QTM
Qualisys Track Manager

OQUS SETUP

Table of Contents

Oqus

The Oqus cameras consist of five series of cameras: 5-series, 4-series, 3+-series, 3-series and 1-series. For more information about the different series of the Oqus camera see "Appendix A: Oqus - Camera manual" in the QTM manual.

The following chapters describe how to setup the Oqus camera system and other hardware information that is common for all of the Oqus-series.

Setting up the system (Oqus)

Before you connect the Oqus camera system, make sure that the QDS (Qualisys DHCP server) is running and that the network interface settings are correct, see "QDS" on page 4 respectively "Network card setup" on page 12.

The Oqus system is easy to setup. The connectors are unique and cannot be connected to the wrong ports. Further, the connector color matches that of the port. The **DATA** connector can be connected to any of the two DATA ports, and the **POWER** connector can be connected to any of the two **POWER** ports, so it does not matter on which side you put the connector. For more information on the connectors, see "Oqus connectors" on next page.

Note: When the cables have been connected correctly the LEDs on the back of the Oqus will be lit. The **EXT** LED will be lit green and the **ACT** LEDs will be blinking.

However, the connection of the power adaptors do require some attention. One power adapter can power up to 4 Oqus cameras. Therefore, the connection of a camera system comprising of more than four cameras must look something like the image below.
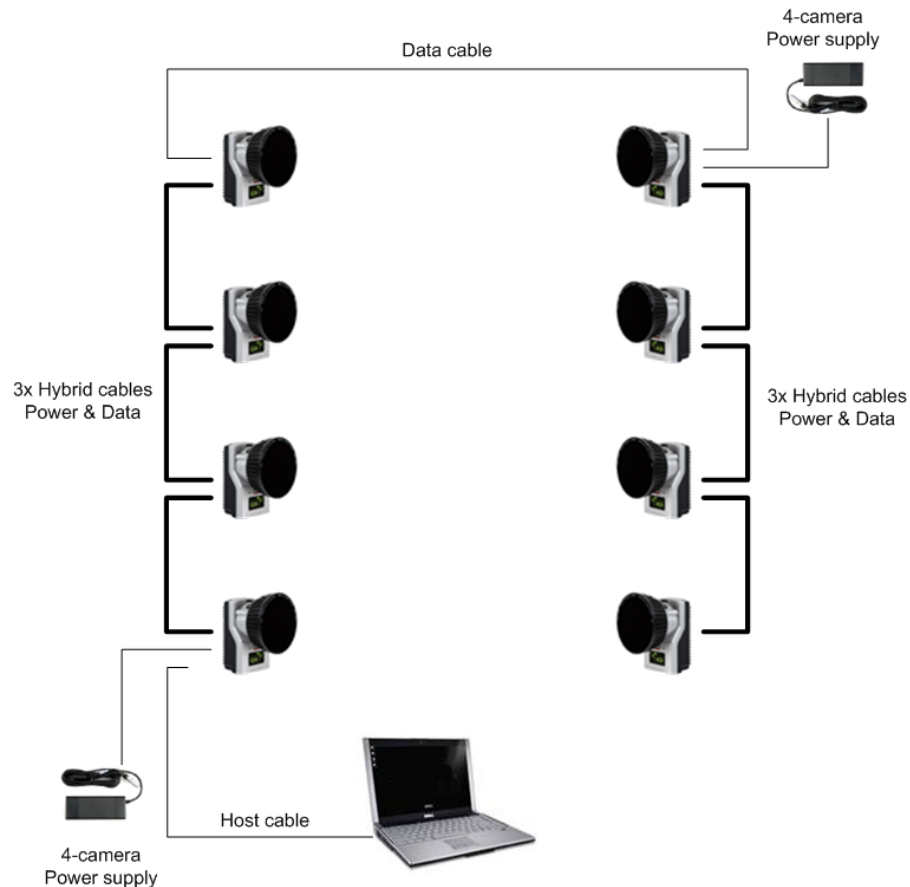
This means that you must use the following cables for an 8 camera system:

> 1 host cable between computer and camera.

> 6 bundled cables with power and data.

> 1 data cable connected between camera 4 and 5 in the setup.

> 2 AC/DC adapters, connected to for example camera 1 and 5.

When the camera system has been connected continue with setting aperture and focus and then arrangement of the cameras, see "Setting the aperture and focus" on page 15 respectively "Arranging the cameras" on page 16.

 Note: For Oqus systems larger than 16 cameras and for systems with many high-speed cameras, the performance can sometimes be improved with a gigabit switch and then connect the cameras in shorter daisy-chains, see "Setup Oqus system with Ethernet switch" on page 14.

Oqus connectors

The back of the camera holds six connectors for power, data and control connections. The view differs slightly depending on the type of camera. The image below shows the standard version of the camera. The water protected version uses different connectors and lacks the LEDs found on the standard version.
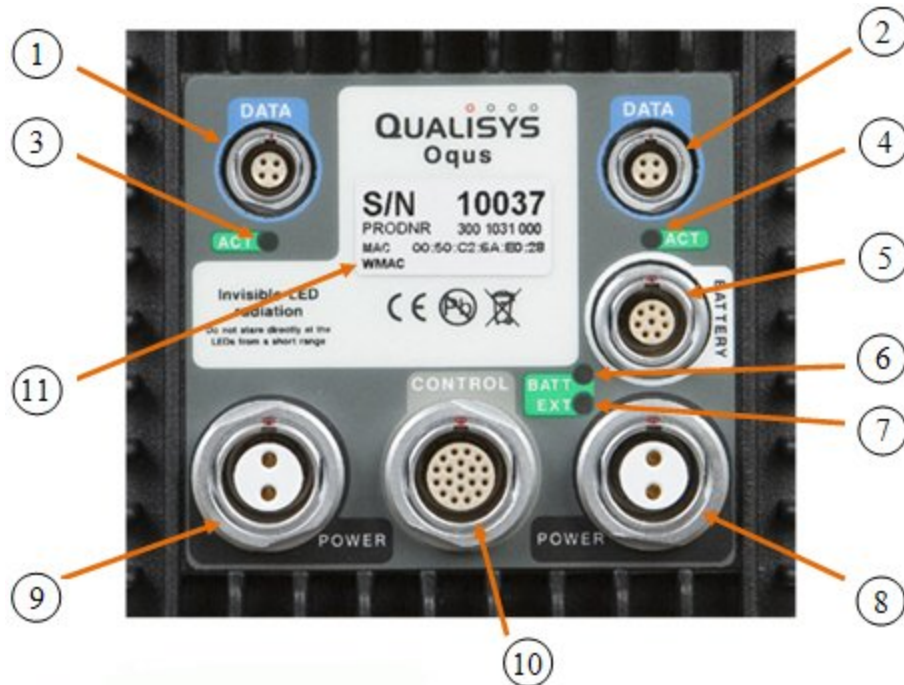
1. **Left Data port** (light blue)
   Ethernet connector. 100BaseTX/802.3i, 100 Mbps, Fast Ethernet.

2. **Right Data port** (light blue)
   Identical to the left data port

3. **Left Ethernet activity indicator**
   Shows the status of the Ethernet connection. Fixed green light means that a carrier signal has been detected and that the connection is up. Flashing green light indicates that data is received and/or transmitted.

4. **Right Ethernet activity indicator**
   Identical to the left indicator.

5. **Battery port** (white)
   Used to supply the camera with power from an Oqus compatible battery.

6. **Battery status indicator**
   Lit green when the camera is supplied though the **BATTERY** port.
   Lit red when a voltage outside the specified range (10-16V) is connected to the port.

7. **Power supply status**
   Lit green when the camera is powered through one of the **POWER** ports. A red light indicates internal power supply error.

8. **Right power supply port** (black)
   Daisy-chain power port. Supplies the camera with 48VDC and can be daisy chained to supply cameras further down the chain with power.

9. **Left power supply port** (black)
   Identical to the right power supply connector.

10. **Control port** (light grey)
    The control port is used to synchronize the camera with external sources, and contains pins for among other things external trigger in, external sync in and external sync out. Splitter cables are needed to connect one or more BNC

cables to this port, for more information see "Control connections" in the QTM manual.

11. **Camera identification**
    This label provides information on:

    - The serial number of the camera
    - The product number
    - The Ethernet Mac address
    - The WLAN Mac address

QDS

QTM comes with a DHCP-server called QDS (Qualisys DHCP Server), which distributes IP addresses to the Oqus cameras. An IP address for each camera is required to be able to communicate with them over the Ethernet network. QDS will be installed automatically with QTM and it must be running at all times, to provide the cameras with IP addresses at startup. The DHCP server will only give IP addresses to Oqus cameras so it will not disturb your computer network.

QDS includes a wizard to configure network interfaces to use them with Oqus cameras and to activate wireless operation on an Oqus camera, see "Oqus network configuration wizard" on the facing page and "Oqus wireless camera setup wizard" on page 7.

QDS menu

To open the QDS menu, right-click on the QDS icon in the status toolbar.

The QDS menu contains the following options:

Oqus configuration wizard
The Oqus configuration wizard can be used to setup your network interface for Oqus and to configure an Oqus camera for wireless operation, see "Oqus network configuration wizard" on the facing page and "Oqus wireless camera setup wizard" on page 7.

Advanced
Advanced configuration of network interfaces on the computer, see "Advanced (network settings)" on page 11.

Camera control utilities
QDS can control the Oqus cameras with the following commands.

Reboot all Oqus cameras
Reboot all Oqus cameras that have an IP-address.

Show IP address on camera display
Switch the display to show the IP-address and Serial number of the camera

Show ID on camera display
Switch the display to show QTM ID of the camera. This is the default for cameras that have been connected to QTM.

Network configurations
Using this sub-menu you can save or load network configurations. Click on **Save** to save the current configuration and then to load a configuration click on **Load**.

About QDS
Information about QDS.

Start QDS automatically
Option for starting QDS automatically on computer startup.

Shut down
Shut down QDS.

Oqus network configuration wizard

The Oqus network configuration wizard will guide you through the different steps to setup the network for Oqus cameras. If you run the wizard you do not need to follow the instructions for network card setup in chapter "Network card setup" on page 12. Follow the steps below.

1. Click on **Oqus configuration wizard** in the QDS menu to start the wizard.
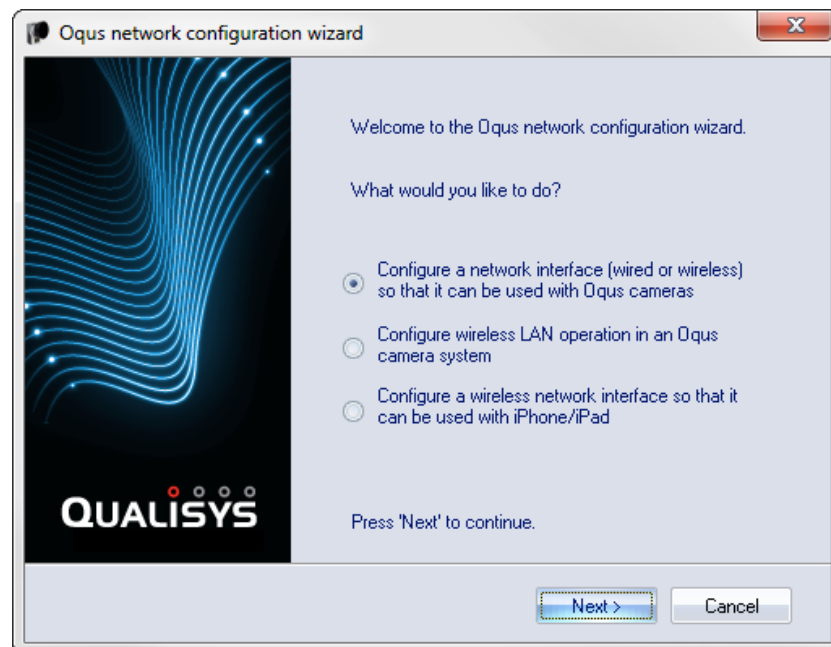
2. Select **Configure a network interface...** and click **Next**.
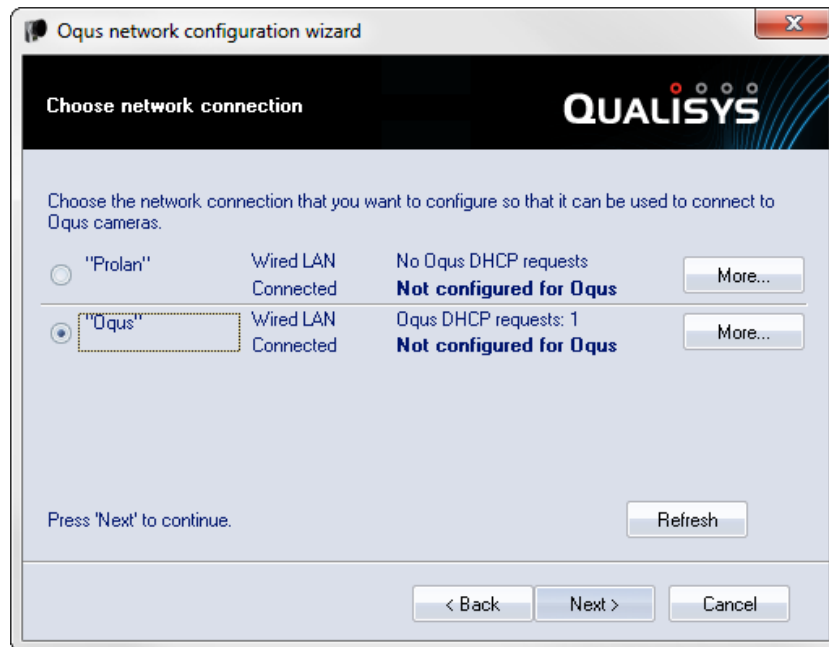
3. The list will show all enabled network interfaces on the computer. Select the interface that you want to use with Oqus cameras and click **Next**.

    Note: The wizard will not configure all interfaces, for example a network interface that is already connected to an internal network and has received an IP address will not be configured because it is considered to have a running DHCP server. However any disconnected interfaces can be configured by the wizard.

a. Click on **More** to see information about the network interface.
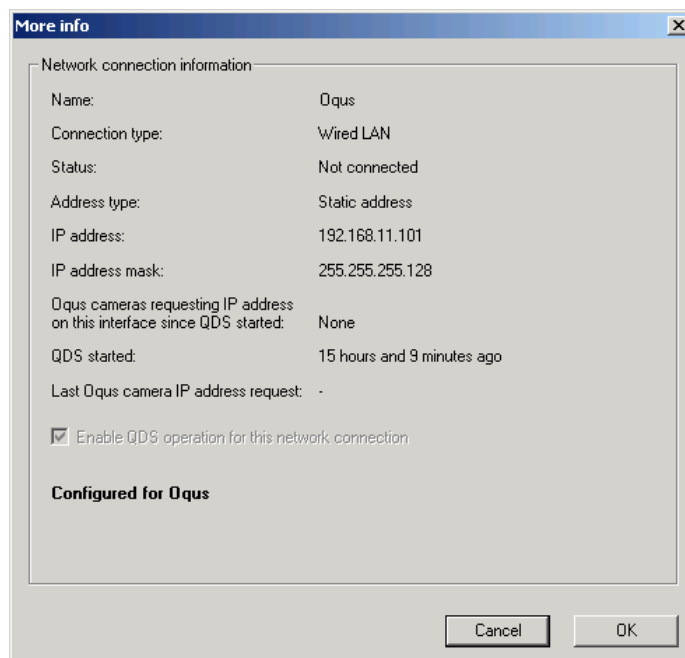
More shows the current settings of the network interface. This is the same information as is shown in Advanced, see "Advanced (network settings)" on page 11.

4. The wizard shows how it will change the selected interface. You can save the current network setup with the **Save** button for backup. Click **Next** to continue.
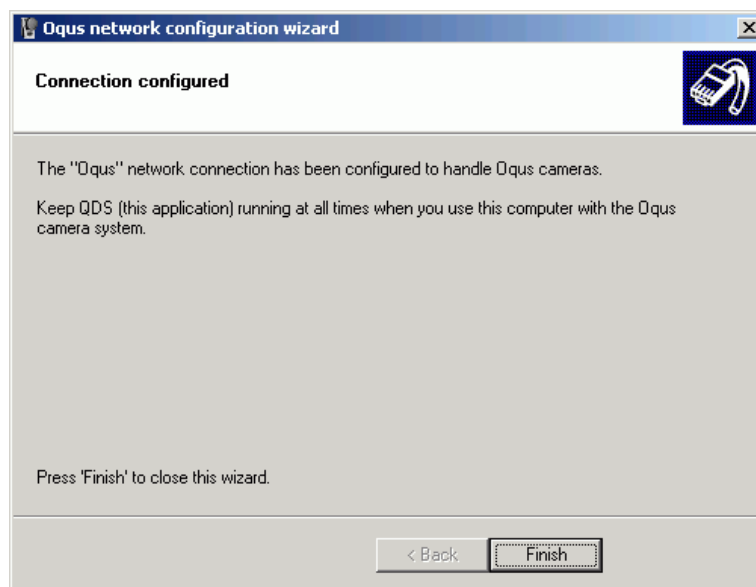
5. Click **Finish** to close the wizard.

Oqus wireless camera setup wizard

The Oqus configuration wizard will guide you through the different steps to setup an Oqus cameras for wireless operation. Follow the steps below.

1. Click on **Oqus configuration wizard** in the QDS menu to start the wizard.
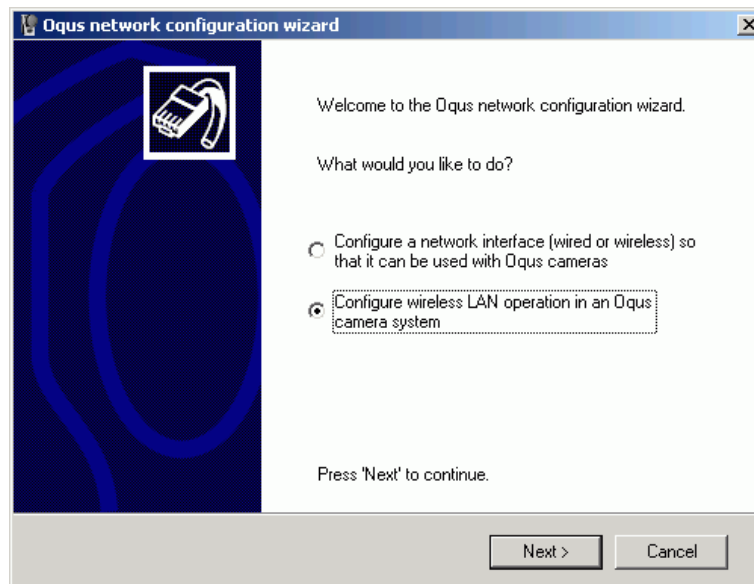
2. Select **Configure wireless LAN operation...** and click **Next**.
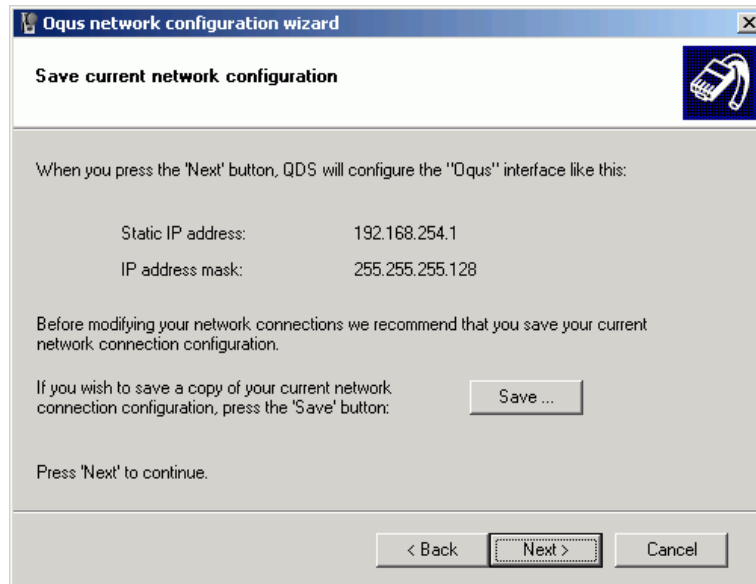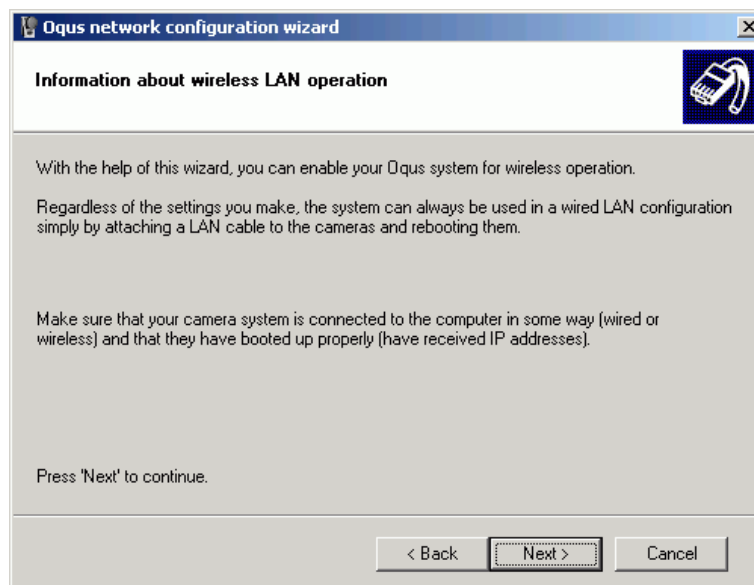

3. Make sure that the camera is connected to the computer and click **Next**.

   ✎ Note: The camera can always be connected with the wired LAN even if it configured for wireless. However the wireless will only work if the camera starts up without a wired connection to the computer.
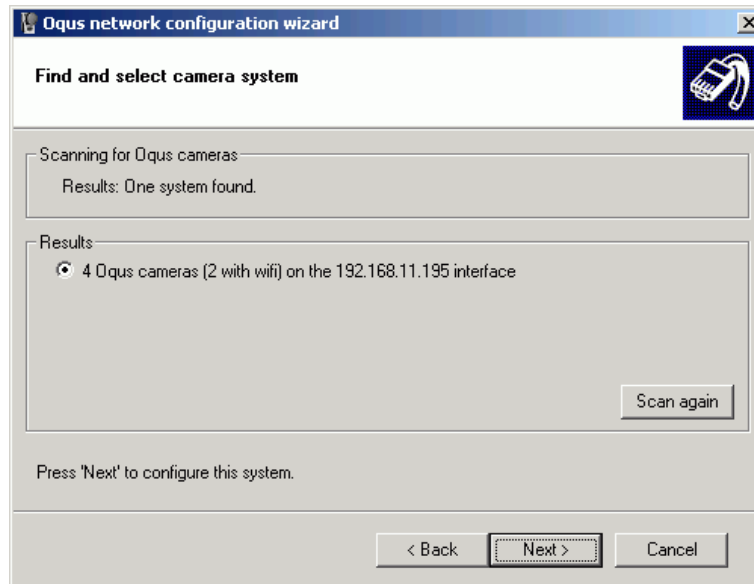
4. Select the camera system that you want to configure and click next. Use **Scan again** to scan for new camera systems.
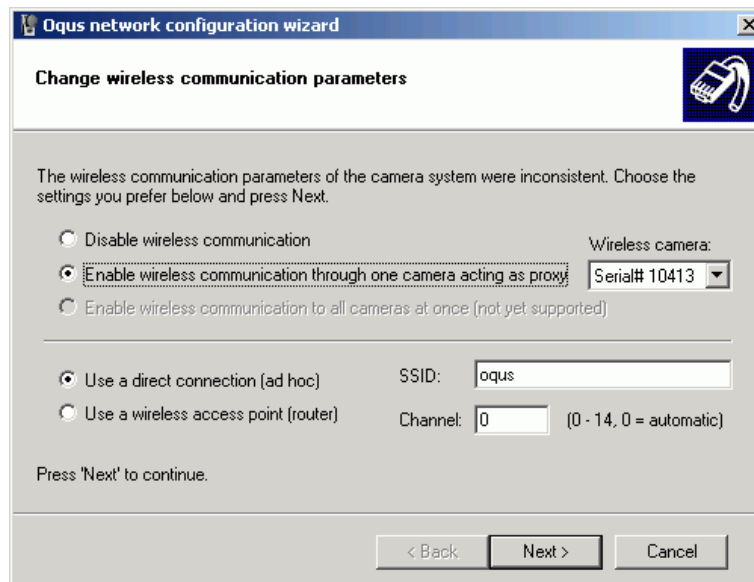
5. The wizard will show the current settings of the camera system. Set the settings to wanted wireless setup.

   Disable wireless communication
   Select this option to disable wireless on all wireless cameras in the camera system.

   Enable wireless communication through one camera acting as a proxy
   Select this option to enable wireless communication on the camera selected with **Wireless camera**.

   ✎ Note: The wireless communication will only be activated on the selected camera, any other wireless camera will be disabled.

   Below the line is the settings for the wireless network.

   Use a direct connection (ad hoc)
   The network is setup as an ad hoc network, which means that the camera and computer is connected directly to each other.

SSID

Choose a **SSID** so that you can identify the network. Make sure that it is not the same as an already existing network.

Channel

Select a channel for the wireless network. Use 0 for automatic if you do not know which channel you want.

Note: The **SSID** and **Channel** will default to oqus and 0 if there are wireless cameras with different wireless settings in the system.

Click **Next** to continue the wizard.
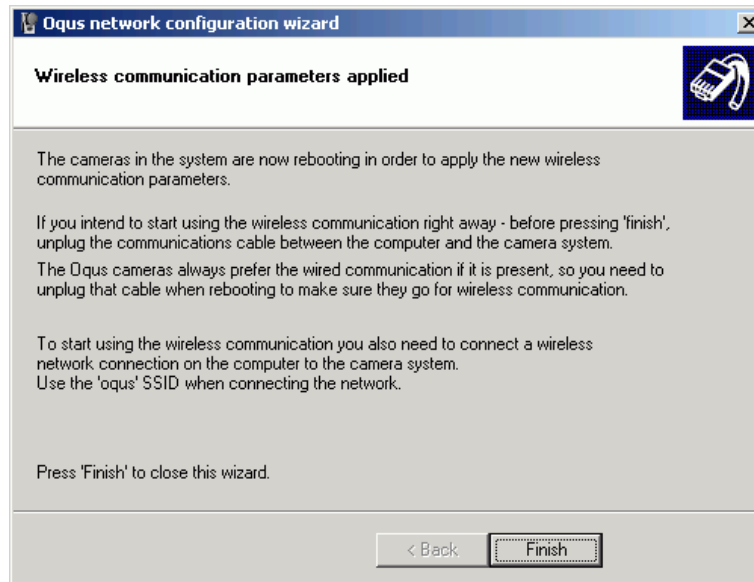
6. To make sure that the camera system starts up on the wireless interface it is important to follow the instructions in the wizard. The important steps are as follows:

   a. Unplug the wired communication. Otherwise the camera will start on the wired interface and will not be configured correctly for the wireless communication.

   b. Then connect the wireless network on the computer to the network with the name (SSID) that was set for the wireless network. Which program to use depends on the wireless hardware, please refer to its manual.

   Click **Finish** to close the wizard. QDS will not give any new IP addresses as long as the wizard is open.

Advanced (network settings)
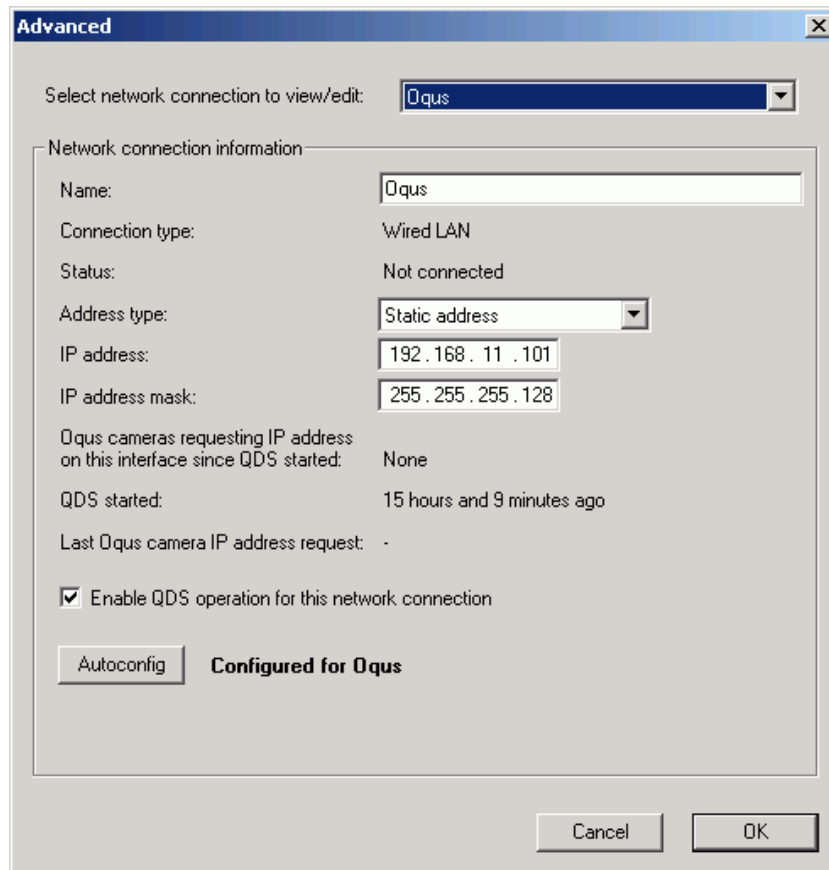
The **Advanced** settings dialog is opened with **Advanced...** in the QDS menu. The QDS dialog contains settings for the enabled network interfaces on the computer. These settings can be used instead of the QDS wizard or the Windows network settings.

Select network connection to view/edit
Select the network that you want to edit in the dialog. The list is in the same order as in Windows and if a network is disabled in Windows network connections it will not be shown in the list.

Name
Current name of the network.

Connection type
Type of network: wired LAN or wireless LAN.

Status
Current status of the connection: Connected or Not connected.

Address type
Select the wanted address type between these two types:

Received through DHCP
The network will receive its IP address from a DHCP server. The standard setting for many networks.

Static address
The network is set to a static IP address with the settings below. This setting must be used for QDS to give IP addresses to Oqus cameras.

IP address
Current IP address of the network. The address can be changed when **Address type** is set to **Static address**.

IP address mask
Current IP address mask of the network. The mask can be changed when **Address type** is set to **Static address**.

Oqus cameras requesting IP address on this interface since QDS started
Number of Oqus cameras requesting IP address on the network.

QDS started
Time since QDS started.

Last Oqus camera IP request
Time since last camera IP request.

Enable QDS operation for this network connection
Activate QDS on the network, i.e. if QDS is disabled for the network Oqus cameras connected on that network will not get any IP address from this QDS. When networks with static IP addresses are disabled it will be shown on the QDS icon.

Some of the networks with static IP addresses have been disabled.

All of the networks with static IP addresses have been disabled.

Autoconfig
Use this button to configure the network interface for Oqus cameras.

QDS conflict

There will be a conflict for the IP addresses when two or more computers with QDS are connected to the same camera system. In those cases the first QDS that replies after the startup of a camera will give the IP address to the camera.

On the other computers the Qualisys DHCP server message below will be shown and QDS operation will be disabled on that network. The QDS operation can be turned on again with the **Advanced** option on the **QDS** menu. However, make sure that the other computers are disconnected from the Oqus system otherwise QDS operation will be turned off again at the camera startup.
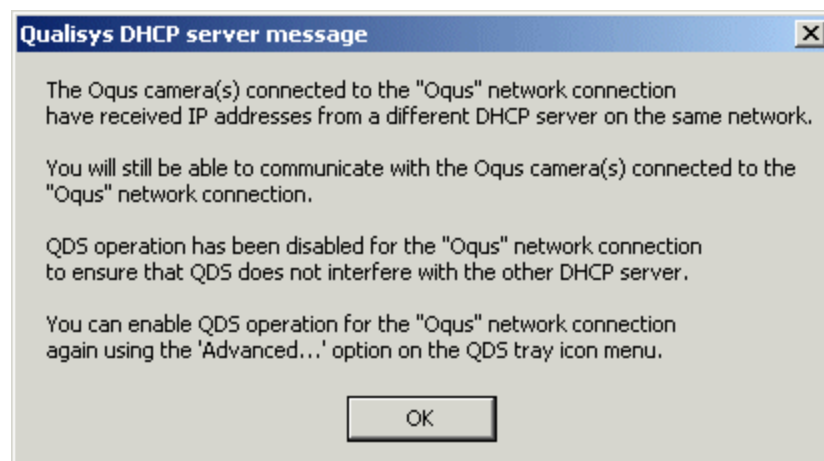
Network card setup

It is recommended to use a computer with two network interfaces, one reserved for the Oqus system and one for an office network or internet. This could be either two

Ethernet interfaces or one Ethernet and one WLAN. If you only have one interface it should be dedicated to the Oqus system.

⚠️ **IMPORTANT:** Do not connect the Oqus system to wired USB to ethernet adapters. The communication cannot be guaranteed on the adapters and there can be communication errors when capturing data.

The recommended setup is to use static IP on the Oqus network, other setups are possible but not recommended by Qualisys. Use the wizard to setup the network interface, see "Oqus network configuration wizard" on page 5.

To setup the network interface manually with a static IP-address follow the steps below.

1. Before changing the network configuration you can save the current configuration in QDS, if you want to use it later. This is recommended when you only have one network card.

2. Click on the Windows **Start Menu\Settings\Network Connections** to open **Network Connections** window.

3. Select the network card that you want to use for the Oqus system. Right-click on the card and select **Properties**.

4. In the list locate the item **Internet Protocol**. Select it and click on **Properties**.

5. Click on **Use the following IP address**.

6. Enter an **IP address**. It must start on 192.168.

   Wired LAN
   It can for example be 192.168.20.1. It is important to check that the first three numbers are not already used on an existing interface. Then the fourth number must be less than 128.

   Wireless LAN
   It can for example be 192.168.20.129 is important to check that the first three numbers are not already used on an existing interface. Then the fourth number must be more than 128.

   🖉 Note: If there are more than one computer that is connected to the Oqus wireless network they cannot have the same IP address.

7. Then enter the **Subnet mask** as 255.255.255.128 for Wired LAN and 255.255.255.0 for Wireless LAN. Click OK twice.

Setup Oqus system for wireless communication

The Oqus system can run with a wireless communication from the camera system to the computer. The camera uses the 802.11b/g@54mbps standard. However the communication speed can be reduced depending on the signal strength or if there are many other wireless networks.

Follow these steps to enable the wireless communication

1. Run the **Oqus network configuration wizard** to setup the wireless network interface on the computer for the Oqus system. Follow the instructions in "Oqus network configuration wizard" on page 5.

2. Make sure that the wireless network on the computer is not connected to any wireless network. Also make sure that no wireless network is set to automatic connection.

3. Connect the cameras to a wired network on the computer and run the QDS wizard to enable wireless in one of the cameras. Follow the instructions in "Oqus wireless camera setup wizard" on page 7.
It is important to connect the wireless network on the computer to the Oqus network when it is created. Otherwise QDS will not give the cameras IP addresses.

Setup Oqus system with Ethernet switch

The Oqus system can be setup in a daisy-chain, each camera connected to a Ethernet switch or in any combination of those setups. For most systems the recommended the setup is the daisy-chain as described in "Setting up the system (Oqus)" on page 1. However if the camera system is used a lot for high-speed video capture or if there are more than 16 cameras in the system, then it can be better to use a Gigabit Ethernet switch. It must be a Gigabit Ethernet switch to be able to handle more data than a daisy-chained system.

To setup the system with the Gigabit Ethernet switch follow these instructions:

1. Check that the computer has a Gigabit Ethernet card. Otherwise using a Gigabit ethernet switch will not change the performance of the system.

2. Connect the Ethernet card with the switch. You can use any of the ports on the switch.

3. Use the standard network card settings as described in the chapter "Network card setup" on page 12.

4. Connect the cameras to the ports on the switch using host cables. There can be any number of cameras connected in a daisy-chain to each port. But the following are the two main setups.

    Setup for high-speed video
    To maximize the video fetching time it is best to have daisy-chains of only 2-3 high-speed video cameras connected to each port. Note that the fetching time is not improved much by just having one camera at each port compared with two.

    Setup for more than 16 cameras
    Connect the cameras in daisy-chains of a maximum of 12 cameras. It is of course best to have a similar amount of cameras on each chain, e.g. a 28 camera system can have three chains with 10, 9 and 9 cameras.

The two setups can be combined, e.g. you can have 8 marker cameras in a daisy-chain connected to one port and then 4 high-speed video cameras split up in two chains connected to two other ports.
Note: Do not connected the different daisy-chains to each other. It will mess up the communication and the switch will be of no use.

Oqus startup sequence

This is the general Oqus startup sequence.The Oqus camera must be connected to a computer with a QDS running during the startup. This is because the camera must receive an IP-address from QDS to be able to communicate with other Oqus cameras. For more information see "QDS" on page 4.

1. Connect the power supply and the green LED on the front will blink twice.

2. After a few seconds the startup bar below is shown.

If the bar stops at two-thirds then the Oqus is waiting for an IP-address. The reason is probably either a missing connection to the computer or that QDS is not running, for instructions on how to search for the error see "Troubleshooting connection" in the QTM manual.

3. When the camera has an IP-address the display will show an image similar to one below. The Oqus will first synchronize to other cameras, during that process the clock is blinking and there is a spinning plus sign instead of the letter M or S. Wait until the clock stopped blinking and the display shows M or S.

The M or S on the display stands for Master respectively Slave. This is only to show which camera that is sending a synchronization pulse to the other cameras.

Setting the aperture and focus

For Oqus it is very important to set the aperture and focus correctly for your measurement volume. If these are not set correctly the cameras will not reach their full potential in detecting markers. Follow this procedure to set the aperture and focus.

1. Turn the strobe part of the camera counterclockwise to expose the lens for adjustment.

2. Open the aperture as much as possible, i.e. set the lowest aperture.

   🖉 Note: For the Oqus 1 series and 3+-series it is sometimes possible to have the aperture on a higher number than the lowest. Check this by using the **Marker intensity** mode in QTM to see whether the markers are bright enough. The advantage with a more closed aperture is a longer focal depth.

3. Place a marker in the measurement volume. Use the same size as will be used in the actual measurement.

4. Switch the cameras to **Video** mode in QTM and change the focus until the markers are as small and sharp as possible. Make sure that the **Flash time** is long enough on the **Camera settings** page.

   a. a.When you have set the focus correctly, switch to **Marker intensity** mode in QTM to make sure that the markers are visible in **Marker** mode. If the color of the markers is not red, set a longer exposure time in QTM on the **Camera settings** page in QTM.

5. Turn the strobe back (clockwise) to close it. The strobe should always be closed during measurement, to achieve the best strobe light distribution.

Arranging the cameras

Once the system has been properly set up, the cameras must be arranged to the current measurement setup. When arranging the cameras, it is best if they are in operating mode.

1. Start the measurement computer and the QTM software.

2. Locate the camera system in QTM on the **Connection** page in the **Project options** dialog, see "Camera system connection" in the QTM manual.

3. Open a new file with a **2D view** window.

4. Arrange the cameras to cover the entire measurement volume of the wanted motion. It is suggested to mark the corners of the measurement volume with markers, and use the **2D view** window to make sure that each camera can see the markers as expected. The **Video** view can also be used to see the camera field of view. For guidelines on how to arrange the cameras see "Camera positioning" in the QTM manual.

🖉 Note: The number of markers seen by each camera is also shown on the display on the front of each camera.

Tips on marker settings in QTM

The two important settings for marker calculation are **Exposure time** and **Marker threshold** . Usually it is sufficient to change them to see the markers in QTM. However it is not possible to give exact advice on how to set the settings, because the relations are too complex. The tips below will show you the basic method of how to use the settings. There are also other settings that can help to get a better measurement, e.g. **Marker masking** and **Marker discrimination**.

First of all make sure that the focus and aperture are correct, see "Setting the aperture and focus" on previous page.

Exposure and threshold must be used together, because changing one can lead to that you have to change the other. Follow these steps to set exposure and threshold settings.

1. Start a new measurement and stay in RT/preview mode. Use the **Camera settings** sidebar to change the settings.

2. Set the **Exposure time** to 400 microseconds (200 µs for Oqus 3+ and Oqus 4) and **Marker Threshold** to 175. These are the default values and often it is a good starting point.

3. Start with looking at the marker intensity image. Click on the **Marker intensity** button in the **Camera settings** sidebar to show the marker intensity image. For more information see "Video preview in QTM" in the QTM manual.

4. If the markers are not bright red in the marker intensity image, try increasing the **Exposure time** until they are bright red. For example with a longer distance to the markers, you may need a longer exposure time.

   a. For higher frequencies it might not be possible to increase the exposure so that the markers are bright red. However, as long as they are brighter than the background the camera should be able to find them by lowering the marker threshold.

   b. If there are extra reflections, you can try reducing the **Exposure time**. Extra reflections are anything that is not a marker and has a color different from blue. Green is the threshold level.

   c. Remember that you can set this setting individually for each camera, see "Camera settings sidebar" in the QTM manual.

5. Switch back to Marker mode and check if the markers are visible. If they are not, go back to Marker intensity mode and adjust the **Marker threshold** value. It is not possible to give an exact value for the threshold at a certain exposure, because each setup is different.

   a. Increase the threshold if the background looks light blue or even green in the marker intensity image. A light blue background will make it harder for the camera to calculate the markers.

   b. Decrease the threshold if the markers are not bright red in the marker intensity image. For example, at short exposure times of 200 µs (100 µs för Oqus 3+ and Oqus 4) and lower the threshold needs to be low, usually around 100-150.

   c. Make sure that the marker calculation is stable at the selected threshold. If the threshold gets too low there will be a lot of extra reflections or no markers at all. A too high threshold will result in small markers or missing markers.

      d.   Remember that you can set this setting individually for each camera, see "Camera settings sidebar" in the QTM manual.

6.   Finally check that the markers are large enough to give a good accuracy. Check that the marker size is at least 200 in the **Data info** window.

Mixing Oqus camera types

The Oqus types are compatible so that different Oqus types can be mixed in one system. The connection is done in the same way as for a regular Oqus system and the cameras can be placed in any order you wish.

When mixing camera types the global camera settings will default to the lowest of the camera limits. This means for example that the capture rate will be limited to 187 Hz at full field of view, when 3- and 5-series are mixed. However individual settings can always be set within the limit of the camera type.

Oqus 3+ features compared to other Oqus models

The Oqus 3+-series has a new sensor with some new features and improvements which are all described below.

Light-sensitivity
The Oqus 3+ is at least 50% more light-sensitive than the other Oqus models. This means that you can see markers at a longer distance with the same exposure and threshold setting as on the 3-series. Or you can use smaller markers at the same distance as you could for the 3-series.

Note: The default exposure time setting for Oqus 3+ is 200 microseconds, because of the increased light sensitivity.

The increased light sensitivity also means that it is easier to see the markers at higher frequencies, because you can use a shorter exposure time.

In small volumes, where the cameras are about 3 m from the subject, the aperture can sometimes be closed more than 2.8. Use for example 4 or 5.6. The advantage is longer focal depth and therefore sharper markers.

Improved image
The image has less static and dynamic noise compared to the other cameras. Therefore the marker threshold can often be lower than on the other camera types.

Sensor High-speed mode
The Oqus 3+ has a special sensor mode where you only use a fourth of the pixels but still keep the field of view. The camera can then capture at 1764 Hz with the sensor resolution of 648*512, slightly larger than the 1-series resolution. For more information see "Sensor mode" in the QTM manual.

Active filtering
The Oqus 3+ camera supports active filtering, in which each image is captured twice to remove the background light. This dramatically increases the ability to capture passive markers in an outdoor environment. For more information see "How to use active filtering" in the QTM manual.

Note: Also available on the 1-series cameras.

Oqus display

The Oqus camera has a large graphical OLED display and three LEDs on the front to inform the user of the current status of the camera. The display shows, among other things, the camera number and the number of markers currently seen by the camera.

🖉 Note: The display will be turned off when the camera enters stand-by mode, i.e. if the camera has not been in use for 2 hours. Start a preview in QTM to light up the display again.
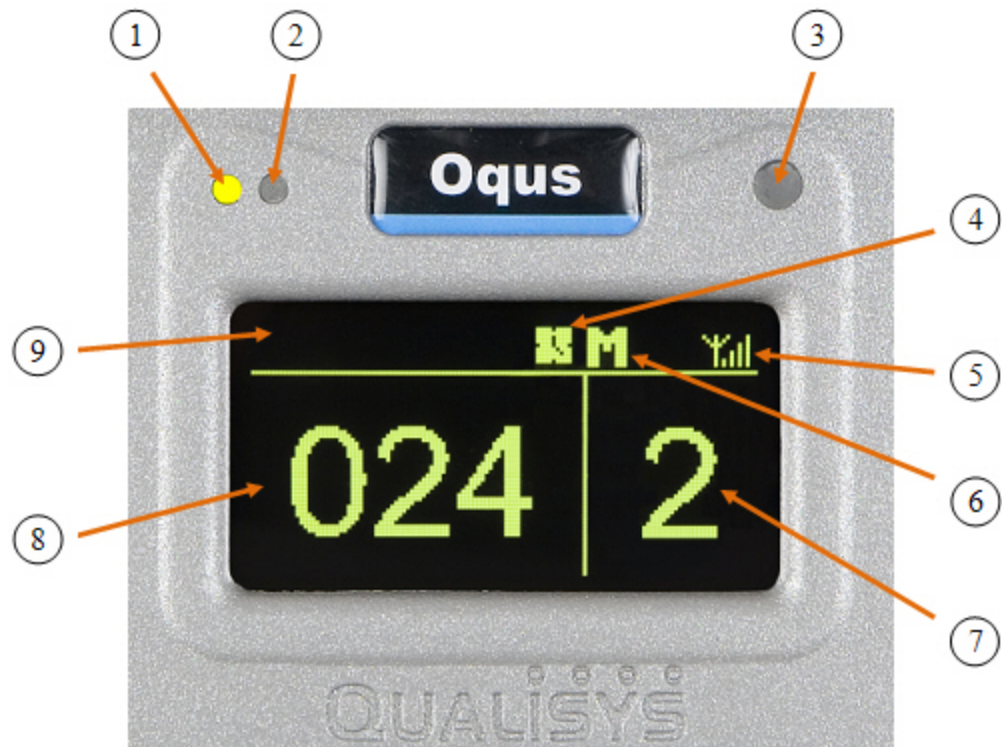
1. **Measurement status indicator**
   Green light - The camera is ready to start a measurement
   Yellow light - The camera is measuring
   Flashing green light - Waiting for trigger to start measurement
   Flashing yellow light - Waiting for trigger to switch from pre-trigger to post-trigger measurement

2. **Error indicator**
   A red light indicates that an error has occurred. The LED is blinking when a software error occurs and is lit constantly if a hardware error occurs.

3. **IR receiver**
   The IR receiver is used for synchronization with certain active markers. It detects modulated light with a frequency of 33 kHz and is sensitive to light with wavelengths between 800 and 1100nm.

4. **Synchronization status**
   During the synchronization phase this symbol is flashing. When the camera is synchronized with the master camera in the system it becomes stable.

5. **WLAN indicator**
   This symbol is displayed when the WLAN of the camera is activated.

6. **Master/Slave indicator**
   An M indicates that the camera is master for the system and by that controls

for example internal synchronization. An S indicates that the camera is a slave. The indicator can also be a rotating + sign, which means that the camera is looking for the Master camera.

7. **Camera number**
The area to the right usually shows the camera number that the camera has in QTM. The camera number can be changed with the **Reorder** tool in the 2D view window. This number is stored in the camera so it is shown at the next camera startup.

   *Note: If the camera has never been connected to QTM the last three digits of the serial number (upper part) and the last octet of the IP-number assigned to the camera (lower part) will be shown instead. This can also be activated from the QDS menu, see "QDS" on page 4.

8. **Marker area**
During a marker measurement this area shows the number of markers currently seen by the camera. When the camera is idle or is collecting video, this area shows '-----'.

9. **Text area**
This area is used for scrolling text messages, for example during startup.

Oqus high-speed video camera

The high-speed video version of a Oqus camera is adapted to capture full-frame, full-speed, full-resolution high-speed video. In this configuration the camera is therefore equipped with a large buffer memory and a clear front glass to get the best possible performance out of the image capture.

The clear front glass is mounted so that all of wavelengths can be captured by the camera. The normal dark front glass is an IR-filter that removes the visible light. However the high-speed version is also delivered with a removable IR-filter on the lens. Which is important to mount if the camera is in the marker mode, because the data is improved when the visible light is removed to increases the contrast between the background and the marker. For instructions on how to get access to the lens see "How to change strobe unit" in the QTM manual.

Oqus underwater system

Qualisys provides the possibility to measure under water, (e.g. in indoor ocean basins used for ship scale model testing or ordinary basins, used for water sports) by using specially modified Oqus motion capture cameras.

Oqus underwater cameras are equipped with a special strobe with high power cyan LED:s. These LED:s are not limited to a flash time of 10% of period time as the regular Oqus LED. Therefore the exposure time can be set to almost the period time. The long exposure times are needed to get enough light in the water. Because the water absorbs more light than air it also means that the measurement distance are more dependent on the exposure time.

⚠ **Warning**: Be careful when using the camera out of water and do not use longer exposure times than 2 ms.

The FOV is also changed by refraction index of water (1.33). This means that a lens with 40º FOV is reduced to 31º FOV.