Installation and Operation Manual for Ethernet Converter

Version 2.0

April 2017

Content

1 Preface

1.1 Conventions

The following conventions are used in this document.

Table 1: Conventions

`Courier Text`	Used for file paths and file names, code, user input and computer output.
Italicized text	Used for citations and marking image callouts in text.
Bold text	Used to indicate UI elements, including text appearing on buttons and menu options.
<angle brackets>	Indicates variable names that must be substituted by real values or strings.
1. Numbered lists	Numbered list elements indicate steps of a procedure.
A. Alphabetical lists	Alphabetical list elements indicate image callout descriptions.

2 Getting Started

The OptoForce Ethernet Converter is used to read and configure the OptoForce 3 and 6-axis sensors via Ethernet interface.

The Ethernet interface supports three modes of operation:

- Webpage access

  For easy, real-time reading and configuration. Network configuration (IP address, and so on.) can be also changed.

- High-speed UDP connection

  High-speed reading (up to 1 kHz) can be achieved through a UDP connection. (This mode is compatible with the ATI-IA's Raw Data Transfer.)

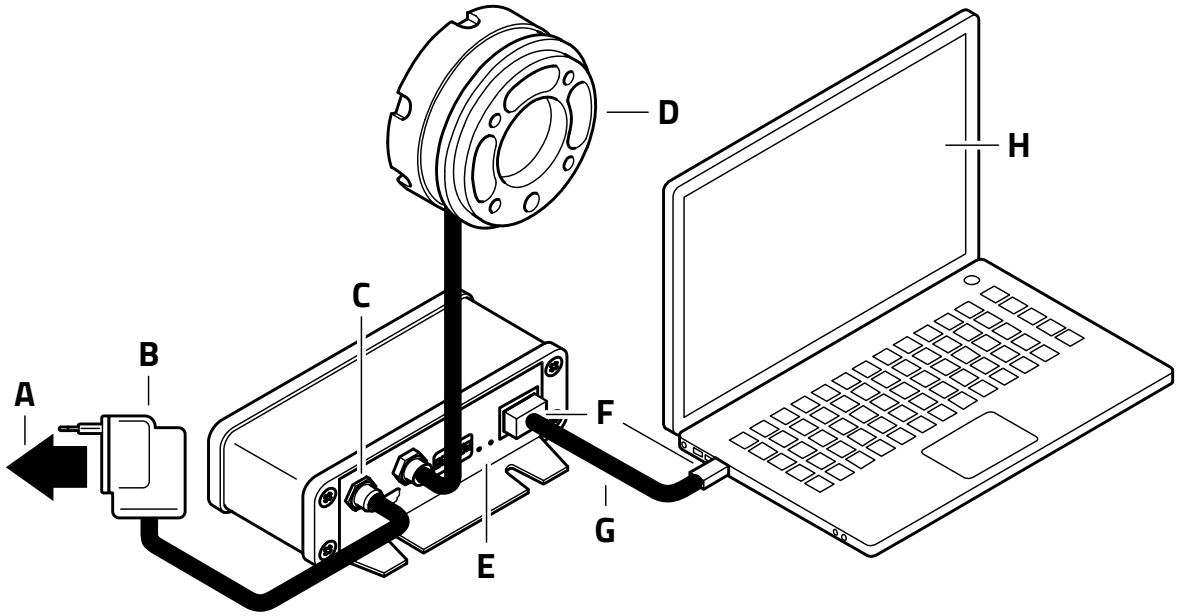
- TCP connection

  Single or iterated reading can be achieved through a TCP connection.

> It is not recommend to use two modes at the same time as this affects performance.

The DAQ must be powered by an external power source via the Power Connector. Power-Over-Ethernet (PoE) is not supported.

Once the device is powered on, it takes about 5 seconds for the system to boot.



A. To AC power socket

B. Power supply

C. Power connector (12-48V DC)

D. Sensor

E. Ethernet converter

F. RJ45 connector

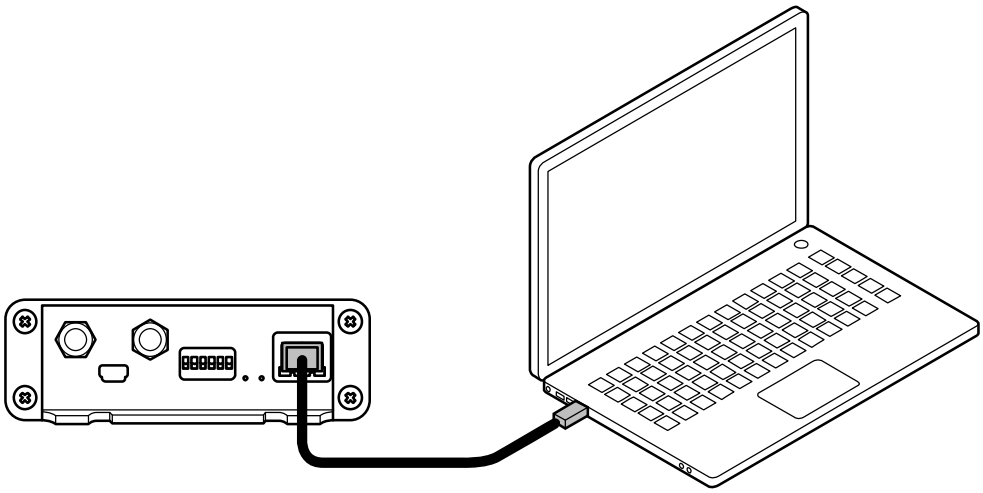
G. Ethernet cable

H. User's computer

3 Quick Setup

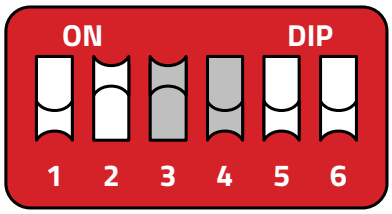
This quick setup guide describes how to connect to the device.

1. Make sure that the device is not powered.
2. Connect the computer (PC or laptop) and the device with the provided Ethernet cable.



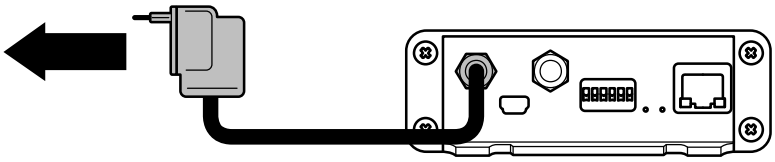
For more information, see **Connectors**.

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



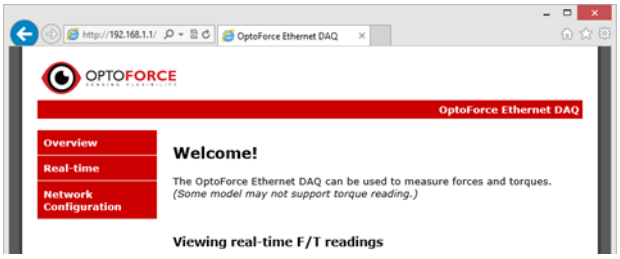
For more information, see **DIP Switch**.

4. Power the device with the provided power supply and wait 5 seconds for the device to boot.



For more information, see **Connectors**.

5. Open a web browser and navigate to **http://192.168.1.1** (Internet Explorer is recommended). The welcome screen is shown and the real-time sensor data is visible.



For more information, see **Web Access**.

6. If the IP address of the device needs to be changed, use the **Network Configuration** menu.

For more information, see **Network Configuration Page**.

3.1 Quick Troubleshooting

In case the webpage cannot be accessed, check the following:

- Check your computer's IP settings. The default setting on most operating systems is the automatic IP mode. If you have other than the default setting, 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 the **Changing the IP of the Sensor** process.
- Close the web browser and reopen it (it might have cached a previous webpage).
- Make sure that no hardware/software firewall (or router) blocks the connection between the computer and the device.
- The device might not be in the factory default state. Repeat **Quick Setup** from step 3.

4 Ethernet Interface

Correct IP addressing must be set in order to use the Ethernet interface. The following methods can be used to configure the IP address:

- Set the IP address of the device to 192.168.1.1 (subnet mask: 255.255.255.0) by setting the DIP switch 3 to ON position.
- Set the IP address to a custom static IP value using the web access **Network Configuration** page. It is important to set the DIP switch 3 to the OFF position.
- Let a DHCP server in your company network assign an IP address using the web access **Network Configuration** page. It is important to set the DIP switch 3 to the OFF position. This is the factory default.

If the device is used in a local network only (directly connecting it to a computer's LAN port), method is recommended to get the system up and running.

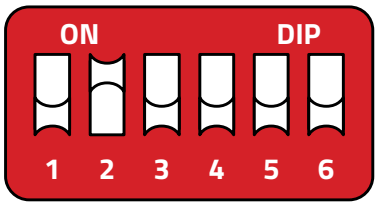
Once the device IP address is set, the computer that will be connected to the device has to be configured. The TCP/IP settings of the computer must be set in accordance with the device's IP address settings. (The computer's IP address must be in the same network. For example, if the device IP address is 192.168.1.1 with subnet mask 255.255.255.0 any value between 192.168.1.2 – 192.168.1.250 would work with the same subnet mask.)

In order to make the computer's IP address settings easier, the device has a DHCP server that is enabled by default. It assigns an IP to your computer in the range of 192.168.1.100-105 with subnet mask 255.255.255.0 in a local network.

If the device is used in a company network where a DHCP server is already in use, disable the device's DHCP server by setting the DIP switch 4 to the ON position.

5 DIP Switch

The DIP switch is used to reconfigure network settings of the device.



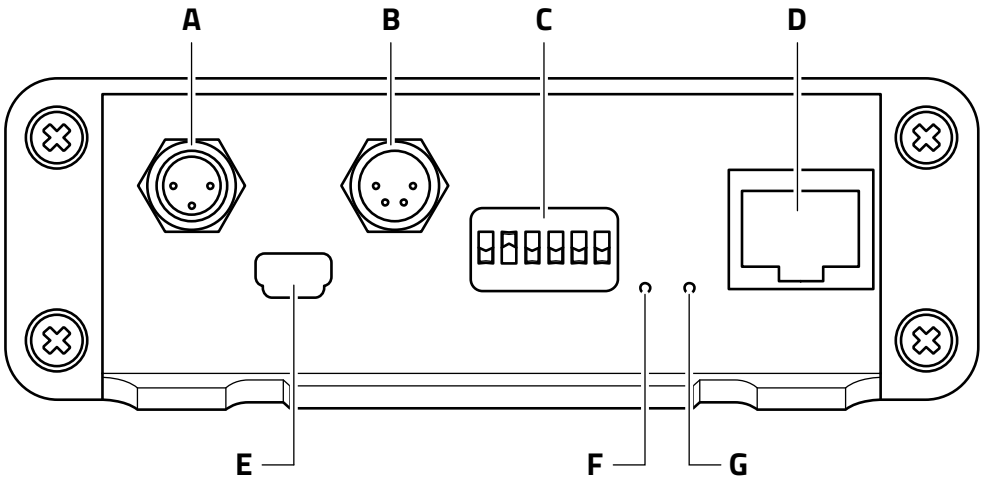
(shown in factory default settings)

1	Reserved
2	Must be in the ON position (up)
3	ON – Device IP address = 192.168.1.1 OFF – Static IP/DHCP
4	ON – DHCP Server disabled OFF – DHCP Server enabled
5-6	Reserved

Any change to the settings only takes effect after a power reset, since all values are read only at the power-on phase.

6 Connectors

The following figure shows the connectors and LEDs of the front panel. In the current version of the product the sensor cables are permanently fixed and cannot be detached from the back panel.



A. Power connector

B. F/T sensor*

C. DIP switches

D. Ethernet interface

E. Optional USB connector

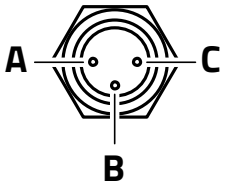
F. Transmit LED

G. Run LED

The DAQ must be powered via the Power Connector. Power-over-Ethernet (PoE) is not supported.

Power Requirements	
Voltage	12V-48V
Power Consumption	5W

The Power Connector is an M8 3 pin connector (Phoenix Contact SACC-DSI-M 8MS-3CON-L180 – 1694334) with the following pinout:



A. Not in use

B. Ground

C. Power

An example for a mating connector is a Phoenix Contact SACC-M 8FS-3CON-M-SW - 1506888.

7 Web Access

The web access can be used with any web browser. Enter 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.

The following welcome page opens if all setting are correct:

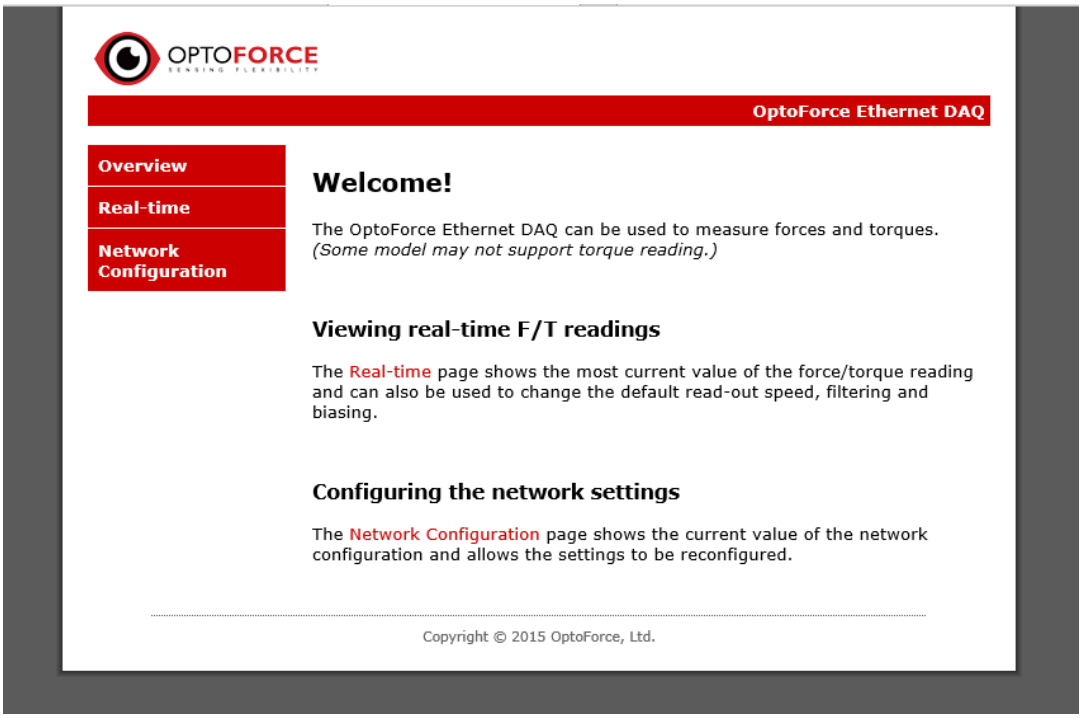


Figure 1: The Welcome page

If you cannot access the welcome page by entering the device IP address, 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 the device cannot be reached by hostname, clear the address caches in the web browser and OS. Enter `nbtstat -R` to the command prompt in Windows to clear the hostname cache. Close your current web browser, open a new web browser and then try to access the web address again.

7.1 Real-time Page

The **Real-time** page, from the top left menu, is used to monitor and change the default reading settings of the OptoForce Ethernet DAQ.

The webpage uses JavaScript to update the page with the most current values. If JavaScript is not enabled in your browser only question marks will appear.

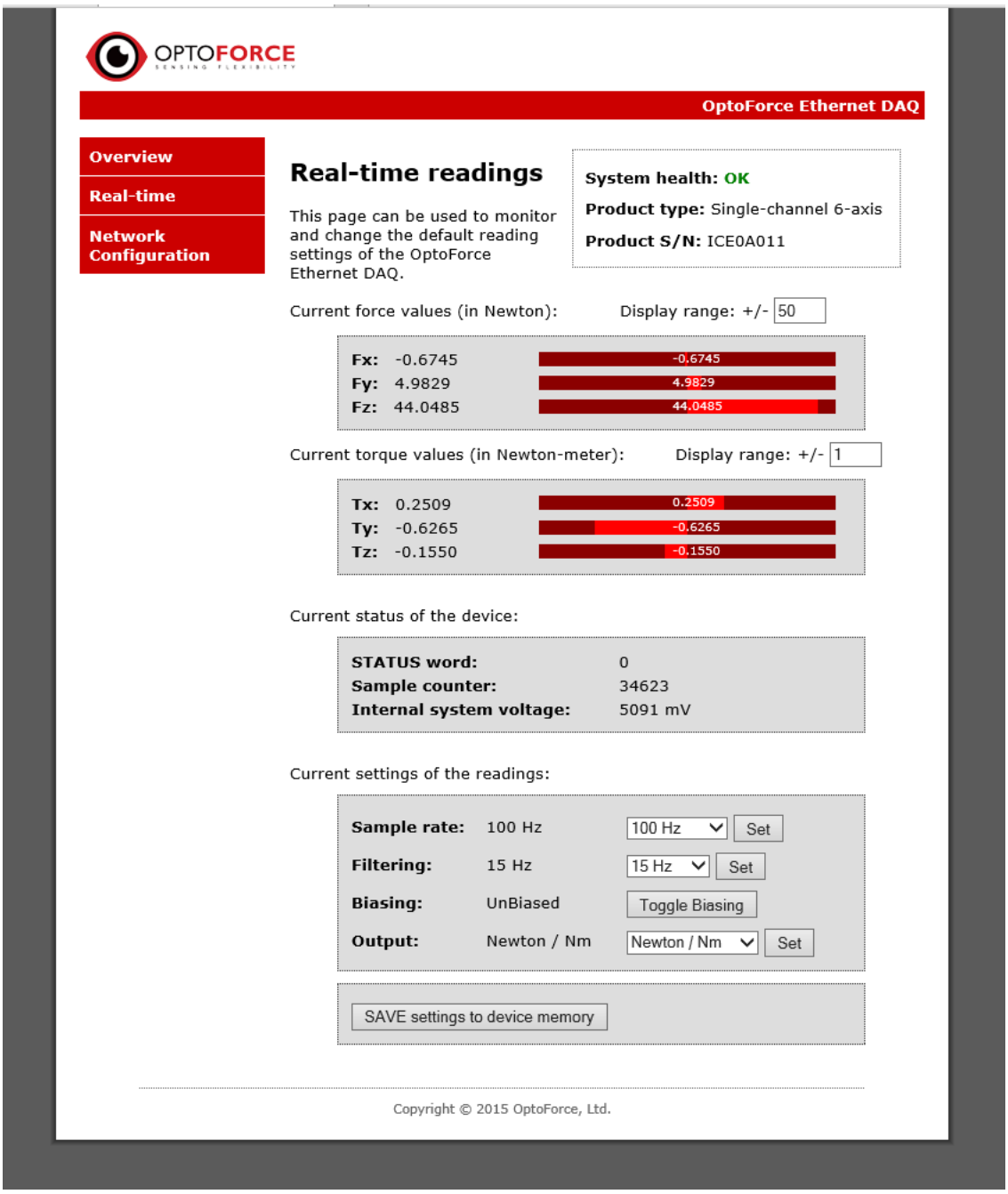


Figure 2: The Real-time page of a 6 axis force/torque sensor

Elements of the Real-time page are as follows:

- **System health** gives a quick overview of the device. It should read **OK**.

- The force and torque values (**Fx**,**Fy**,**Fz** and **Tx**,**Ty**,**Tz**) are shown in Newton/ Nm by default. The **Display range** can be used to alter the range of the vertical bars (has no effect on the reading via UDP or TCP) and uses the same unit as the **Output**.

- The **STATUS Word** stores the status of the Sensor and DAQ with the following description:

Name	Type	Description	
STATUS word	UINT16	Bit	Function
		0-2	Sensor number (zero means no error)
		3	Single/Multiple errors
		4	OVERLOAD – in Fx
		5	OVERLOAD – in Fy
		6	OVERLOAD – in Fz
		7	OVERLOAD – in Tx
		8	OVERLOAD – in Ty
		9	OVERLOAD – in Tz
		10-12	000 = No error 001 = The sensor has not been detected 010 = Sensor failure
		13-15	000 = No error 001 = DAQ error 010 = Communication error

- **Sample counter** is an UINT16 value that is incremented after each internal sample (1ms).

- **Internal system voltage** indicates if there are any power errors. The value should be between 4500-5500 mV.

- **Sample rate** is displayed and can be changed. The default value is 100 Hz.

- **Filtering** displays the internal advanced signal filtering's cut-off frequency and the value can also be set here. The default value is 15 Hz.

- **Biasing** is used to zero the force and torque reading. When the system is UnBiased (default) the force and torque reading should be close to zero (in the range of [-300;+300] Counts). If the **Toggle Biasing** button is clicked, the current values are stored as an offset to make the force and torque values 0.

- **Output** can be changed from the default Newton/Nm to dimensionless Counts. It can be used for user-side calibration. The Counts can be converted to Newton/ Nm with the help of the sensor's Sensitivity Report.
- By clicking on the **SAVE settings to device memory** button, the current **Sample rate** and **Filtering** can be permanently stored.

> **Biasing** and **Output** set on this page is not stored permanently and are restored to the default values on power reset.

7.2 Network Configuration Page

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

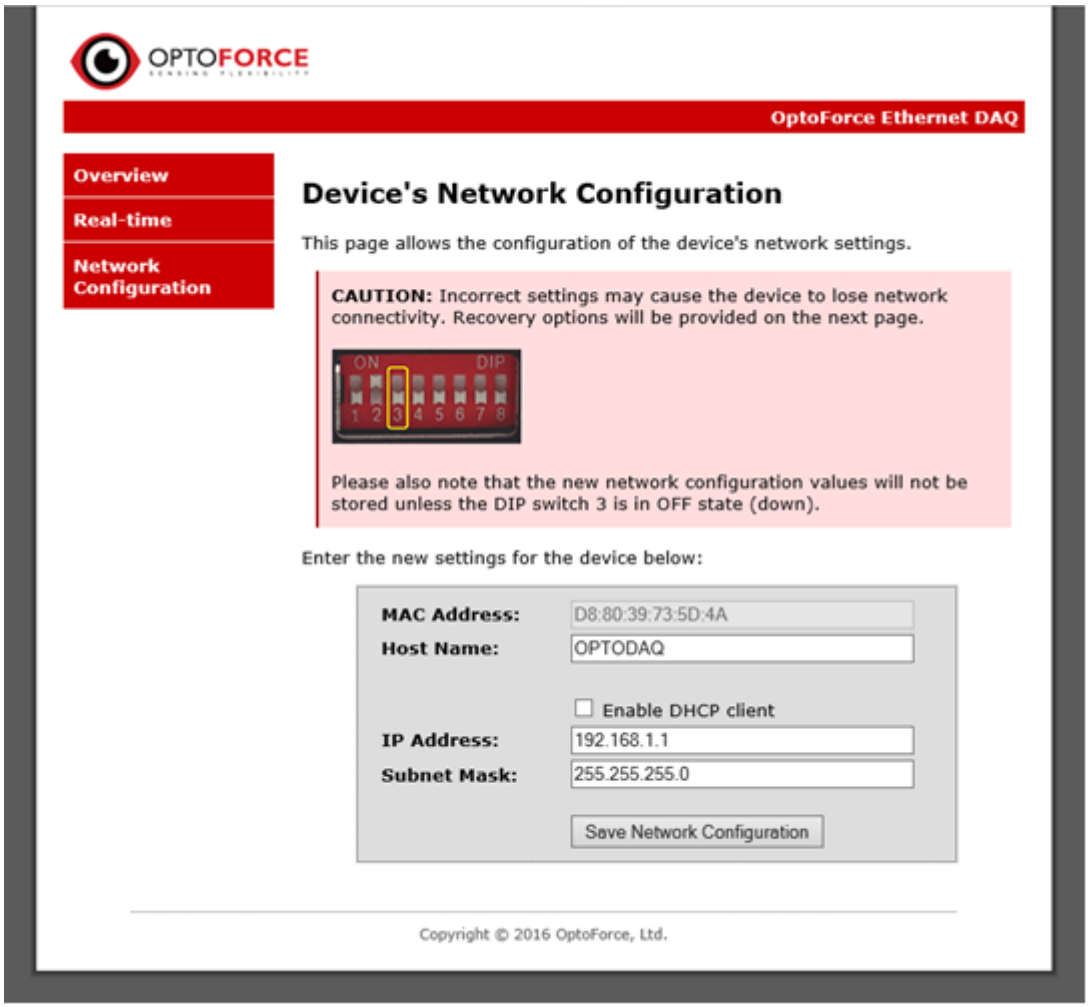


Figure 3: The Network Configuration page

> In older versions (prior to 2016 Q2) this page is password protected. Log in with:
>
> Username: admin
>
> Password: optoforce

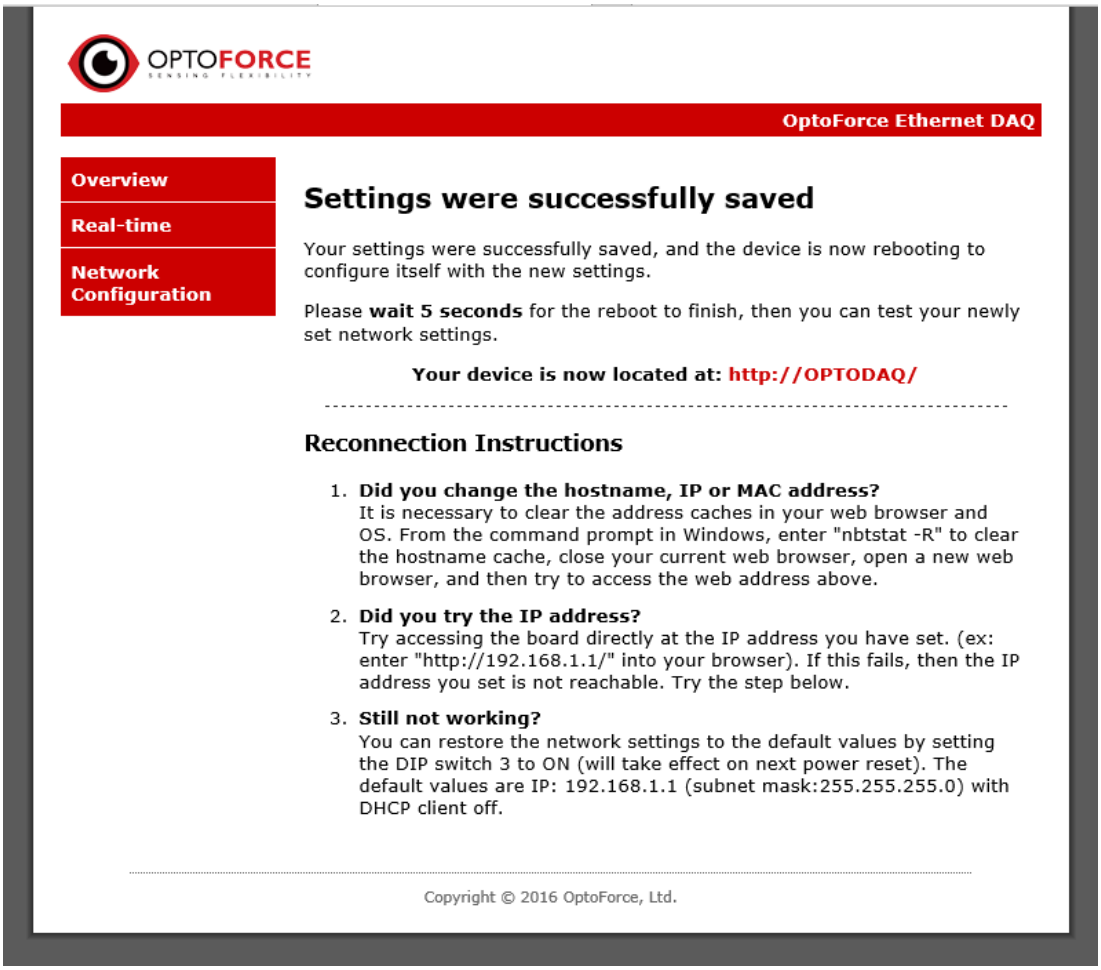
Elements of the **Network Configuration** page are as follows:

- The **MAC Address** is the word-wide unique ID that is fixed for the device.
- The **Host name** can be a maximum of 16 characters long.

- The **Enable DHCP** client checkbox can be used to enable or disable automatic IP addressing. With DHCP client enabled, if the network that the device is connected to has no DHCP server, then the fixed 192.168.1.1 IP is used for the device. If DHCP client is disabled, then the static IP address can be set.

> If the device is used within a company network, contact the IT department for the correct IP and subnet mask to be assigned.

After all parameters are set, click on the **Save Network Configuration** button to store the new values permanently. After the new parameter are stored, the next page describes how to proceed:



8 High-speed UDP

The High-Speed UDP connection (HS UDP) can be used to read the sensor's output at a maximal rate of 1 kHz. The HS UDP can also be used to set the read out, cut-off frequency and to bias the sensor's output.

HS UDP is compatible with the ATI-IA's Raw Data Transfer (RDT).

The HS UDP protocol has five commands. To start the device outputting the HS UDP messages, send a request to the device's IP address. The device listens for UDP requests on port 49152. This port is also used for the output messages.

8.1 Commands

The following five commands are implemented:

Command	Name	Data	Response
0x0000	Stop sending the output	Any value	none
0x0002	Start sending the output	Sample count	HS UDP record(s)
0x0042	Set software bias	0 or 255 decimal	none
0x0081	Set internal filtering	0-6 decimal	none
0x0082	Set read-out speed	Period in ms	none

The only command with a response is 0x0002, that starts sending of the output. The other commands are not acknowledged, therefore have no response.

8.2 Request

The commands must be sent to the device as a request with the following structure:

```
UINT16    Header;        // Must be 0x1234
UINT16    Command;       // Value according to the command table
UINT32    Data;          // data according to the actual command
```

The byte count of the request must be 8 bytes and multi-bytes values have to be sent as high byte first.

8.3 Response

The device sends the output as a HS UDP record that has the following structure:

```
UINT32    HS_sequence;    // The sequence number of the current HS UDP record
UINT32    FT_sequence;    // The internal sample counter of the DAQ
UINT32    Status;         // Status word of the sensor and DAQ
UINT32    Fx;             // X-axis force in 32 bit Counts*
UINT32    Fy;             // Y-axis force in 32 bit Counts*
UINT32    Fz;             // Z-axis force in 32 bit Counts*
UINT32    Tx;             // X-axis torque in 32 bit Counts* (0 if not available)
UINT32    Ty;             // Y-axis torque in 32 bit Counts* (0 if not available)
UINT32    Tz;             // Z-axis torque in 32 bit Counts* (0 if not available)
```

The byte count of the output is always 36 bytes. If less than 36 bytes are received, they are ignored. For multi-byte values the byte order is high byte first.

The `HS_sequence` shows the current number of the output. If the start request was sent with data (sample count) = 1000 then the `HS_sequence` will be starting from 1 and end with 1000. If the data (sample count) was 0, then the output is produced until a stop request is sent.

> The Fx, Fy, Fz, Tx, Ty, Tz values can be converted to Newton/Newton-meter by dividing the force values by 10000 and the torque values by 100000.
>
> The default setting in the web interface is the Newton/Newton-meter mode but if it has been changed to Dimensionless mode the conversion is not available.

8.4 Biasing

Biasing can be used to zero the force and torque reading. When the system is unbiased the force and torque reading should be close to zero (in the range of -300 to +300 Counts). If the data (bias) is set to 255 (decimal) the current values are stored as an offset to make the force and torque values 0.

If the data (bias) is set to 0 the stored offset resets and the device restores to the unbiased state.

The biasing is not permanently stored and it is restored on power reset to the default unbiased state.

8.5 Filtering

Internal filtering can be programmed to have a custom cut-off frequency. There are 7 options:

Data/Filter (decimal)	Cut-off frequency
0	No filter
1	500 Hz
2	150 Hz
3	50 Hz
4	15 Hz
5	5 Hz
6	1.5 Hz

The new value is not permanently stored and is restored on power reset to the default 15Hz.

8.6 Read-out Speed

The read-out speed is the rate at which new samples are available. This value can be set in the range of 255ms to 1ms, which are 4Hz to 1kHz respectively.

The value can be any value from 0-255, but note that 0 would stop the read-out. Values other than 0 can be converted to read-out frequency with the following formula:

`1000 Hz / new_value = new_frequency`.

For example 2 would mean `1000 Hz / 2 = 500 Hz`

The new value is not permanently stored and it is restored to the default 100 Hz on power reset.

9 TCP Connection

TCP mode is used to read the sensor's output and status information. TCP mode is compatible with the ATI-IA's TCP connection.

In TCP protocol the device is the server and clients can connect to it. The connection is established as follows:

- The device listens for connection on the 49151 TCP port.
- Once a client has successfully established the connection to the device, the client can request data from the device.
- After receiving the request the device replies promptly with a response.
- After the response has been received by the user, a new request can be sent without reestablishing the TCP connection. If the device does not receive a request for more than 1 second, the connection is closed (timeout) by the device. In this case, the user needs to reestablish the TCP connection to be able to request more data.

Only one TCP connection can be active at the same time.

9.1 Get the Latest F/T Reading

9.1.1 Request

A simple command has to be sent to the device as a request that has the following structure:

```
UINT8      Command;           // Must be decimal 0 (0x00)
UINT8      Reserved[19];      // All the 19 value should be 0s.
```

The byte count of the request must be 20 bytes.

9.1.2 Response

The device sends the output as a record that has the following structure:

```
UINT16    Header;      // Fixed 0x1234
UINT16    Status;      // Status word of the sensor and DAQ
 INT16    Fx;          // X-axis force in 16bit Counts*
 INT16    Fy;          // Y-axis force in 16bit Counts*
 INT16    Fz;          // Z-axis force in 16bit Counts*
 INT16    Tx;          // X-axis torque in 16bit Counts* (0 if not available)
 INT16    Ty;          // Y-axis torque in 16bit Counts*(0 if not available)
 INT16    Tz;          // Z-axis torque in 16bit Counts* (0 if not available)
```

The byte count of the response is always 16 bytes with multi-bytes values sent as high byte first.

> The Fx, Fy, Fz, Tx, Ty, Tz values can be converted to Newton/Newton-meter with the help of the conversion parameters. See, **Get the Newton/Newton-meter Conversion Parameters**.

Fx (in Newton) = Fx * ScaleFactor[0] / CPF

Fy (in Newton) = Fy * ScaleFactor[1] / CPF

Fz (in Newton) = Fz * ScaleFactor[2] / CPF

Tx (in Newton-meter) = Tx * ScaleFactor[3] / CPT

Ty (in Newton-meter) = Ty * ScaleFactor[4] / CPT

Tz (in Newton-meter) = Tz * ScaleFactor[5] / CPT

TCP connections are generally slower compared to the UDP connections, and several software and hardware factors can affect the speed of the response (software firewall, router, and so on). For faster read-out speed, it is recommended to use the HS UDP mode.

9.2 Get the Newton/Newton-meter Conversion Parameters

9.2.1 Request

A simple command has to be sent to the device as a request that has the following structure:

```
UINT8    Command;          // Must be decimal 1 (0x01)
UINT8    Reserved[19];     // All the 19 value should be 0s.
```

The byte count of the request must be 20 bytes.

9.2.2 Response

The device sends the output as a record that has the following structure:

```
UINT16   Header;           // Fixed 0x1234
UINT8    Unit_Force;       // The unit of the calculated Force values
UINT8    Unit_Torque;      // The unit of the calculated Torque values
UINT32   CPF;              // Counts per Force value
UINT32   CPT;              // Counts per Torque value
UINT16   ScaleFactor[6];   // Additional scaling factor (for the Fx,Fy,Fz,Tx,Ty,Tz)
```

The byte count of the response is always 24 bytes with multi-byte values sent as high byte first.

The `Unit_Force` could be (decimal):

0 – No Newton conversion is available

2 – Newton will be the calculated value (this is the default when powered on)

The `Unit_Torque` could be (decimal):

0 – No Newton-meter conversion is available

3 – Newton-meter will be the calculated value (this is the default when powered on)

10 Mechanical Drawing of the Converter

All dimensions are in mm.