OPTOFORCE USER GUIDE

FOR

UNIVERSAL ROBOTS

Version 1.2

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CONTENT

1. GETTING STARTED

All provided parts are required to be able to connect the OptoForce force/torque sensor (with CAN-Ethernet v1.6x) to your Universal Robot. Here is a step by step guide:

1) Install the sensor to the robot. For more information, go to the **SENSOR MOUNTING** section.

2) Connect the 4 pin M8 cable (5m long) to the sensor and secure it to the robot, with cable ties. *Be careful to have enough extra cable around the joints for the bending.*

3) Place the DAQ somewhere near or inside the UR robot Control BOX and connect the 4 pin M8 sensor cable. The provided cable gland (size PG16) can be used to lead in/out the cable from the UR Control BOX.

4) Connect the DAQ 's Ethernet interface with the UR controller's Ethernet interface via the supplied UTP cable (yellow).

5) Use the 3 pin M8 cable (1m long) to power the OptoForce force/torque sensor from the Control BOX. (Please see the UR documentation, if you have difficulties to find the extra 24V power source in the Control BOX)

6) The correct network settings must be applied both on the Ethernet converter and on the UR robot. The default Ethernet converter IP address is 192.168.1.1. If you need to change that sensor IP address please refer to Section 5.

7) Insert the supplied USB stick into the Teach Pendant, which will automatically copy the required script files and examples to the UR robot. For further info, go to **SOFTWARE INSTALLATION**

Please make sure that you use the screws provided with the sensor, as higher deviation in screw dimension may damage the sensor or the robot.


Assembly guide for HEX-70-X Series
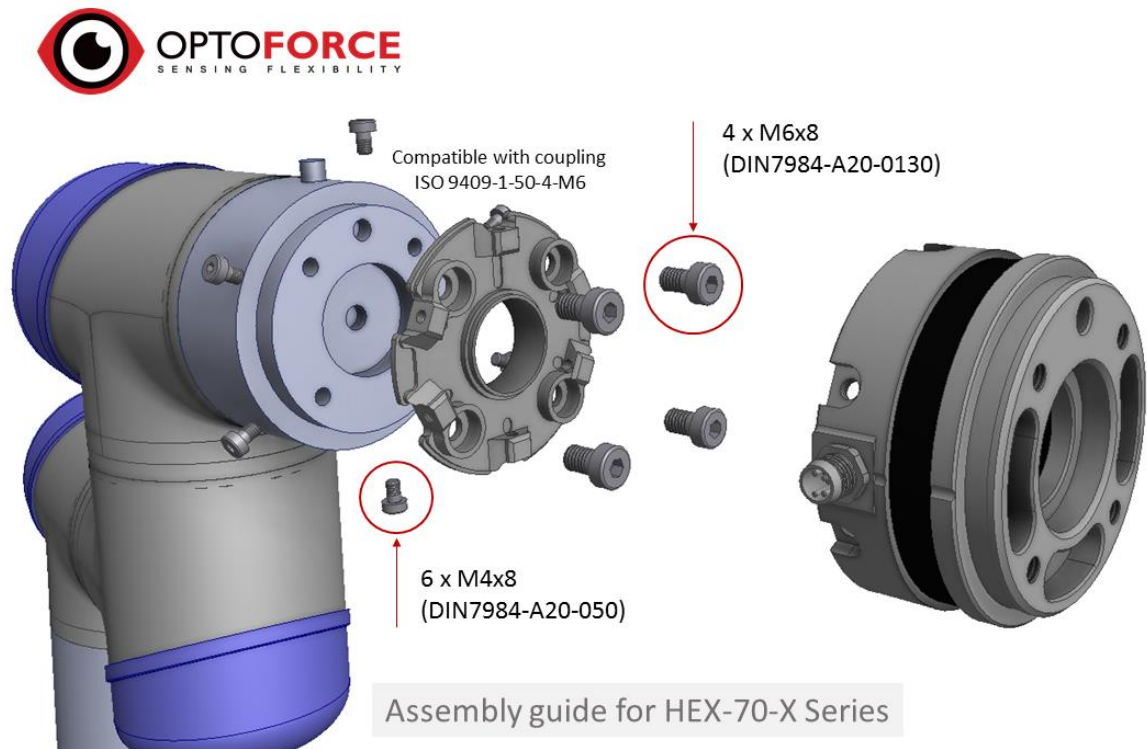
3. SOFTWARE INSTALLATION / UNINSTALLATION

INSTALLATION

If you have finished with the mechanical and electrical installation please insert the USB stick in the USB slot in the Teach Pendant.

- ✓ A red "! USB !" warning sign will appear indicating the upload is in progress.

- ✓ Await a green " USB" sign appearing, indicating the upload is completed.

- ✓ Remove USB stick and now you can find the example codes in your UR robot program folder.
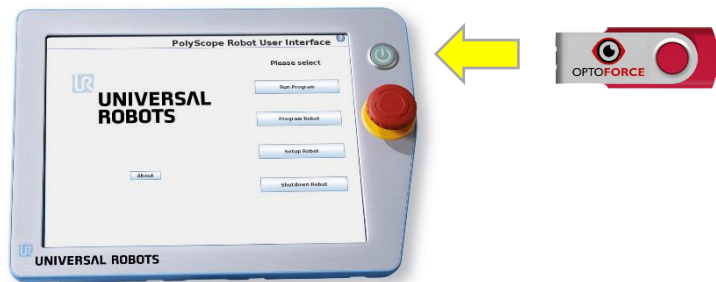
The scripts have the DAQ's IP address preset to **192.168.1.1** which is the default IP address of the DAQ. Please revise the UR robot network configuration accordingly.

The robot program files will be automatically copied to a new folder called 'OptoForce_UR_Programs'.

UNINSTALLATION

If you wand to uninstall (remove) the previously installed files you can either,

a) remove the files and folder, using the 'Delete' option on the Tech Pendant during file operation (e.g: Load Program, Save Program)
b) copy the 'uninstall.sh' file from the USB pendreive to a new one, and rename it to "urmagic_optoforce_uninstall.sh" and plug it into the Tech Pendant

If you use the 'uninstall.sh' file, first it will create a back-up copy to the pendrive, than it will permanently delete the 'OptoForce_UR_Programs' folder.

4. OPTOFORCE SCRIPTS

The sensor uses TCP/IP Ethernet to communicate with the UR robot, which is easy to use in the UR script. However, to make it even easier, a pre-written script code is made, with all the basic functions that may be required to use the OptoForce force/torque sensor.

To access the OptoForce force/torque sensor in your UR program, two things have to be added to the before program section:

1. A **SensorIP="192.168.1.1"** variable as string has to be defined with the correct sensor IP address.
2. The **OptoForce_Functions_v1.x.script** code has to be loaded

In the **OptoForce_Functions_v1.x.script** the Ethernet communication with the sensor is automatically handled (initialization, open, close and error handling).

The script creates the following global variables, which can be accessed in your UR script code at any time, these variables are updated automatically with approximately 127Hz:

Fx: Force vector in X direction (according to the sensor coordinate system), in Newton (N)

Fy: Force vector in X direction (according to the sensor coordinate system), in Newton (N)

Fz: Force vector in X direction (according to the sensor coordinate system), in Newton (N)

Tx: Torque in X direction (according to the sensor coordinate system), in NewtonMeter (Nm)

Ty: Torque in X direction (according to the sensor coordinate system), in NewtonMeter (Nm)

Tz: Torque in X direction (according to the sensor coordinate system), in NewtonMeter (Nm)

F3D: Length of the 3D force vector

T3D: Length of the 3D torque vector

counter: Number of data pocket received from the beginning of the program start (always increasing)

safety_counter: Has to be equal with counter (if not the program execution is stopped due to safety reasons)

If you want to tare the sensor values during operation, you can use the **OF_FT_Bias()** function for this purpose.

A. SCRIPT FUNCTIONS

The following functions are implemented. (Please note that these functions are mainly used internally in the **OptoForce_Functions_v1.x.script** file, only the **OF_FT_Bias()** my be required to be used in your script code)

OF_FT_Open()

Open the TCP socket communication, use the '**SensorIP**' global variable to open the socket, with the default port of 49151, and with the default socket name of "mysocket"

Return: No return parameter is provided, as in case of unsuccessful socket open an error message is generated, which stops the program execution.

OF_FT_Close()

Close the TCP socket communication (uses the default socket name "mysocket")

OF_FT_Read ()

Updates the global force/torque variables.

global variables are Fx,Fy,Fz,Tx,Ty,Tz, F3D,T3D

OF_FT_Read_Scale()

Reads the OptoForce Force/Torque sensitivity parameters, which are used to create the N and Nm output.

Only used ones at startup.

OF_FT_Bias()

Offset cancellation. Reads the OptoForce Force/Torque current values and these values are used for taring.

OF_FT_Init()

Opens the TCP/IP socket communication. Reads the sensitivity parameters from the sensor. Makes an offset cancellation. And start a treads which automatically updates the global Force/Torque values.

B. SCRIPT EXAMPLES

OptoForce_EmptyProgram.urp

In the program the **SensorIP** address is set to the default value (**192.168.1.1**), and the **OptoForce_Function_v1.x.script** file is loaded in the **BeforeStart** sequence.

The force/torque values are global variables thus you can access them anywhere in you code.

OptoForce_SimpleDemo.urp

In this example the robot is navigated between the two waypoints (Waypoint_1 and Waypoint_2). If the force is above a threshold limit (2N) then the robot motion is stopped and the robot mode is set to tech mode, where it can be moved by hand.

5. CHANGING THE IP OF THE SENSOR

It is necessary to connect a your Laptop or an external PC to the OptoForce sensor device in order to be able to change the sensor's IP address. In the following you will see the required 5 steps:

1.) Make sure that the device is not powered on. Plug the provided Ethernet cable's one end to your computer (PC or laptop) and the other end to the device.

*(For more details read chapter "**Hiba! A hivatkozási forrás nem található.. Hiba! A hivatkozási forrás nem található.".)***

2.) If your device is in the factory default settings you can proceed to step 3. Otherwise make sure to switch the DIP switch 3 to ON position (up) and the DIP switch 4 to OFF position (down).

*(For more details read chapter "**Hiba! A hivatkozási forrás nem található.. Hiba! A hivatkozási forrás nem található.".*)*
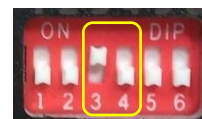
3.) Power the device from the provided power supply and wait for 5 seconds for the device to boot up.

*(For more details read chapter "**Hiba! A hivatkozási forrás nem található.. Hiba! A hivatkozási forrás nem található.".)***

4.) Open your web browser (Internet Explorer is recommended) and navigate to **http://192.168.1.1**. If you have reached the welcome screeen you can show the real-time sensor data.

*(For more details read chapter "**Hiba! A hivatkozási forrás nem található.. Hiba! A hivatkozási forrás nem található.".)***
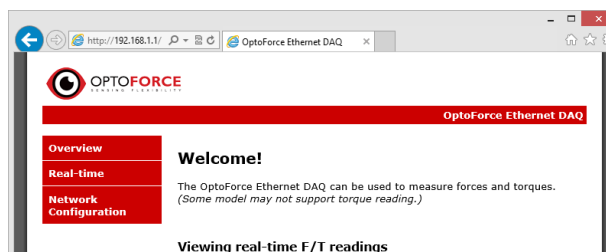
5.) Finally, if you need to change the device's IP address then use the Network configuration menu.
*(For more details read chapter "**Hiba! A hivatkozási forrás nem található.. Hiba! A hivatkozási forrás nem található.".)***

QUICK TROUBLESHOOOTING

If you had trouble accessing the webpage:

✓ Check your computer's IP settings. The defualt setting on most operating system is the automatic IP mode. If you have other setting first save your current setting and then set it to automatic mode or to a fixed IP: 192.168.1.2 (sub-net mask: 255.255.255.0). Then repeat from step 1.

✓ Try to close the web browser and re-open it (it might have cached a different webpage previously)

✓ Make sure that no hardware/software firewall (or router) blocks the connection between your computer and the device.

✓ Your device might not be in the factory default state. Repeat from step 2 according to that.

The web access can be used with any web browser by entering the device IP address or the device hostname.

For example **http://192.168.1.1** or **http://OPTODAQ/** if the factory default values are used.
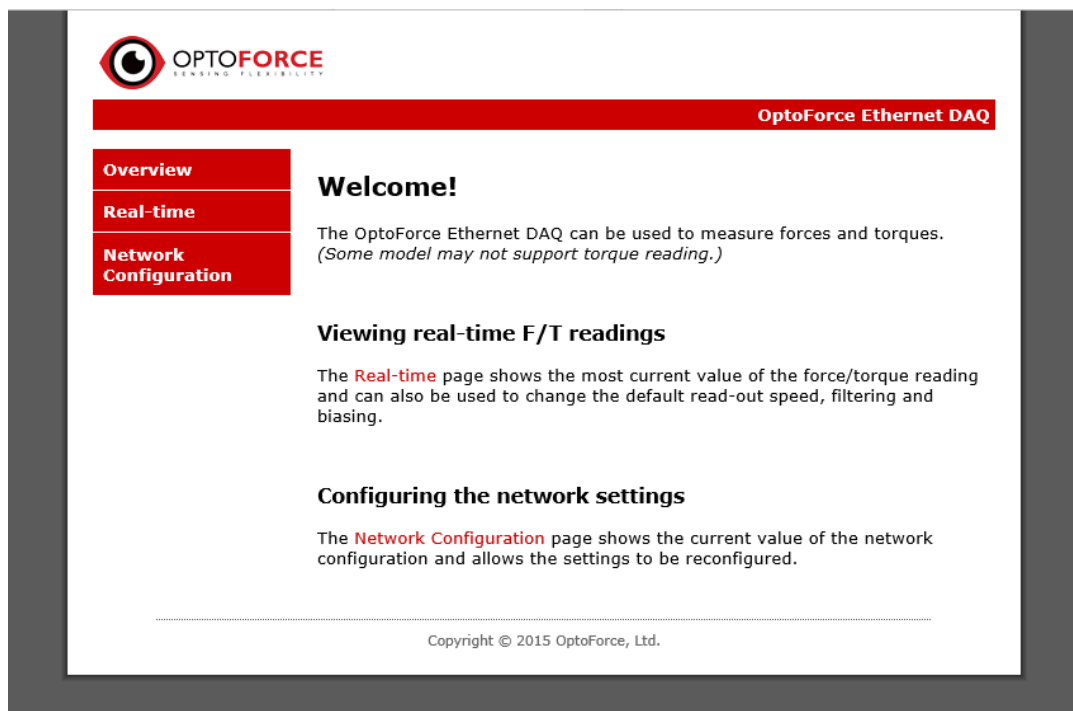
Figure 1 | This is the Welcome page that opens if all settings are correct.

If you cannot access the welcome page by entering the device IP address you can restore the network settings to the default values by switching the DIP switch 3 ON. The default values are IP: 192.168.1.1 (subnet mask: 255.255.255.0) with DHCP client off.

If device cannot be reached by its hostname, it might be necessary to clear the address caches in your web browser and OS. From the command prompt in Windows, enter "**nbtstat -R**" to clear the hostname cache, close your current web browser, open a new web browser, and then try to access the web address above.

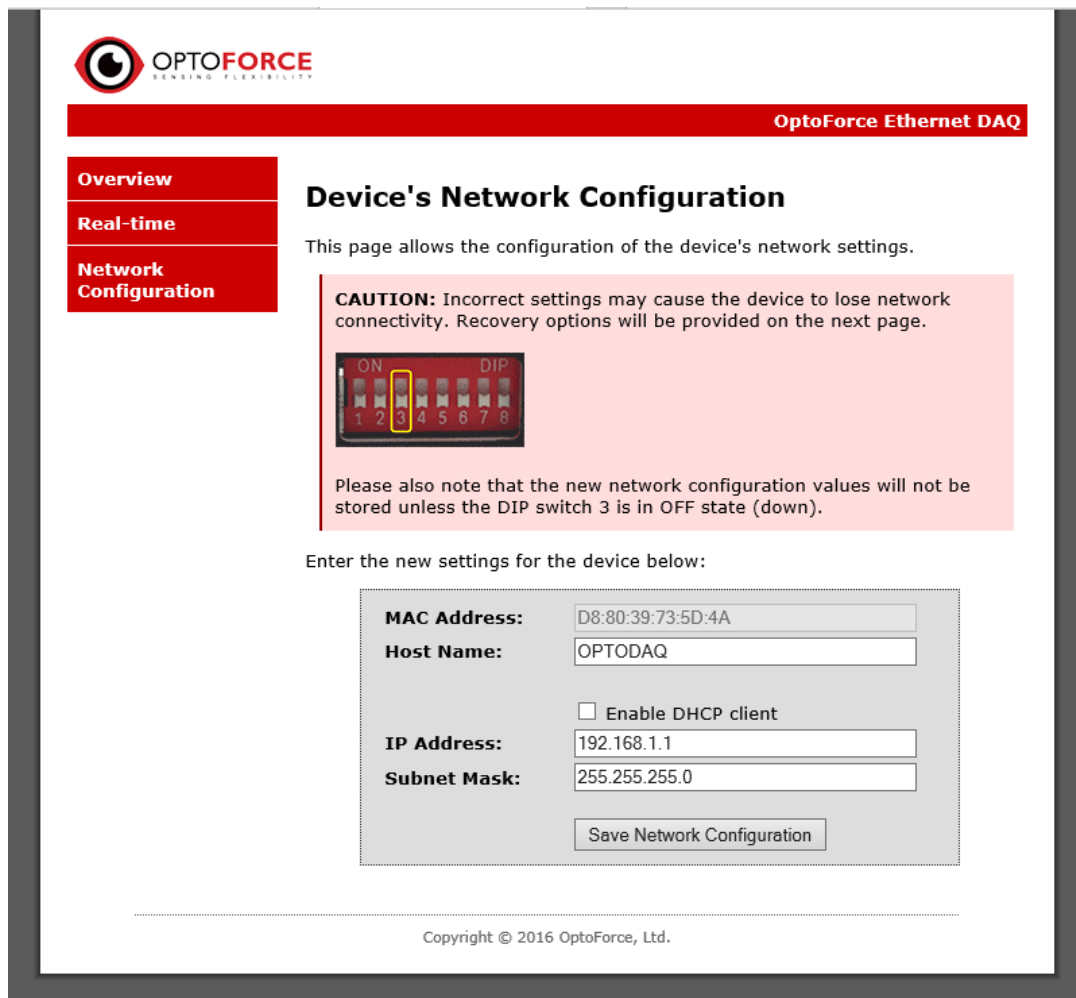The *Network Configuration* menu on the top left can be used to check or change the device's network configuration.

Figure 2 | Network Configuration page

*In older version (prior to 2016 Q2) the page is password protected. You can login with the following username and password: Username: **admin** Password: **optoforce***

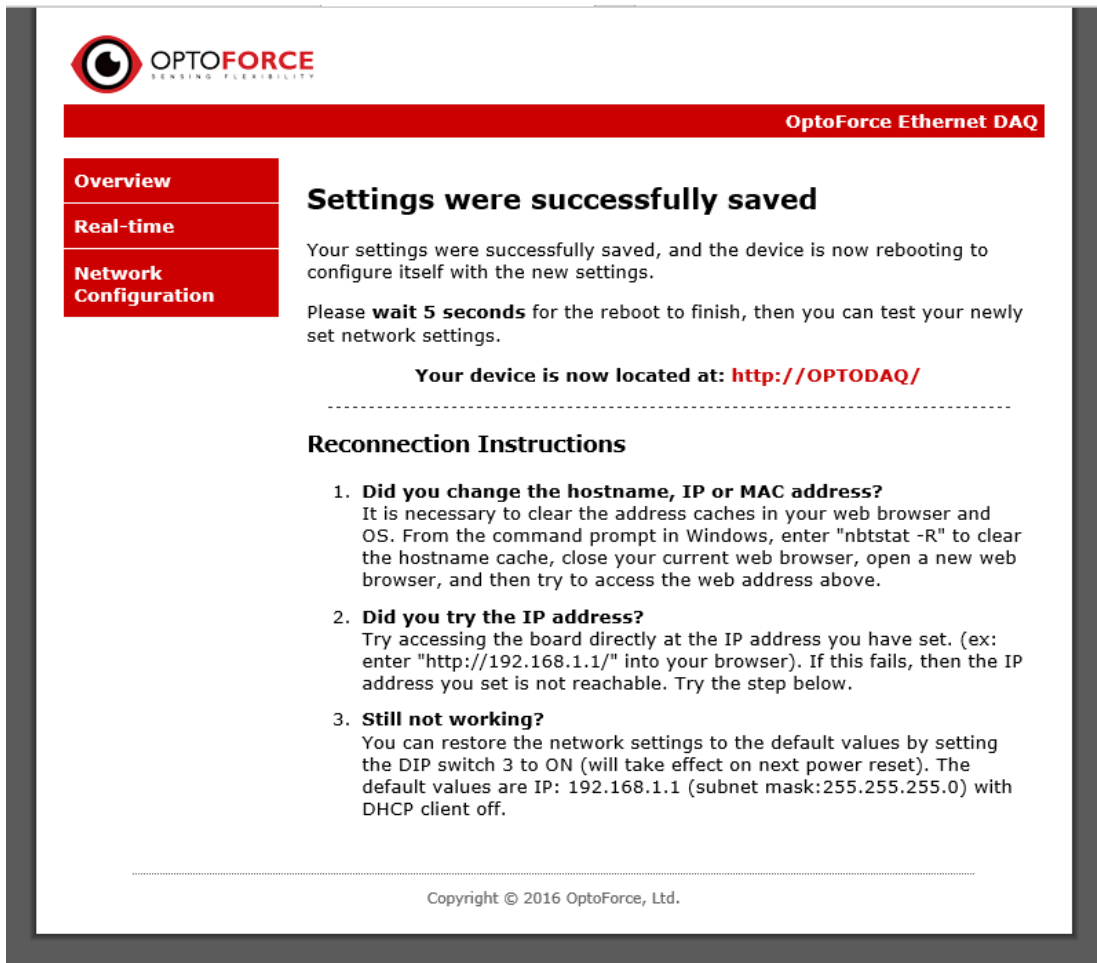The **MAC address** is the word-wide unique ID that is fixed for the device.

The **Host name** can be maximum 16 character long.

The **Enable DHCP client** checkbox can be used to enable or disable the automatic IP addressing. Please note that, with DHCP client enabled, if the network that you connected to has no DHCP server then the fixed 192.168.1.1 IP will be used instead for the device.

If DHCP client is disabled the static IP address can be set.

If you are using the device within a company network contact your IT department for what IP, subnet mask should be assigned.

After all the parameters are set, by clicking on the *Save Network Configuration* button the new values will be stored permanently and you should be redirected to a new page.

For further info, please read the **OptoForce DAQ - Ethernet_v1.6.pdf** *that you can find on the provided USB pendrive*.