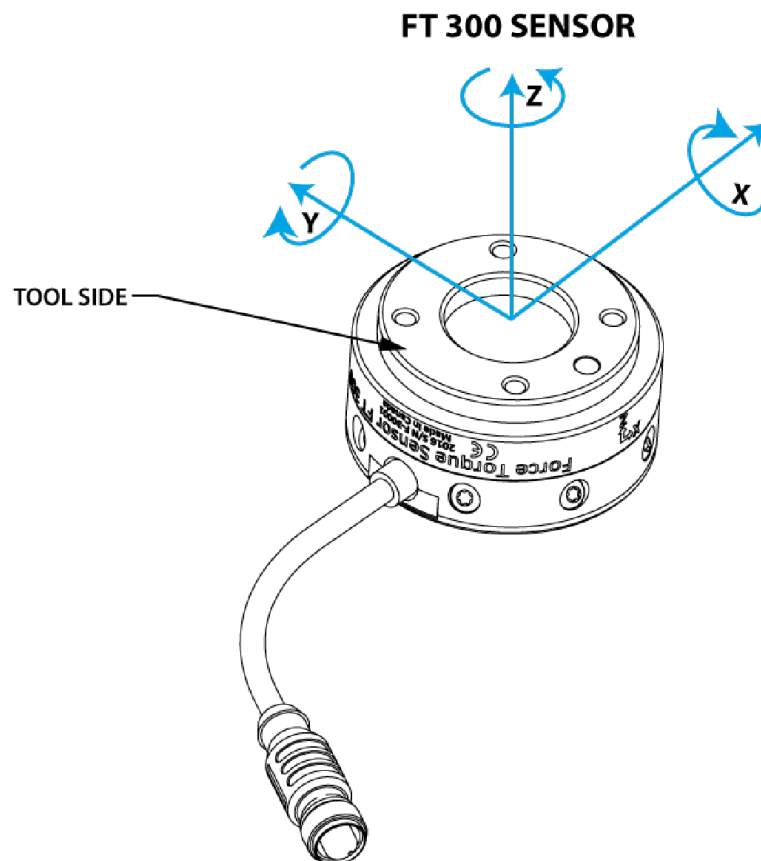


Fig. 1.2: FT 300 Force Torque Sensor force and torque diagrams.





The figure above represents the various force and torques that the FT 300 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.

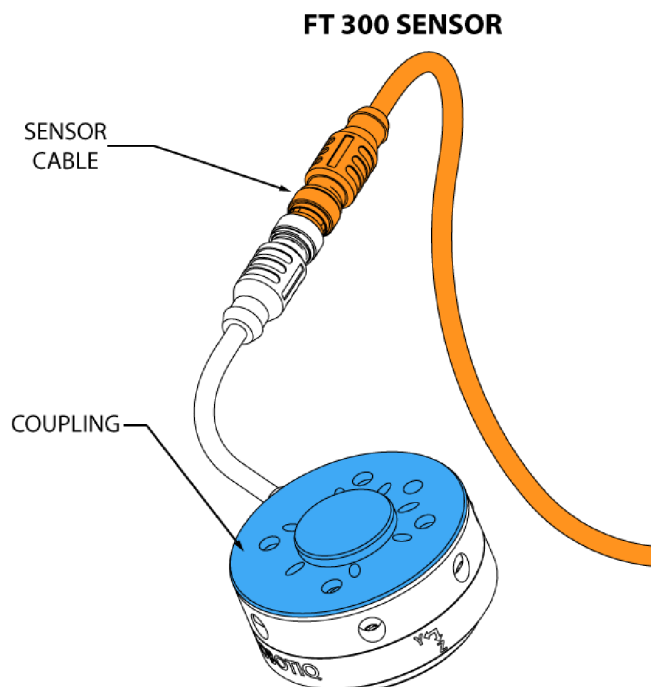


Fig. 1.3: FT 300 Force Torque Sensor options.

The figure above represents various options available. They can be found in the **Spare Parts, Kits and Accessories** section.

- **Couplings** are meant to install the FT 300 Force Torque Sensor on various robot models, see available models.
- **Sensor Cable** is used for power and communications with the FT 300 Force Torque Sensor and is available in different lengths.
- **Mechanical Protector** is meant to protect the cable connector from collisions that can occur when operating the robot (especially useful when in teach mode).
- **Tool Plate** is not shown, but might be required when certain end-of-arm tools are mounted on the FT 300 Force Torque Sensor.

#### Info

Please refer to the **Installation** section for details on the installation of various options.

Several software packages are provided and detailed in the **Software** section of this manual.

#### Tip

It is important to understand that the FT 300 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.



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## 2. Safety

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### 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 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:

#### General Kit

Robotiq Force Torque Sensor FT 300 unit

1 m pigtail cable (CBL-COM-2068-01)

10 m Robotiq Device Cable (CBL-COM-2065-10-HF)

USB Signal Converter (ACC-ADT-USB-RS485)

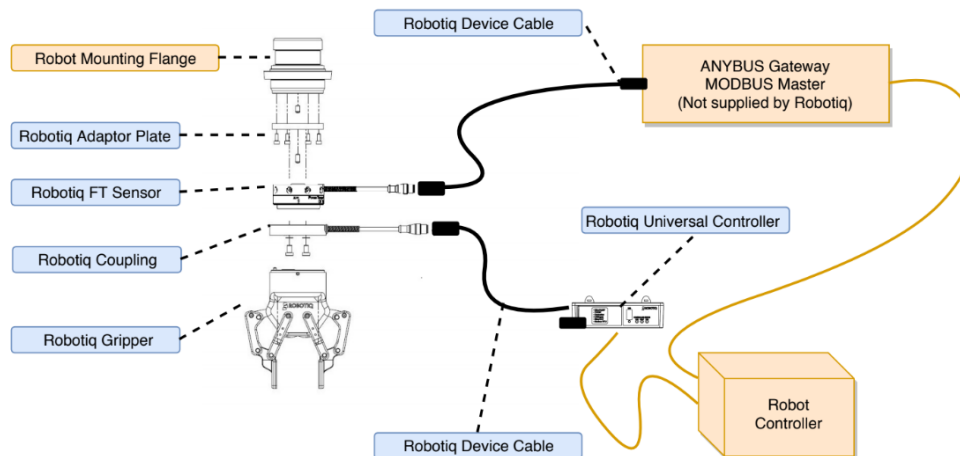


Fig. 3.1: Schema of the required hardware.

## 3.1.1. Options

- Couplings

### Info

Coupling is mandatory for the FT 300.

- Adapter plates
- Tool plates
- Different cable lengths

### 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 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 <sup>1</sup> | 5°C                                                                                                                                                                                                                                          |
| Maximum operating temperature <sup>1</sup> | 40°C                                                                                                                                                                                                                                         |
| Humidity (non-condensing)                  | 20-80% RH                                                                                                                                                                                                                                    |
| Maximum vibration (storage / transit)      | 5G                                                                                                                                                                                                                                           |
| Maximum vibration (operating)              | 2G                                                                                                                                                                                                                                           |
| IP rating                                  | IP 40                                                                                                                                                                                                                                        |
| Other                                      | <ul style="list-style-type: none"> <li>• Free from dust, soot or water</li> <li>• Free from corrosive liquids or gases</li> <li>• Free from explosive liquids or gases</li> <li>• Free from powerful electromagnetic interference</li> </ul> |

<sup>1</sup>Refer to the **Signal Specifications** section for details on temperature compensation range.

## 3.3. Mechanical Connections

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 or Robotiq can create a custom version for you. 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 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 figure below). Note that all screws must be locked in place using medium strength threadlocker, such as *Loctite 248* or a similar product.



1. Align the indexing dowel pin between the coupling and the robot (usually press fitted to the robot).
2. Screw the coupling to the robot with the robot mounting screws (with lock washers if provided) and threadlocker.
3. Align the Sensor indexing dowel pins (prefixed to the Sensor) to the coupling.
4. Screw the Sensor to the coupling using the coupling mounting screws (with lock washers if provided) and threadlocker.

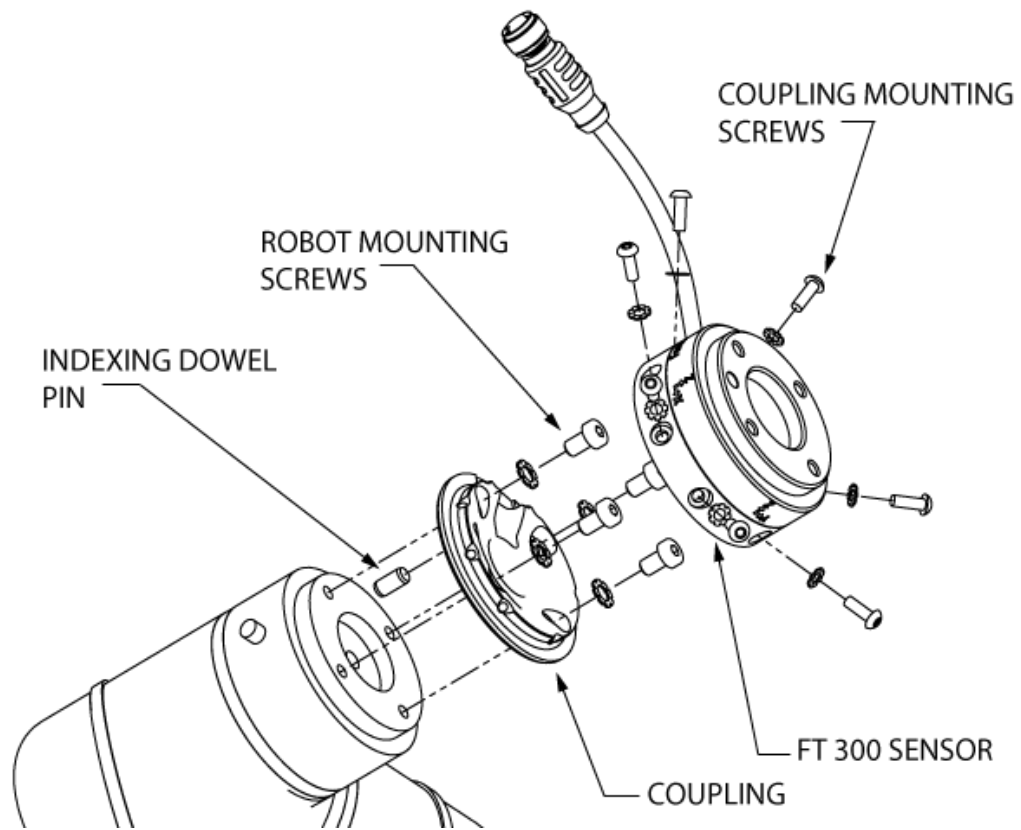


Fig. 3.2: Attaching the FT 300 sensor to a robot arm using the mandatory coupling.





## 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      | <div style="border: 2px solid red; padding: 5px;"> <p><b>Warning</b></p> <p>Maximum output voltage tolerance is 10%, exceeding this limit, 26.4 V DC could damage the Sensor.</p> </div> |

### Info

Robotiq recommends the use of the following power supply:

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



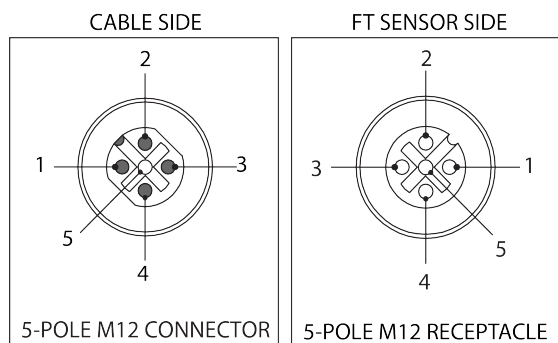
## 3.5. Wiring

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

The figure below represents the FT 300 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.



| PIN | END OF CABLE COLOR | SIGNAL  |
|-----|--------------------|---------|
| 1.  | (SHIELD)           | 485 GND |
| 2.  | RED                | 24 V    |
| 3.  | BLACK              | GND     |
| 4.  | WHITE              | 485 +   |
| 5.  | GREEN              | 485 -   |

Fig. 3.3: Pinout of the Robotiq Force Torque Sensor FT 300 and color code for the respective cable type.

### Info

Power pins 2 & 3 are connected to the specified power supply.

### 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.



### 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.

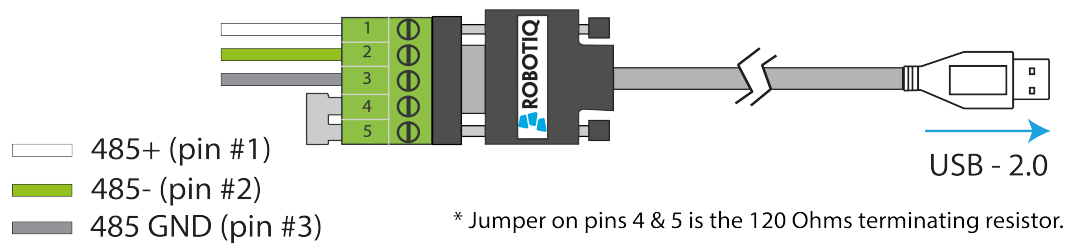


Fig. 3.4: Wiring diagram for the RS485 to USB converter

#### 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.

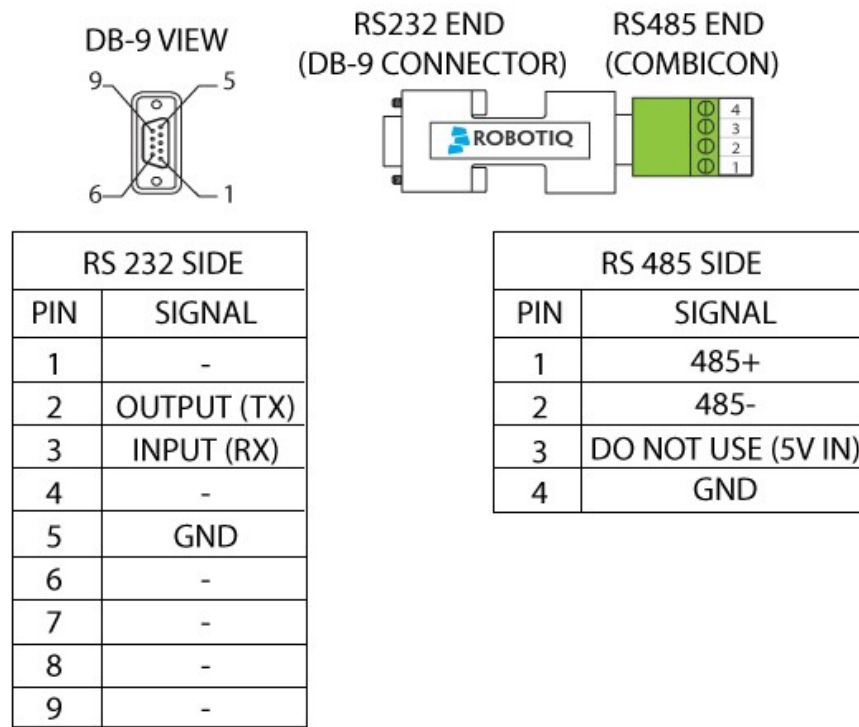


Fig. 3.5: Wiring diagram for RS232 to RS485 converter.



## 3.6. Status LED

A single status LED provides information on both Sensors, detailed information can be found in the tables below, while a representation of both Sensor status LEDs is shown in the figure below.

On the FT 300 Sensor, the cable sleeve is the LED conductor:

| COLOR      | LED STATE | INFORMATION                                            |
|------------|-----------|--------------------------------------------------------|
| -          | off       | No power                                               |
| Blue / red | on        | FT 300 Sensor is booting                               |
| Red        | on        | FT 300 Sensor is functional, no communication detected |
| Red        | blinking  | FT 300 Sensor fault detected                           |
| Blue       | on        | FT 300 Sensor is functional, communication established |

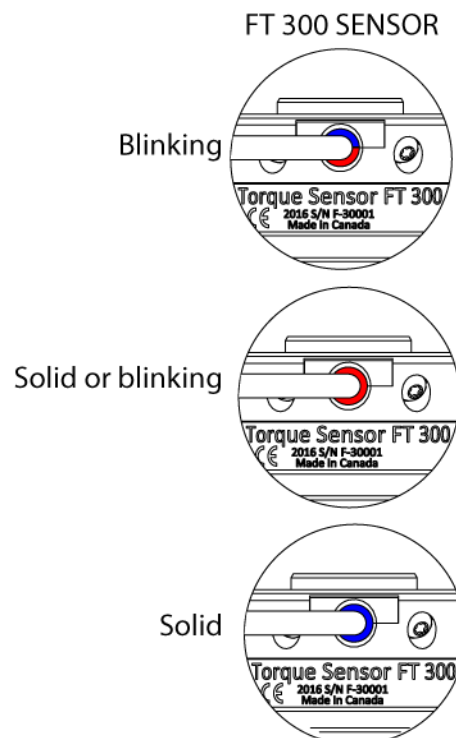


Fig. 3.6: FT Sensor status LED.



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## 4. Software

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- 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 links to ROS.
- Section 4.3 explains the Demo Software
- Section 4.4 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](http://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.

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```

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```



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LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN  
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POSSIBILITY OF SUCH DAMAGE.





## 4.1.2. 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.



## 4.1.3. 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.

```

C:\Users\rd\Desktop\driver\Windows\bin\driverSensor.exe
< 1.760000 , -2.690000 , 0.650000 , 0.044000 , -0.031000 , -0.156000 >
< 1.760000 , -2.690000 , 0.650000 , 0.044000 , -0.031000 , -0.156000 >
< 1.740000 , -2.630000 , 0.580000 , 0.040000 , -0.034000 , -0.174000 >
< 1.740000 , -2.630000 , 0.580000 , 0.040000 , -0.034000 , -0.174000 >
< 2.080000 , -2.910000 , 0.950000 , 0.043000 , -0.032000 , -0.167000 >
< 1.490000 , -2.550000 , 0.870000 , 0.046000 , -0.036000 , -0.164000 >
< 1.490000 , -2.550000 , 0.870000 , 0.046000 , -0.036000 , -0.164000 >
< 1.160000 , -3.070000 , 0.570000 , 0.041000 , -0.027000 , -0.164000 >
< 1.160000 , -3.070000 , 0.570000 , 0.041000 , -0.027000 , -0.164000 >
< 1.540000 , -2.870000 , 0.860000 , 0.043000 , -0.011000 , -0.173000 >

```

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.



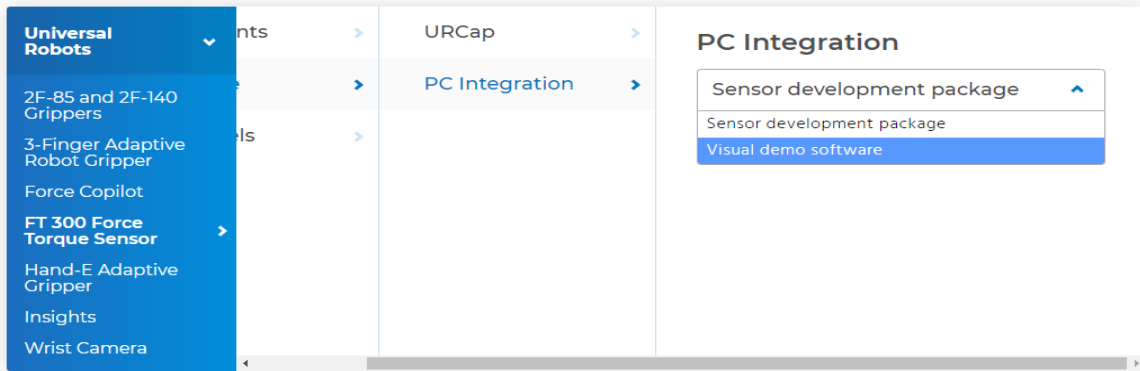
## 4.2. Visual Demo Software

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](http://support.robotiq.com).

Support

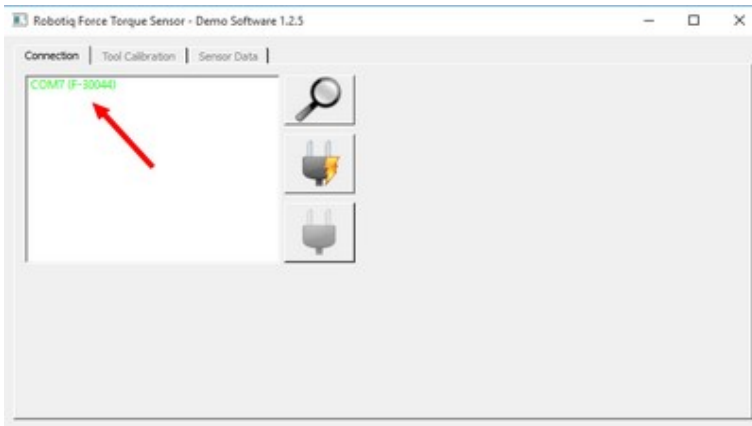


- 2 Copy all the files of this folder onto a PC.
- 3 Connect the USB connector to the converter attached to the PC. Important : The Sensor must NOT be powered at this time.
- 4 Wait while the driver(s) install. After all the drivers have been installed.
- 5 Plug the Sensor cable into the Sensor.
- 6 Connect the Sensor cable to the power supply.
- 7 Launch the demo application.

| File Name              | Modified             | Type                  | Size     |
|------------------------|----------------------|-----------------------|----------|
| instructions           | 2014-09-19 4:41 PM   | Text Document         | 1 KB     |
| libgcc_s_dw2-1.dll     | 2009-06-22 3:42 PM   | Application extens... | 42 KB    |
| libstdc++-6.dll        | 2011-12-01 7:30 PM   | Application extens... | 958 KB   |
| mingwm10.dll           | 2009-01-10 1:32 PM   | Application extens... | 12 KB    |
| QtCore4.dll            | 2014-01-13 3:11 PM   | Application extens... | 2,479 KB |
| QtGui4.dll             | 2010-09-10 8:32 AM   | Application extens... | 9,632 KB |
| QtNetwork4.dll         | 2010-09-10 8:07 AM   | Application extens... | 1,114 KB |
| robotiq_FT_sensor_demo | 2016-02-17 12:01 ... | Application           | 937 KB   |



- 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](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](http://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)<br>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  |
| 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 | $F_x * 100$ (N)   |
| data2 | $F_y * 100$ (N)   |
| data3 | $F_z * 100$ (N)   |
| data4 | $M_x * 1000$ (Nm) |
| data5 | $M_y * 1000$ (Nm) |
| data6 | $M_z * 1000$ (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](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

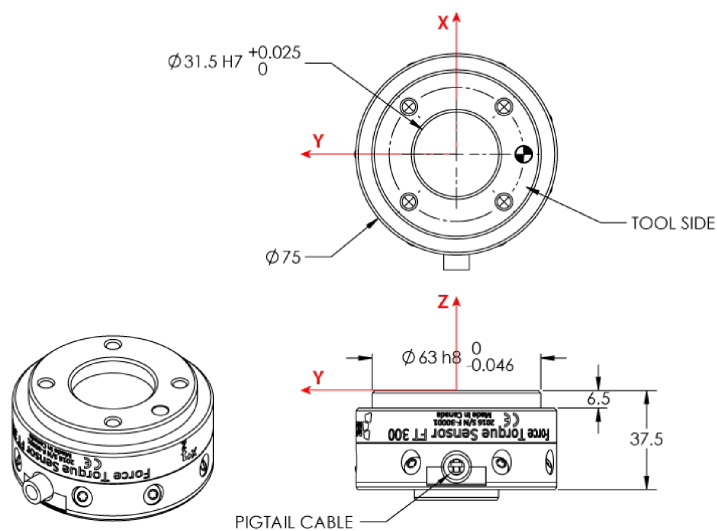


Fig. 5.1: Robotiq FT 300 Sensor general technical dimensions.

#### Info

Reminder: Measures are in millimeters.



## 5.1.1. Tool Side Bolt Pattern

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

- Bolt pattern diameter is 50 mm
- Mounting holes are M6 thread, 6 mm deep.
- Indexing hole for M6 dowel pin has a tight fit (H7) and 6 mm deep.
- Outside diameter of the flange is 64 mm and inside is 45 mm.

### Info

FT 300 tool side bolt pattern matches ISO-9409-1-50-4M6.

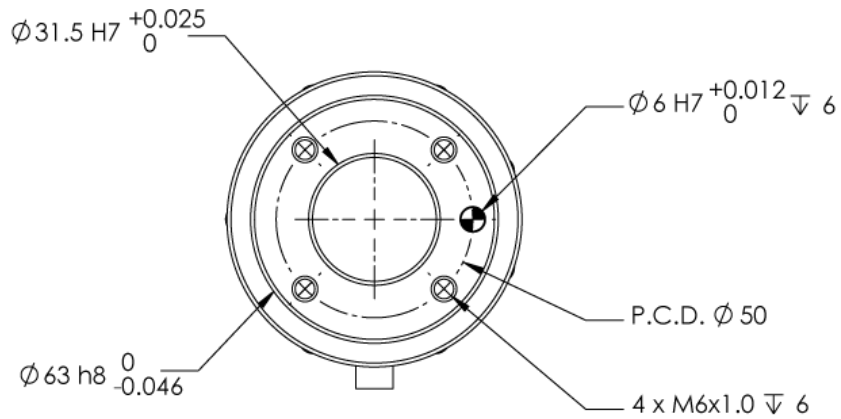


Fig. 5.2: FT 300 Sensor tool side bolt pattern.



## 5.2. Mechanical Specifications

### Info

Reminder: all units are within the metric measurement system.

| SPECIFICATION      |            | VALUE                                                                                                                                                                         |
|--------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Approximate weight |            | 300 g                                                                                                                                                                         |
| Overload capacity  |            | A combined load exceeding 500% of the measuring range will permanently damage the Force Torque Sensor<br>( $F_x/300 + F_y/300 + F_z/300 + M_x/30 + M_y/30 + M_z/30 < 500\%$ ) |
| Outside diameter   |            | 75 mm                                                                                                                                                                         |
| Thickness          |            | 37.5 mm                                                                                                                                                                       |
| Stiffness          | $F_x, F_y$ | $35 \times 10^6$ N/m                                                                                                                                                          |
|                    | $F_z$      | $30 \times 10^6$ N/m                                                                                                                                                          |
|                    | $M_x, M_y$ | 10,000 Nm/rad                                                                                                                                                                 |
|                    | $M_z$      | 20,000 Nm/rad                                                                                                                                                                 |

<sup>1</sup>Expected rating, certification is planned and will be forthcoming (see manual revision date).



## 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 figure below.

### Info

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

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

| Sensor | Combination                   | x (mm) | y (mm) | z (mm) | Mass (g) |
|--------|-------------------------------|--------|--------|--------|----------|
| FT 300 | -                             | 0      | 0      | 17     | 300      |
|        | 2-Finger 85                   | 0      | 0      | 76     | 1205     |
|        | 2-Finger 140                  | 0      | 0      | 83     | 1275     |
|        | Wrist Camera                  | 0      | 2      | 30     | 530      |
|        | Wrist Camera and 2-Finger 85  | 0      | 1      | 77     | 1275     |
|        | Wrist Camera and 2-Finger 140 | 0      | 1      | 85     | 1340     |

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

$$\begin{array}{c} \text{FT 300} \\ \\ \mathbf{I} = \begin{bmatrix} I_{xx} & I_{xy} & I_{xz} \\ I_{yx} & I_{yy} & I_{yz} \\ I_{zx} & I_{zy} & I_{zz} \end{bmatrix} = \begin{bmatrix} 262 & 0 & 1 \\ 0 & 265 & 1 \\ -1 & 1 & 219 \end{bmatrix} \text{ kg} \cdot \text{mm}^2 \end{array}$$

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





## 5.2.2. Overload Capacity

The FT 300 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 <sup>1</sup> |
|--------|-----------------|--------------------------------|
| FT 300 | +/- 300 N       | 1500 N (500%) <sup>2</sup>     |

<sup>1</sup>Overload capacity with all axes combined.

<sup>2</sup>Maximum 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

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



## 5.3. Signal Specifications

| SPECIFICATION                                 |        | FT 300<br>(prior to 10/2017) | FT 300   |
|-----------------------------------------------|--------|------------------------------|----------|
| Measuring range                               | Force  | $\pm 300$ N                  |          |
|                                               | Torque | $\pm 30$ Nm                  |          |
| Signal noise*                                 | Fx, Fy | 1.2 N                        | 0.1 N    |
|                                               | Fz     | 0.5 N                        | 0.1 N    |
|                                               | Mx, My | 0.02 Nm                      | 0.005 Nm |
|                                               | Mz     | 0.03 Nm                      | 0.003 Nm |
| Recommended threshold when mounted on a robot | Fx, Fy | 5 N                          | 1 N      |
|                                               | Fz     | 2 N                          | 1 N      |
|                                               | Mx, My | 0.08 Nm                      | 0.02 Nm  |
|                                               | Mz     | 0.12 Nm                      | 0.01 Nm  |
| External noise sensitivity**                  |        | Immune                       |          |
| Data output rate                              |        | 100 Hz                       |          |
| Temperature compensation***                   |        | 15 to 35 °C                  |          |

Table 5 - 1: Signal Specifications

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

\*\*Under normal operating conditions

### Caution

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

\*\*\*Specifications 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, 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 V DC $\pm$ 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 <i>15W Single Output DIN Rail Mount Power Supply</i> ,<br><b>DPP15-24</b> |



## 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 indexing pins are not provided.**



## 5.5.1. Blank Coupling

The figure below schematics represent the optional blank coupling for the FT 300 Sensor :

- (7) M4 threads and the 63 mm (H8) circle are meant to affix the FT 300.
- The circular section of 75 mm diameter (blue section in the figure below) represents the customization area and has a depth of 5 mm.

### Warning

Make sure your custom design does not interfere with the M4 threads or the 63 mm, H8 centering circle.

- Spare part list number is FTS-300-CPL-BLANK.

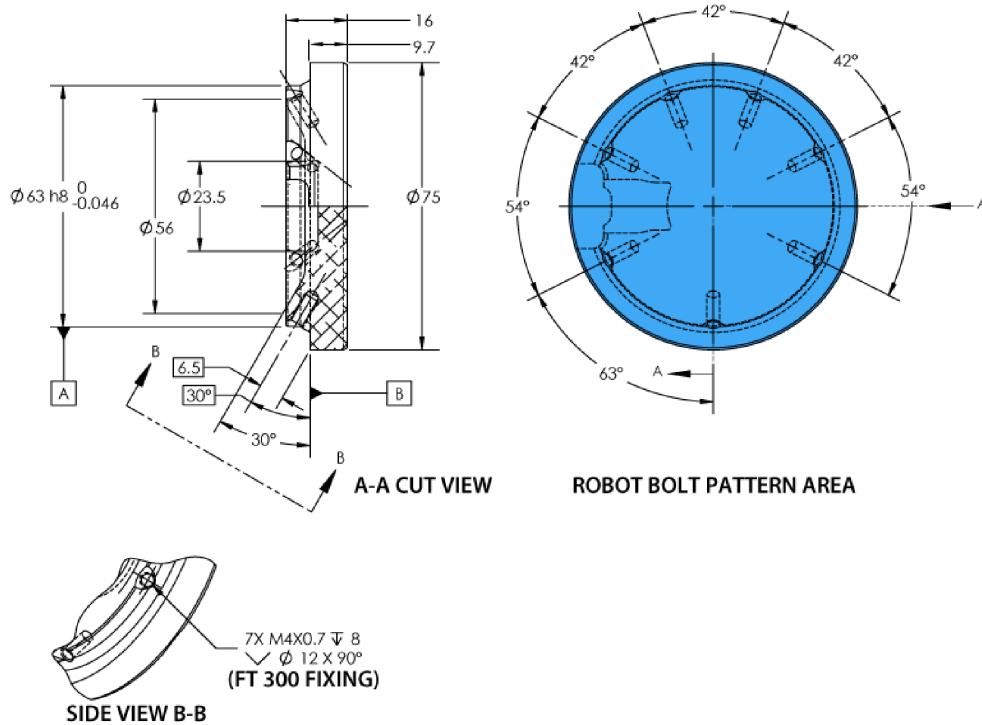


Fig. 5.4: Technical dimensions of the blank coupling for the FT 300.



## 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](https://support.robotiq.com) for details on the maintenance operation.

### Warning

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

### 6.1. Maintenance Intervals

| Operation           | Daily            | Weekly            | Semiannually |
|---------------------|------------------|-------------------|--------------|
| Zero calibration    | X1               |                   |              |
| Sensor cleaning     | Dirty conditions | Normal conditions |              |
| Periodic inspection |                  |                   | X2           |

<sup>1</sup>Zero 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).

<sup>2</sup>If there is any visible damage to the Sensor, contact [support@robotiq.com](mailto:support@robotiq.com).



## 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.

| Item                            | Description                                                                                              | Ordering Number   |
|---------------------------------|----------------------------------------------------------------------------------------------------------|-------------------|
| Standard Kit                    | Robotiq Force Torque Sensor FT, includes cable and USB converter.                                        | FTS-300-KIT-001   |
| Kit for <i>Universal Robots</i> | Standard Sensor with Couplings for <i>Universal Robots</i> and software package.                         | FTS-300-UR-KIT    |
| Sensor                          | Replacement sensor, sensor alone.                                                                        | FTS-300-SEN-001   |
| Blank coupling                  | Blank coupling with FT bolt pattern on one side and the other side clear.                                | FTS-300-CPL-BLANK |
| Coupling 50-4M6-1D6             | Coupling for 50 mm PCD <sup>1</sup> (4) M6 thread and (1) 6 mm M6 indexing pin. To be used on UR robots. | FTS-300-CPL-062   |
| Coupling 39-8M3-1D3             | Coupling for 39 mm PCD <sup>1</sup> (8) M3 thread and (1) 3 mm indexing pin.                             | FTS-300-CPL-069   |
| Coupling 40-4M6-1D6             | Coupling for 40 mm PCD <sup>1</sup> (4) M6 thread and (1) 6 mm M6 indexing pin.                          | FTS-300-CPL-064   |
| Coupling 31_5-4M5-1D5           | Coupling for 31.5 mm PCD <sup>1</sup> (4) M5 thread and (1) 5 mm M6 indexing pin.                        | FTS-300-CPL-063   |
| Robotiq Device Cable            | 5 or 10 m cable for power and communication with the FT Sensor                                           | CBL-COM-2067-10   |

<sup>1</sup>Pitch Circle Diameter





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# 8. Troubleshooting

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The following are some common troubleshooting hints, if you need further assistance please contact [support@robotiq.com](mailto:support@robotiq.com).

## 8.1. General troubleshooting

### 8.1.1. 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.

### 8.1.2. Procedure to determine if the Sensor is functional

- Verify that the Sensor is connected according to the Installation section of this manual.
- When powered, verify that the LED on the Sensor is blue (not red/blue). FT 300 LED is red if powered without communication, blue if powered with communication. For detailed information on the LED status, refer to the **Status LED** section.
- 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](http://ftdichip.com) website.
- Power the Sensor with the recommended voltage.
- Download the simple data logger application at [support.robotiq.com](http://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 is a well known 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. Warranty

Robotiq warrants the FT 300 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.



## 9.1. 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.



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# 10. Contact

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[www.robotiq.com](http://www.robotiq.com)

## Contact Us

### Phone

1-888-ROBOTIQ (762-6847)

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

### Fax

1-418-800-0046

### 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](http://dof.robotiq.com)





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# Appendices

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## Appendix A – Translation of Original EC Declaration of Incorporation



### Translation of original declaration of incorporation

In terms of the Directive 2006/42/EC, Annex II, part B of the European Parliament and of the Council on machinery,

We, the manufacturer,                      Robotiq Inc.  
                                                            966, Chemin Olivier, suite 325  
                                                            Lévis, Québec, Canada, G7A 2N1

Hereby declare that the following product:

Robotiq Force Torque Sensor FT 150 & FT 300  
Identified F-1001 / G-1001 and over

Meets the applicable basic requirements of the Machinery Directive 2006/42/EC

The incomplete machine may not be put into operation until conformity of the machine into which the incomplete machine is to be installed with the provisions of the Machinery Directive is confirmed. Compliance with all essential requirements of Machinery Directive relies on the specific robot application and overall risk assessment.

The manufacturer agrees to forward on demand of national authorities the relevant technical documents specified by Annex VII part B within the required time.

Additionally the product declares in conformity with the following directives, according to which the product is CE marked:

2014/30/EU      Electromagnetic Compatibility Directive (EMC)

2011/65/EU      Restriction of the use of certain hazardous substances (ROHS)

Person responsible for documentation: Mr. Étienne Samson, address: see manufacturer address

Lévis, July 2016  
(place and date of emission)

A handwritten signature in black ink, appearing to read 'JP Jobin'.

Jean-Philippe Jobin  
Chief Technical Officer  
Robotiq Inc.



## Appendix B – Applied Standards

This section describes all applied harmonized standards for the design and production of the Robotiq Force Torque Sensor FT 300. 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:

|                   |      |                                                                                          |
|-------------------|------|------------------------------------------------------------------------------------------|
| NF EN ISO 12100   | 2010 | Safety of machinery — General principles for design — Risk assessment and risk reduction |
| NF EN IEC 60204-1 | 2006 | Safety of machinery — Electrical equipment of machines — Part 1: General requirements    |

