info@radar-touch.com

Manual Version 3.4

Table of contents

This manual is made for the radarTOUCH software version [3.1], which offers a few new features like build in MultiBlobViz.

1. radarTOUCH Contents

The radarTOUCH system should contain the following:

» RT500 measurement device (Figure 1)
- Power supply cable and mains adapter (Figure 2)
- Ethernet cable with 5Pin XLR female to Ethernet adapter (Figure 3)
- USB Dongle containing the radarTOUCH Software (Figure 5)

» Mounting system (not always necessary)

RT500 deluxe mounting system (Figure 6) with:
- Doughty half coupler and screw M10 * 30 (Figure 7)
- Two screws M5 * 45 (Figure 7)
- Two screws M5 * 50 (Figure 7)
- Safety wire

RT500 standard mounting system (Figure 8) with:
- Two screws M5 * 45
- Two screws M5 * 50
- Safety wire

Figure 1 RT500 measurement device
(Colour might vary!)

Figure 2 Power supply cable and mains adapter

Figure 3 Ethernet cable with 5Pin XLR female to Ethernet adapter

Figure 4 RS232 cable

Figure 5 USB Dongle containing the radarTOUCH Software

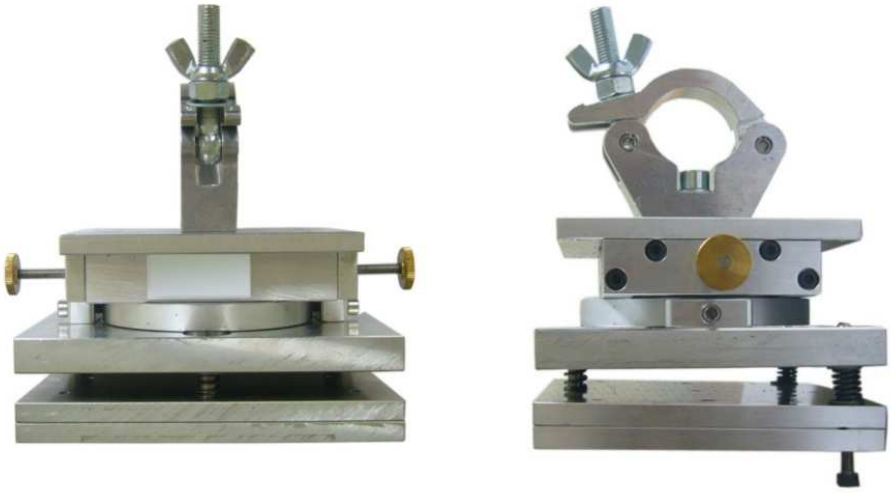


Figure 6 RT500 Deluxe mounting system

Figure 7 Accessories deluxe mounting system

Figure 8 RT500 Standard mounting system (in case of renting)
Consists of: Truss mounting (left) and ceiling mounting (right)

2. About the radarTOUCH

The radarTOUCH measurement device is a rotating laser scanner. The laser is a Class 1 Laser and not dangerous for the human eye. The laser works with a wavelength of 905nm. It scans over 190° and does 528 distance measurements in ca. 40ms. The measurements are based on the Time-of-Flight (TOF) method.

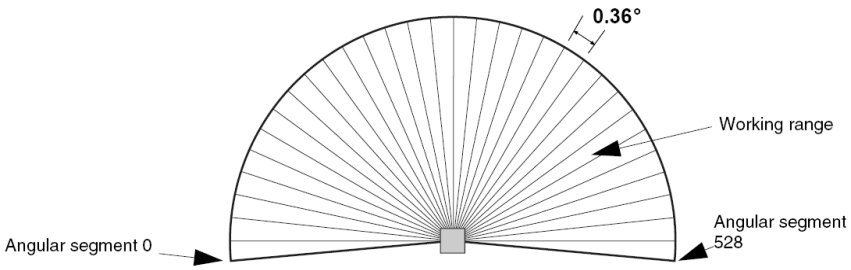


Figure 9 Working range and angular resolution

The radarTOUCH can be installed above or below every surface. This surface can be for example a display (LCD, PDP, OLED, …), a projection screen, an LED wall etc. The radarTOUCH is also able to make surfaces interactive, which are usually never used, to realise some computer – user interaction like the wall of a building or a car.
Furthermore, this system can be used completely detached from any surface giving the user the possibility to interact “free in the air”, for example with gestures. Figure 10 shows how the radarTOUCH could be used in front of a rear projection screen. Please note that the real measurement resolution is a lot higher than in this model which is made to give you an idea of how to use the device.

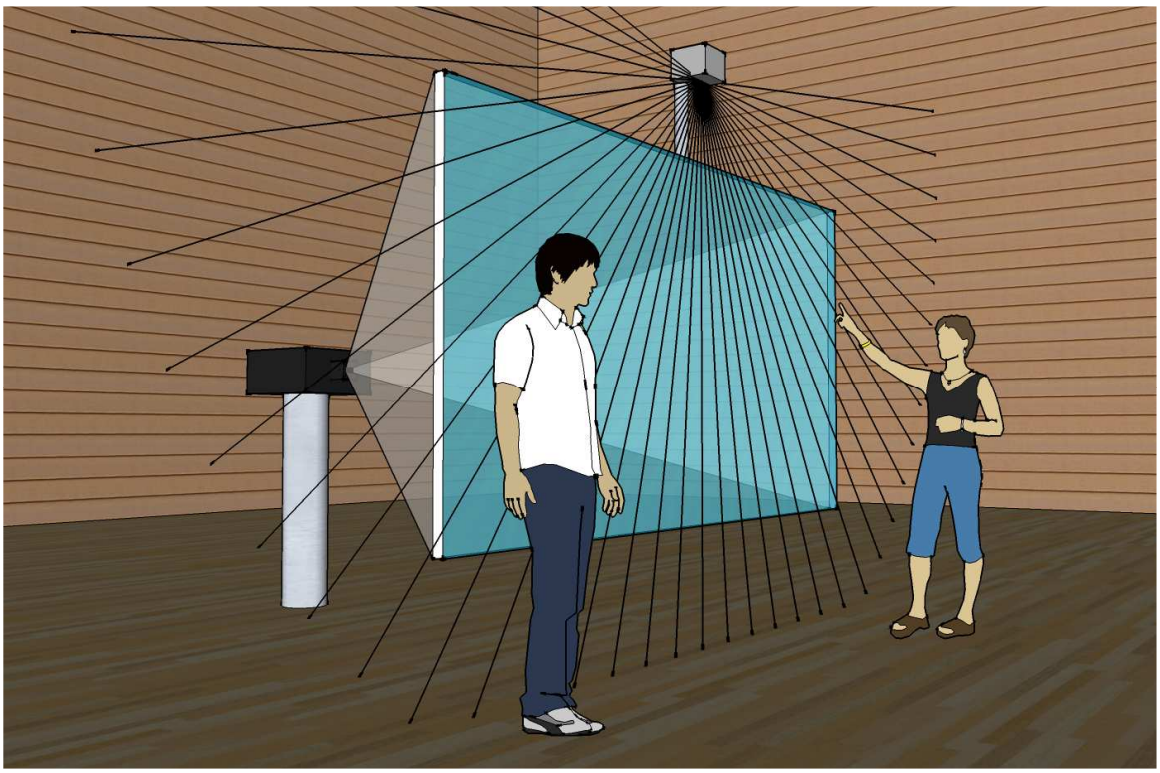


Figure 10 Using the radarTOUCH in front of a rear projection

Figure 11 shows how the radarTOUCH could be used on a stage to give the presenter the possibility to interact with his presentation in a completely new way. Please keep in mind again that the real measurement resolution is a lot higher than in this picture.

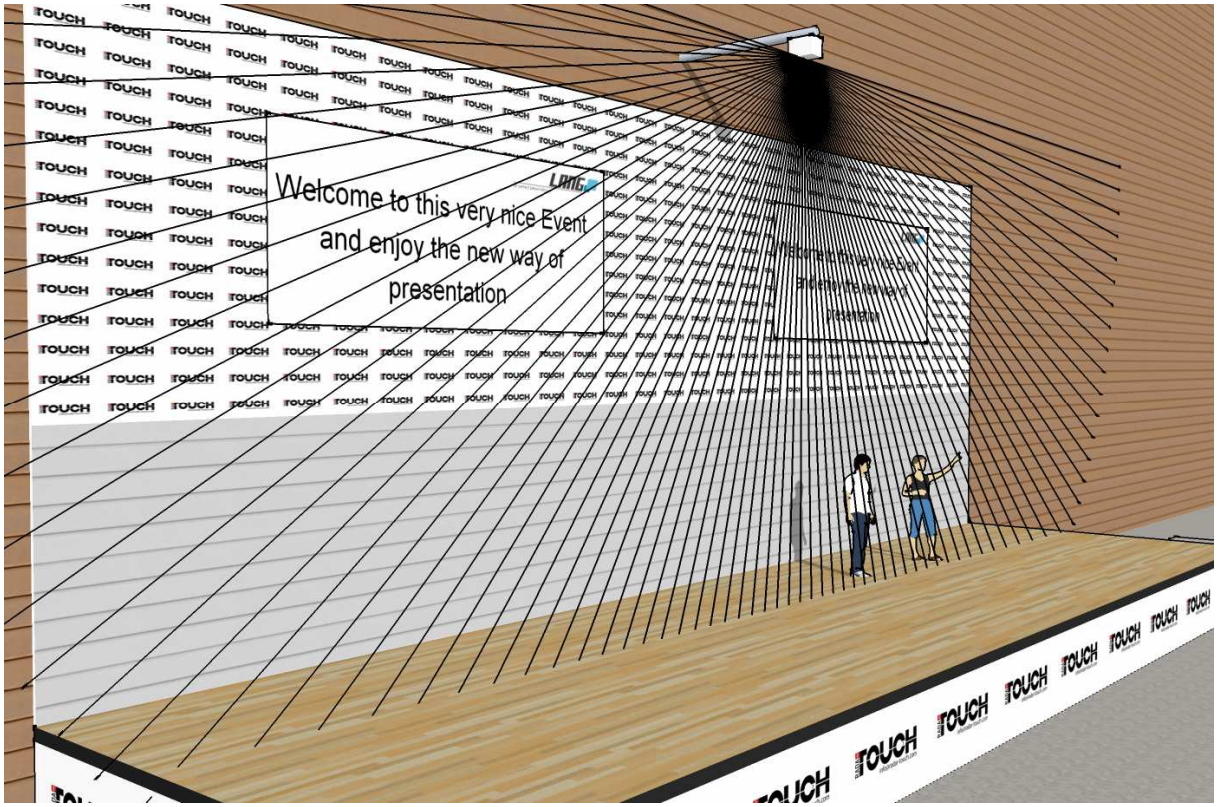


Figure 11 radarTOUCH used on a stage

Theoretically the maximum distance for an obstacle to be detected is 50m. If an obstacle gets successfully detected depends on a few parameters. These are theoretical values and the performance should be tested while planning a project.
It depends mostly on the following parameters:

» Remission of the obstacle
Remission is not equal to reflexion: it describes a diffuse reflexion.
An ideal remitter would remit the light in the same way a Lambert emitter would.
The remission must be high enough to give the detecting unit in the measurement device a chance to receive sufficient light. The so called inverse square law describes the fact that the remitted light is reduced by the reciprocal value of the radius. This law makes the importance of the remission obvious.
Figure 12 shows the minimum diffuse reflection in percent compared to the distance that an obstacle needs to be detected. For these values the size of the obstacle has to be big enough and is a given fact in the diagram.

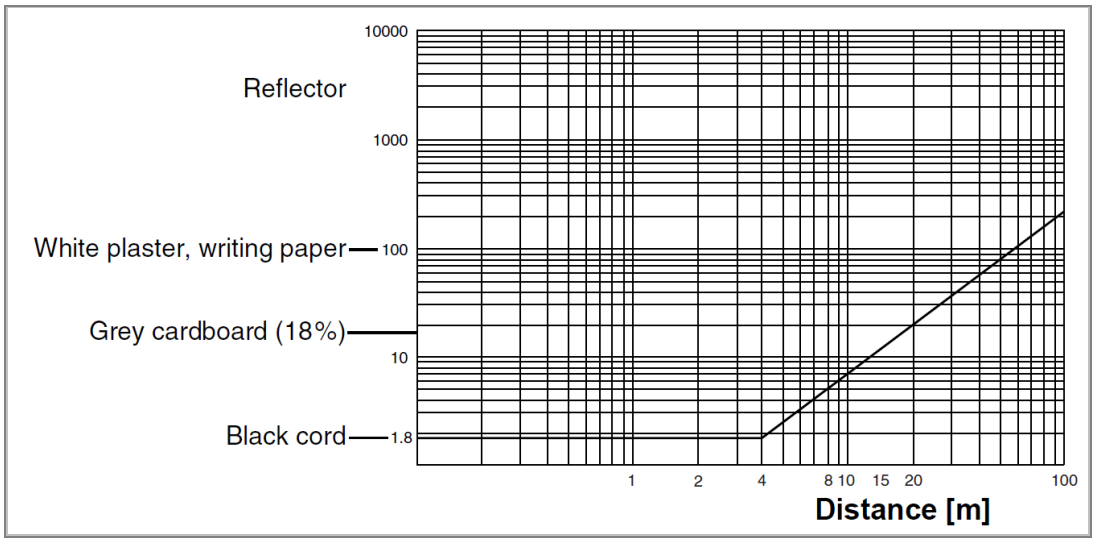


Figure 12 Diffuse reflection in %

» Size of the obstacle
The measurement resolution decreases with rising distance between the obstacle and the measurement device. This is due to the fact that the size of the laser spot gets bigger with increasing distance.
Figure 13 shows the minimum object size with changing distance. It is important to know that the values in this diagram are determined with the least possible remission. That means it describes a “worst case scenario”.

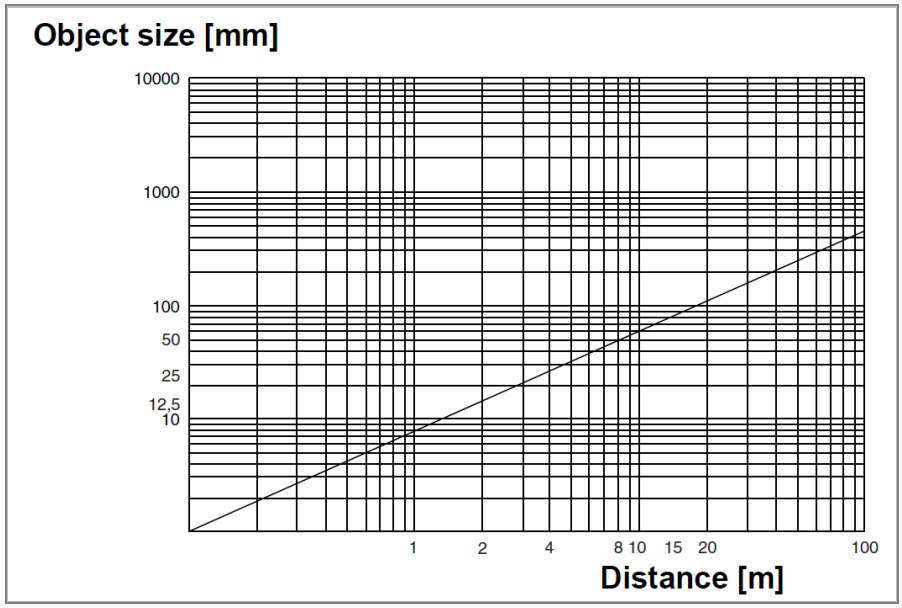


Figure 13 Minimum object size

These diagrams should only provide an approximate idea of the object sizes that might be considered when integrating a radarTOUCH and are usually more pessimistic than the reality. In the end, only practical tests can deliver reliable answers.

3. Installing and connecting the radarTOUCH

3.1 Mechanical Installation

In Figure 14 you can see the working principle of the radarTOUCH System.

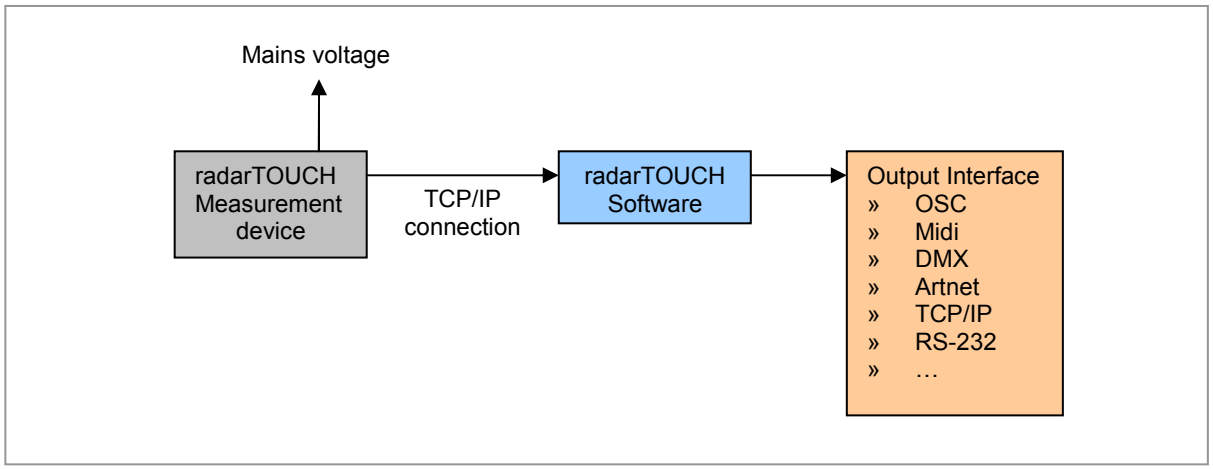


Figure 14 Working principle

You can place the radarTOUCH measurement device on the floor or you can mount it above your interactive area, for example fixed on a truss system. The flying installation requires a radarTOUCH mounting system.
We offer two mounting systems which are described in the next passage.

3.1.1 Deluxe mounting system

With the deluxe mounting system you can adjust the following parameters:

- Rotation angle measurement device compared to the active area (should be 0°).
- Distance in z-direction between the measurement device and for example the screen you are using as active area.
- The tilt in y-direction

To attach the radarTOUCH measurement device at the mounting system, use the four M5 screws (the longer 50mm screws belong to the top of the measurement device, this is where the cables are connected) (see also Figure 17).
The mechanical adjustments require some practice but then it is possible to adjust it rather close to any surface (~2.0cm).

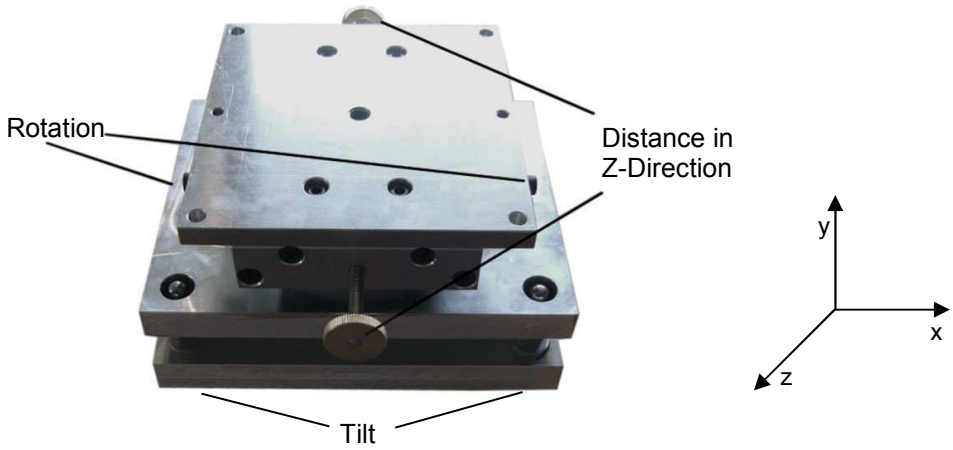


Figure 15 Adjustment features Deluxe Mounting System (Top view)

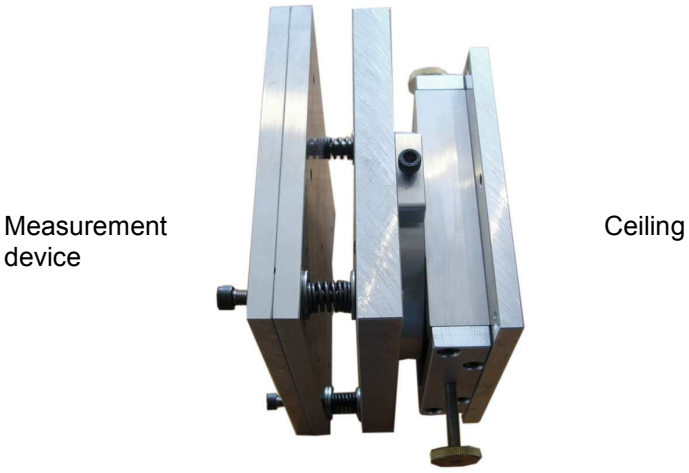


Figure 16 Deluxe Mounting System (Side view)

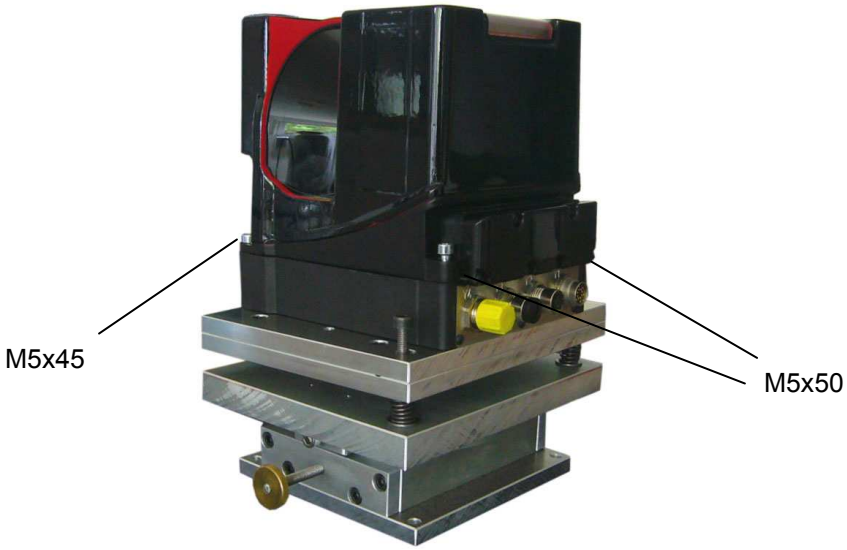


Figure 17 Measurement device attached to the deluxe mounting system

3.1.2 Standard mounting system

The standard mounting system is a good solution for most applications.
However, if the installation requires a very high precision you should use the deluxe system.

With the standard mounting system you can adjust the following parameters:

- » Tilt in y-Direction
- » Rotation angle measurement device compared to the active area (should be 0°) but only in a small range

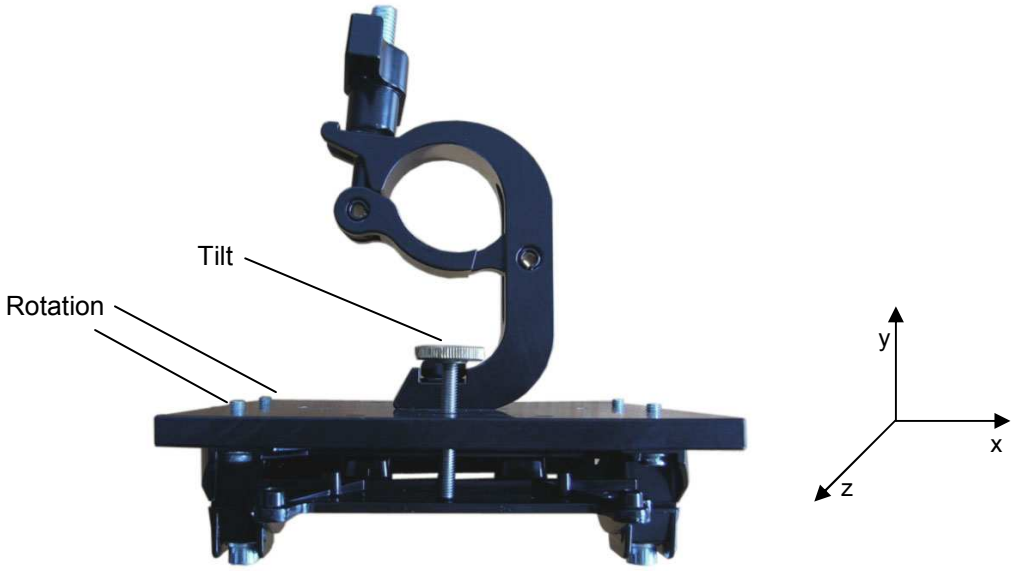


Figure 18 Adjustments for standard mounting system

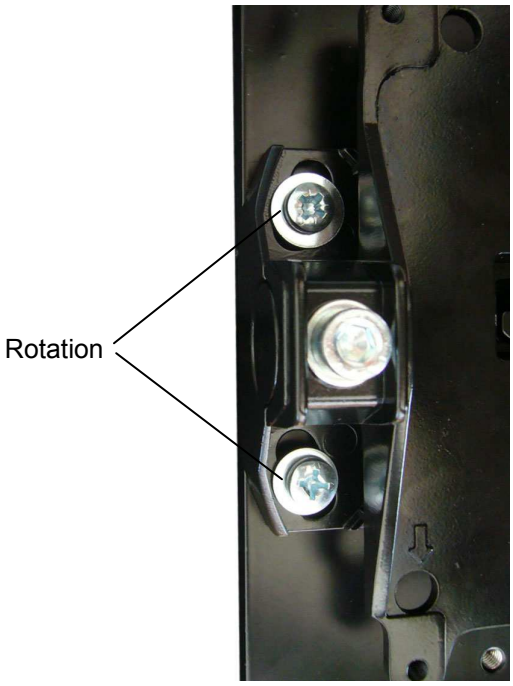


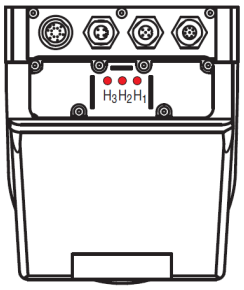
Figure 19 Screws for rotating adjustment

3.2 Connection

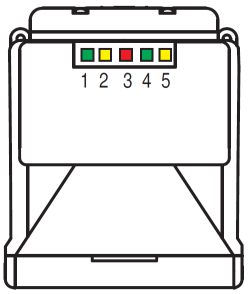
To run the radarTOUCH software, you need a Windows PC with an installed Java Runtime Environment (Version 1.6 or newer, 32 bit). For downloading the JRE just follow this web address: www.java.sun.com/javase/downloads/index.jsp.
The radarTOUCH Software will only run if it is started directly from the USB Dongle.

Follow the next steps to connect the radarTOUCH hardware with the radarTOUCH software.

- » Use the Ethernet cable to connect the measurement device connector Y2 with your computer.
- » Connect the power supply cable to the connector Y1 on the measurement device. Plug in the mains adaptor.
- » First of all a red LED will light up. After a few seconds one or two other LEDs will light up. The measurement device is now ready. For further explanation regarding status LEDs please see below.
- » Configure your PCs network settings by using a static IP-address 192.168.xxx.yyy where yyy and xxx is a number between 0 and 255.
- » Depending on the radarTOUCH software version you are using in your application, you might have to use one specific IP address. Information like this will be communicated before you are going to use it. Usually the measurement devices are shipped with the IP 192.168.60.3, so your computer can get the IP 192.168.60.11 for example. (This is the default OSC client IP)
- » Start the .exe file on the USB Dongle. The Software will start and automatically build up a connection to the radarTOUCH measurement device. You cannot remove the files from the dongle and start them from another location.
- » If it doesn't start automatically please have a look at chapter "5.3 How to ping the radarTOUCH" and check the connection between your computer and the measurement device.
- » (Please refer to chapter "5.1 Changing the IP address of your computer" learn how to change the IP address)
- » Status LEDs – function and meaning:



LED	Colour	Function / Meaning
H_1	red	Ethernet system ready
H_2	red	Ethernet connection present
H_3	red	Ethernet data transmission active



LED	Colour	Function / Meaning
1	green	Sensor functions active, near detection field is free
2	yellow	Far detection field is occupied
3	red	Near detection field is occupied, Fn outputs are switched off
4	green	Near detection field is free, Fn outputs are free
5	yellow	» Slowly flashing (SF) at approx. 0.25Hz: warning message » Flashing fast (FF) at approx. 4Hz: error message » Continuous light (CL): restart-disable locked

4. The radarTOUCH Software

4.1 Graphical user interface

The graphical user interface (GUI) contains two main windows. The first window, the settings panel, offers the user the possibility to adjust the parameters which affect the way the system works. The second window, the PreViz, shows the measurement data in a pre-visualisation. Figure 20 shows the GUI. In the menu bar you can save your current settings or you can load settings you have done previously. Furthermore you can turn the PreViz on or off and you can open an Info-Window.

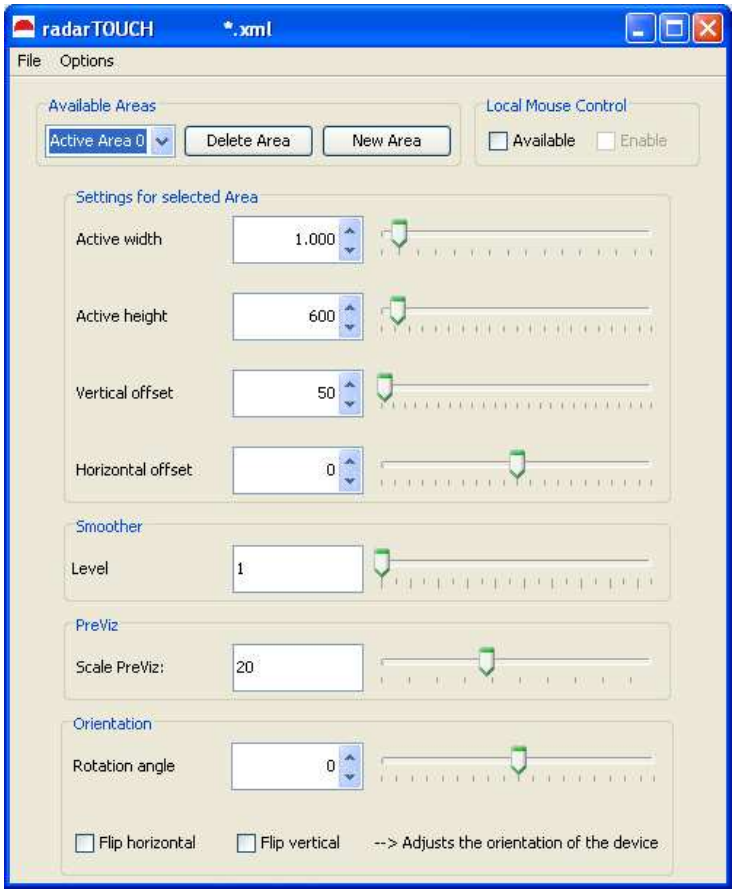


Figure 20 GUI settings

In the upper part of the GUI, labelled as “Available Areas”:

- » You can see all available active areas
- » You can create a new area or
- » You can delete the active area that is selected in the drop down box.

In the part “settings for selected area” you have to define the size of the active area. The active area is the area in which the system interprets obstacles. Everything out of this area does not have any effect on the system.

The slider “Vertical offset” and “Horizontal offset” adjust the vertical and horizontal position of the active area.
With the Smoother slider you can adjust the strength of a de-noising algorithm. If it is set to the value 1, it is set to bypass.

The smoothing value and the setting for active area can be done for each area separately. The next parameters in the settings GUI (Rotation angle, Flip horizontal / vertical, Scale PreViz) work in a global way: they have effect on each active area.

By varying the parameter “Rotation angle” you can virtually rotate the measurement device. With the use of the check box “Flip horizontal” and “Flip vertical” you can flip the horizontal and vertical orientation of the device. With this you can define how the device is installed
The Slider “Scale PreViz” scales the Pre-Visualization.

Creating a new active Area
By clicking the “New Area” button a window (Figure 21) will appear, asking you to select an interface. Right now there is only TUIO available. Press next and you can adjust the settings of your chosen interface like OSC Port and the IP address of the receiver (Figure 22).

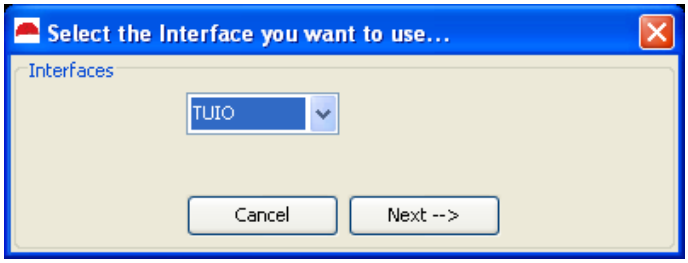


Figure 21 Creating a new active Area: Select Interface

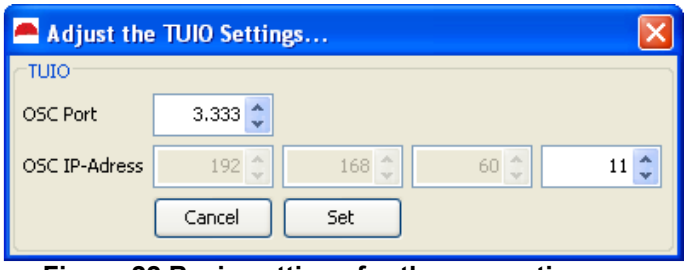


Figure 22 Basic settings for the new active area

Local Mouse Control
By clicking the “Available” check box, the active area that controls the local mouse will appear in the PreViz and in the drop down box. The ID is always -1. You can adjust all parameters like the way it is done with all the other active areas. If you check the “Enable” box, the mouse will be controlled.

4.1.1 The PreViz

An active area is displayed in the PreViz window as a coloured rectangle. If you move with the mouse over the rectangle, it will show the current settings regarding the IP-Address and the port to which the data is sent. If you click in one rectangle, it will automatically be selected in the settings GUI. Figure 23 shows the PreViz with one active area. Figure 24 shows the PreViz with two active areas.
By using Keyboard-Shortcuts you can define what data should be displayed in PreViz Window. To use them, the focus must be on the PreViz.
Here is a short overview:

- » m: Draws every 10 measurements the number on the angular element
- » g: Draws start and end points of the obstacles

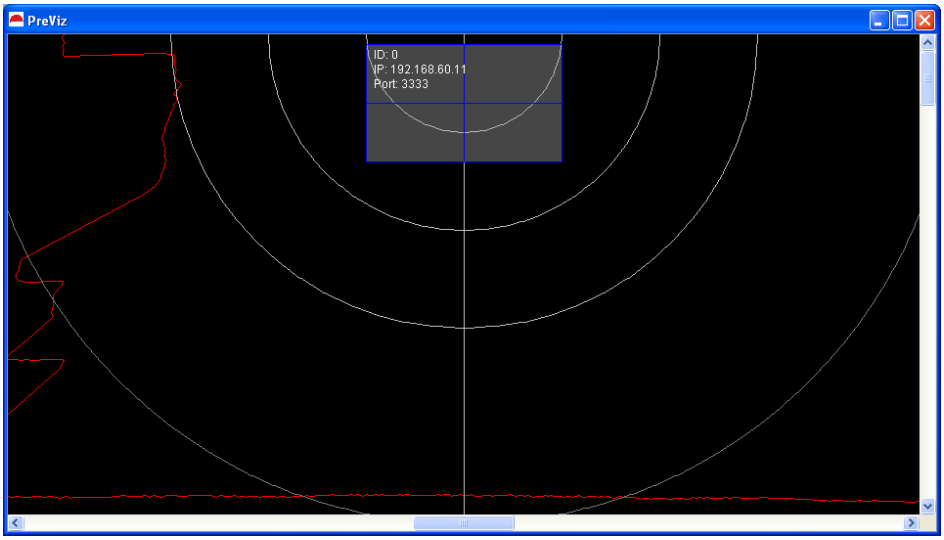


Figure 23 PreViz with one active area

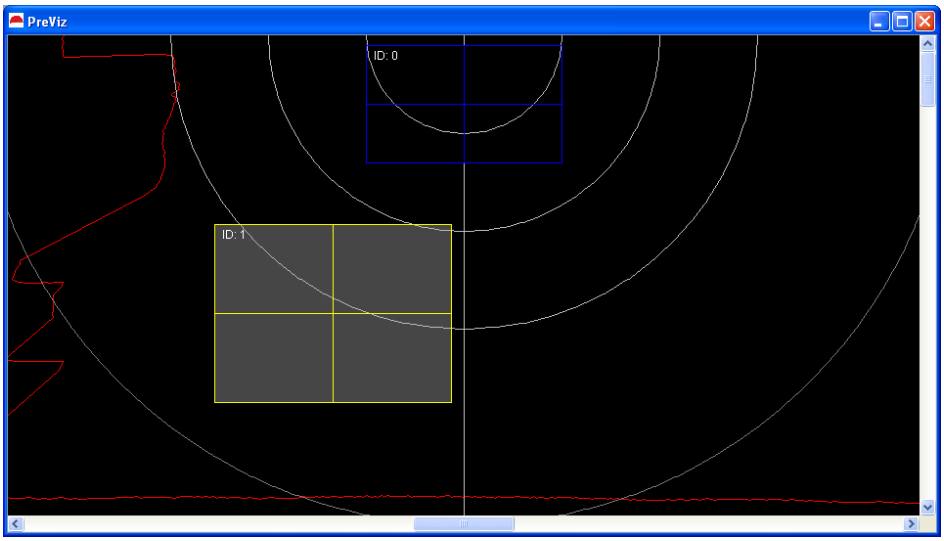


Figure 24 PreViz with two active areas

4.1.2 MultiBlobViz

If you are ready with setting up the active area you can use the test program which will help you to do some fine adjustments. This tool is called “MultiBlobViz”, you will find it under Options → Start MultiBlobViz.
What it does is to receive TUIO data on port 3333 and draws circles on the corresponding screen position (see also chapter 4.2.2 Open sound control (OSC): TUIO). Make sure that your PC on which you are running the radarTOUCH software, has the IP address to which you are sending the TUIO data.
By using the arrow keys you can change the position and size of your active area:

Arrow keys up, down, left, right
→ Changes horizontal and vertical offset

CTRL + arrow keys up and down
→ Changes active height

CTRL + arrow keys left and right
→ Changes active width

The small icons in the lower part of the screen will help you during your adjustments.
You are only changing the active area which has the focus in the PreViz window.

You can leave this application by pressing ESC but keep in mind that you have store your new settings are not stored automatically.

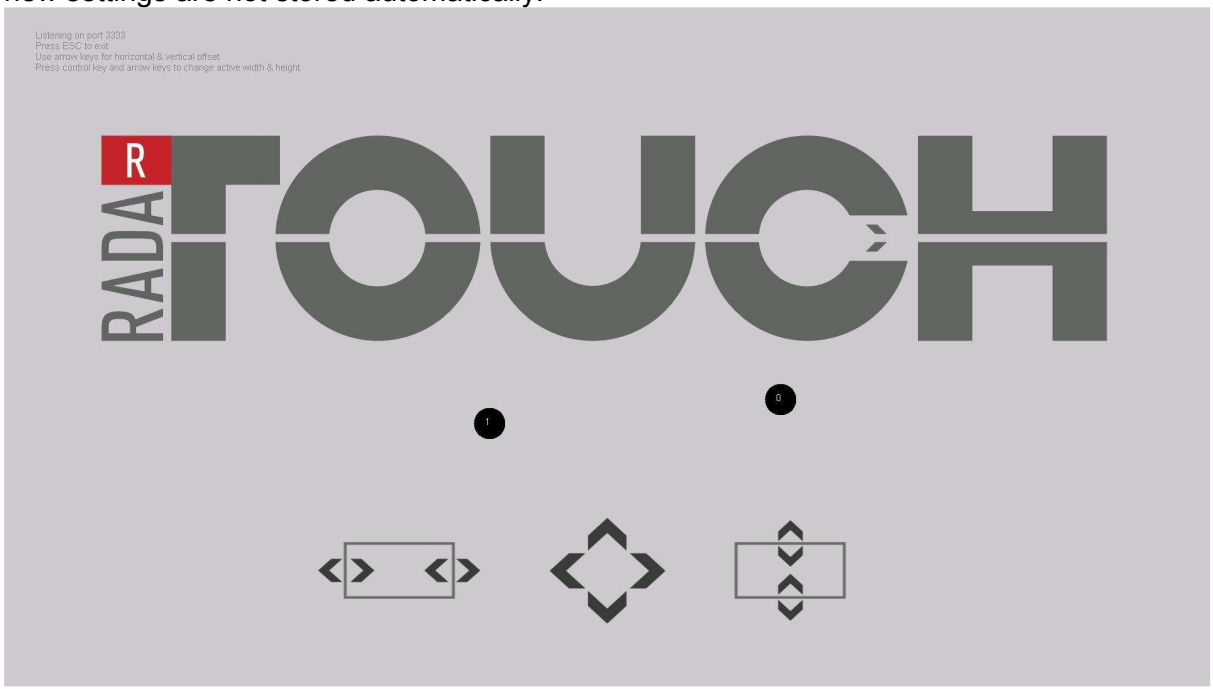


Figure 25 MultiBlobViz test program

The middle of a blob should be the middle of you finger, then the active area was set up correctly. Check the center and also the boarders of your screen.

4.1.3 The Info-Window

The Info-Window (Options → Info) informs you for example regarding network setting and used output interfaces.

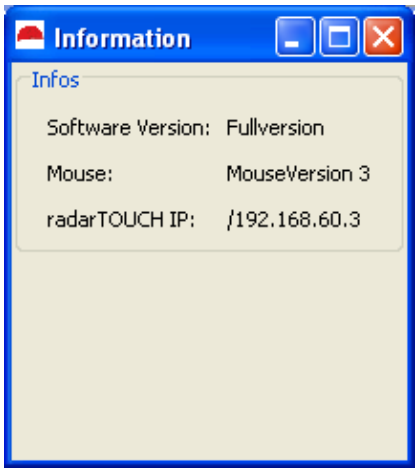


Figure 26 The Info-Window

4.2 Output interfaces

In the radarTOUCH software output interfaces are used to send data of detected obstacles to a receiving software. There are a lot of possibilities to do this. In most cases the radarTOUCH software sends the data via OSC or it simply controls the windows mouse directly. Controlling a windows mouse usually offers only single touch or dual touch interaction. These interfaces will be described in the next paragraph.

4.2.1 Mouse Emulation

First of all it is important to know that the radarTOUCH is not a device that can be used as a complete mouse replacement. If emulating a mouse, the software has to run on the PC whose mouse shall be controlled. Furthermore, it is important to know how the mouse should react. Shall the left button be clicked and released when entering the active area with an obstacle? Or shall it work like a drag and drop function which keeps the button clicked as long as the obstacle is detected?

4.2.2 Open sound control (OSC): TUIO

OSC is an interface that usually uses the UDP protocol. Data is sent to so called OSC-Addresses. For more information please have a look at http://opensoundcontrol.org/.
One very popular protocol for multi touch applications is TUIO. It defines different Profiles; we are using the /2dCur Profile. It sends the following data always to the OSC-Address */tuio/2dCur* .

set, s, x, y, X, Y, m

With:

set	→ String that always comes first to indicate which data will follow
s	→ Object ID [int 32]
x	→ x-Coordinate, Range 0…1 [float 32]
y	→ y-Coordinate, Range 0…1 [float 32]
X	→ Movement vector x-Direction (motion speed and direction) [float 32]
Y	→ Movement vector y-Direction (motion speed and direction) [float 32]
m	→ motion acceleration [float 32]

This is sent for each detected obstacle.

alive, [List of all objects alive]

With:

alive:	→ String that always comes first to indicate which data will follow
id's	→ IDs of all detected obstacles

This is sent once for one measurement and includes all active detected obstacles.

For more detailed information please have a look at http://www.tuio.org/?tuio10. Everything needed is described there.

4.3 XML Files

There are two different XML files used in the radarTOUCH software which will be described in the following paragraph.

4.3.1 Setting files

The user can store all settings that he has done by using the GUI in a XML file. The software automatically stores one XML file (RadarTOUCH_lastSettings.xml) that keeps track of the last used settings. This file is always located in the same path as the software itself and is loaded automatically on restart if the file is available. Otherwise the software will start with default values.
This is how a stored file with one active area and disabled mouse looks like:

```
<ns2:settings xmlns:ns2="test">
    <selectedOutputID>1</selectedOutputID>
    <skalierungDerZeichnung>20</skalierungDerZeichnung>
    <rotationAngle>0</rotationAngle>
    <hFlip>false</hFlip>
    <vFlip>false</vFlip>
    <interpreterList>
        <activeArea>
            <activeHeight>600</activeHeight>
            <activeWidth>1000</activeWidth>
            <colour>0</colour>
            <colour>0</colour>
            <colour>255</colour>
            <HOffset>0</HOffset>
            <VOffset>50</VOffset>
        </activeArea>
        <smootherLevel>1</smootherLevel>
        <port>3333</port>
        <inetAdress>192.168.60.11</inetAdress>
        <uniqueID>0</uniqueID>
    </interpreterList>
    <selectedInterpreterInComB>0</selectedInterpreterInComB>
    <mouseSettings>
        <activeArea>
            <activeHeight>200</activeHeight>
            <activeWidth>300</activeWidth>
            <colour>255</colour>
            <colour>0</colour>
            <colour>0</colour>
            <HOffset>0</HOffset>
            <VOffset>50</VOffset>
        </activeArea>
        <smootherLevel>1</smootherLevel>
        <uniqueID>-1</uniqueID>
        <mouseEnabled>false</mouseEnabled>
    </mouseSettings>
</ns2:settings
```

4.3.2 Configuration file

There are a few settings that are typically not often changed. If the user needs to change them, he can open the RadarTOUCH_Config.xml with a text editor, for example word pad, and change and save the parameters. The software needs to be restarted to use the new configuration file.
Here is an overview of the parameters:

```
<ns2:configSettings xmlns:ns2="config">
    <radarTouchIP>192.168.060.004</radarTouchIP>
    <oscClientIP>192.168.060.011</oscClientIP>
    <mouseVersion>1</mouseVersion>
    <allowStartingTwice>true</allowStartingTwice>
    <startMinimised>false</startMinimised>
    <wideWorkingRange>false</wideWorkingRange>
    <minObjectSizeIs_1>false</minObjectSizeIs_1>
    <flipXandY>false</flipXandY>
    <maxDistance>0</maxDistance>
    <maxAngularDistance>0</maxAngularDistance>
    <trackingSettings>
        <factorSimilarityThreshold>40</factorSimilarityThreshold>
        <weightDistance>200</weightDistance>
        <weightMoveVec>400</weightMoveVec>
        <weightPredict>200</weightPredict>
        <weightSize>100</weightSize>
    </trackingSettings>
</ns2:configSettings>
```

radarTouchIP
The software has to know which IP the measurement device is using. This can be set with this parameter. For changing the IP address of the measurement device please refer to chapter “5.2. Changing the IP address of the measurement device”.

oscClientIP
This is the IP that is as default set in the interface settings dialog that is shown in Figure 22.

mouseVersion
This Integer value defines the mouse version that is used if mouse emulation is activated. Mouse emulation can be done in various ways, it is important to test applications if the mouse emulation works the way it is needed.
Right now there are three different versions implemented:

> *mouseVersion* == 1
> This Version keeps the left mouse button clicked as long as the obstacle stays in the active area. If the system detects two obstacles, it scrolls the mouse wheel up or down depending on a changing distance between the two obstacles. With this, some sort of zoom gesture can be used.
>
> *mouseVersion* == 2
> This version does a single click and a double click depending on the time between two new obstacles. If the system detects two obstacles, it keeps the left mouse button clicked.

mouseVersion == 3
This Version keeps the left mouse button clicked as long as the obstacle stays in the active area. Compared to version 1, it does not scroll the wheel if two objects are detected. No matter how many objects are detected, it simply tracks on the first obstacle that was detected and follows it with the mouse.

allowStartingTwice
Usually the software can not be started twice. For some reason it might be needed to run the software two times on one computer. This can be done with setting this parameter to true. Be aware of the fact that you can not connect two times to one radarTOUCH measurement device. If you want to use two units, you have to change the IP address. For this please refer to chapter “5.2. Changing the IP address of the measurement device “

startMinimised
If this Boolean variable is true, the GUI starts minimised to the task bar.

wideWorkingRange
If you want to use the radarTOUCH in very large distances (>12m), you should set this parameter to true. It has the effects on the software that the range of the sliders in the GUI is larger

minObjectSizeIs_1
Just like the parameter above, this is useful if you use the radarTOUCH in very large distances. If you are not using the device that way it should always be set to false.

flipXandY
If this parameter is set to true, the x- and y-coordinates in the TUIO data are flipped. That means x becomes y and y becomes x.

maxDistance and *maxAngularDistance*
Sometimes it is useful to reduce the resolution which the radarTOUCH offers. Some users point with their hand at a button and not with just one finger. If they use the hand, the system might detect a few more blobs than just one. This might trigger some wrong events. You can reduce the resolution by setting these two parameters higher than zero.
maxDistance describes the maximum distance in mm for two obstacles to be detected as one.
maxAngularDistance describes the maximum distance angular measurements that could be between two obstacles to be detected as one.
If both parameters are set to zero, the system uses the normal algorithm for detecting obstacles. If you choose to use them, the system uses a different algorithm that has its strengths performing some sort of a blob reduction.

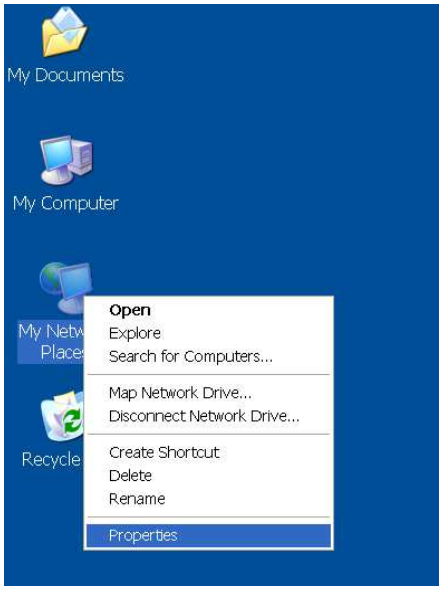
trackingSettings
You should not change anything here!

5 Appendix

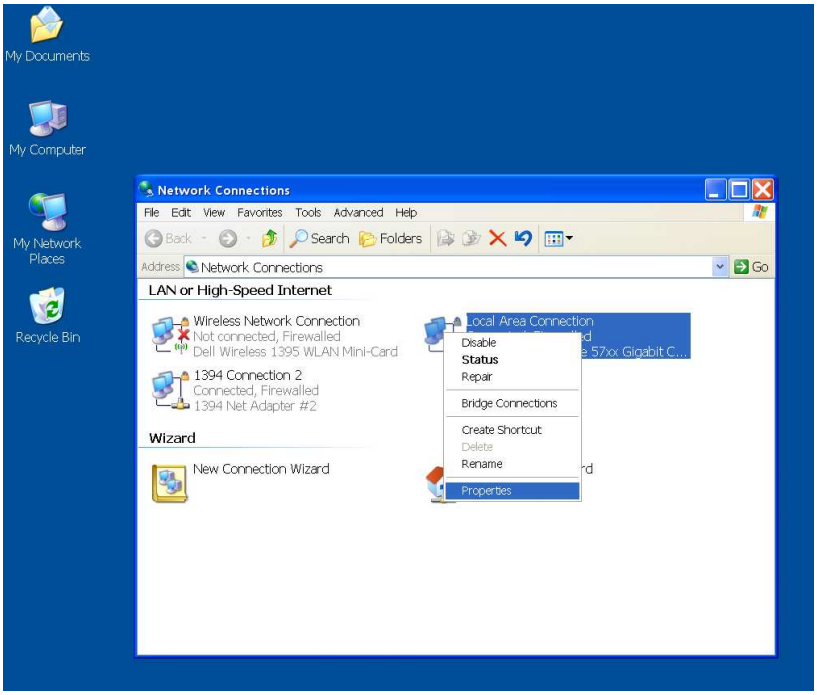
5.1 Changing the IP address of your computer

To change the IP address of your computer please connect the radarTOUCH measurement device to the power supply and connect it with the Ethernet cable to the computer.

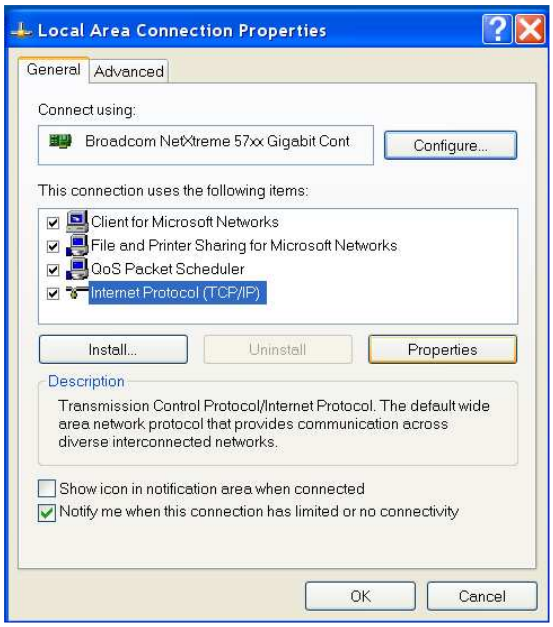
» Go to „My Network Places (right mouse button) > Properties„



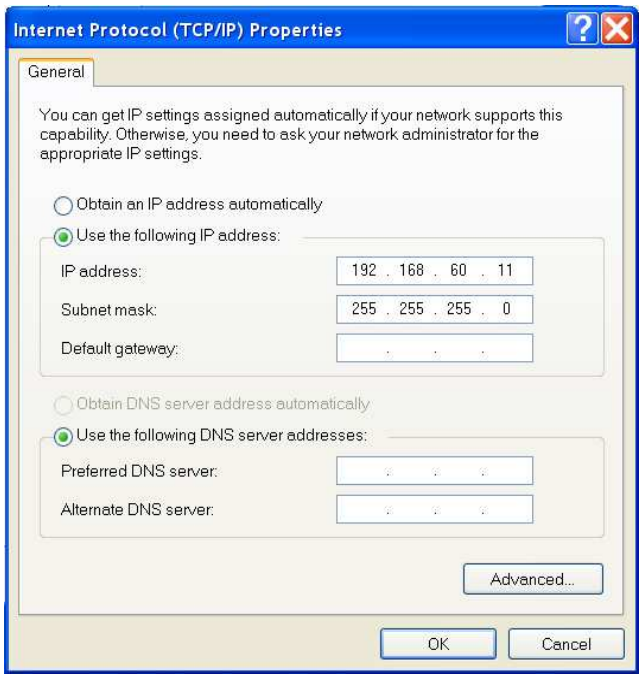
» Make sure that this LAN-connection is the connection to the radarTOUCH and open its Properties:



» Now the following window should appear:



» Choose the TCP internet protocol and click on Properties
» Now you can give your computer a static IP address or change it:



» Confirm your settings and close the Network Places

5.2. Changing the IP address of the measurement device

Note: This small application changes the IP address of the measurement device, not the IP of your local computer!
Make sure that the rxtxSerial.dll is saved in the same folder as the IPChanger, like it is on the radarTOUCH dongle.
To change the IP address you have to connect the device to the power supply and connect it with the Ethernet cable to your PC.
Make sure that your PC network settings are correct regarding the current IP settings from the measurement device. You have to be sure that you can connect to the device.
Start the IP changer software for the radarTOUCH; you will see the small GUI which is displayed in Figure 27.
Please enter the current IP address of the measurement device in the upper four fields. You only have to enter the value, no dots or anything like that. If you type a number in the field, always confirm by pressing enter on your keyboard.
Then enter the new IP address in the same way and press the “Set” button, a window asking you if you really want to set the new IP will appear (Figure 28). This is your chance to check if the settings are correct.
If the new IP was successfully set after you have confirmed the dialog, you will see a new window that looks like the one in Figure 29. If this was not successful, an error message will appear.
The measurement device will reboot, only the red light will be on. After a few seconds also the orange led will turn on. Now please always restart the device after a few seconds by unplugging it from the power supply.
If you change the IP address of the device, you also have to change the IP in the radarTOUCH software. For this, please refer to chapter 4.3.2 Configuration file.

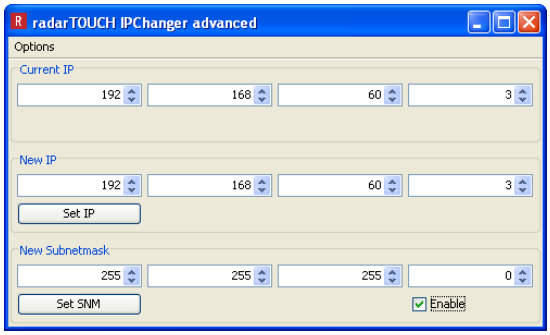


Figure 27 radarTOUCH IP Changer GUI

Figure 28 Confirm dialog

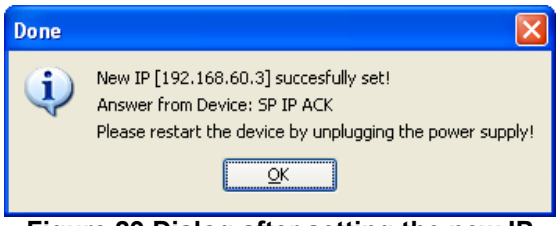


Figure 29 Dialog after setting the new IP

To change the Subnetmask it is the same procedure like changing the IP.
BOT NOTE: Changing the Subnetmask should be only done by a specialist! Usually it is not necessary for integrating radarTOUCH in a network.

If you don't know the IP of your measurement device you can reset all network settings. Please connect the measurement device at port Y3 to your PC with the RS232 cable.

Go to "Options" and click on "Reset all Network Settings". Now you have to choose the right COM port (Figure 29). To find out to which port the device is connected you have to go to the windows device manager (Figure 30) and search for "USB Serial Port".

If the reset was successfully done after you chose the COM port, a new window will appear like in Figure 31.

Please reboot the measurement device afterwards by unplug and plug the power supply.

Figure 30 Dialog to choose the COM port

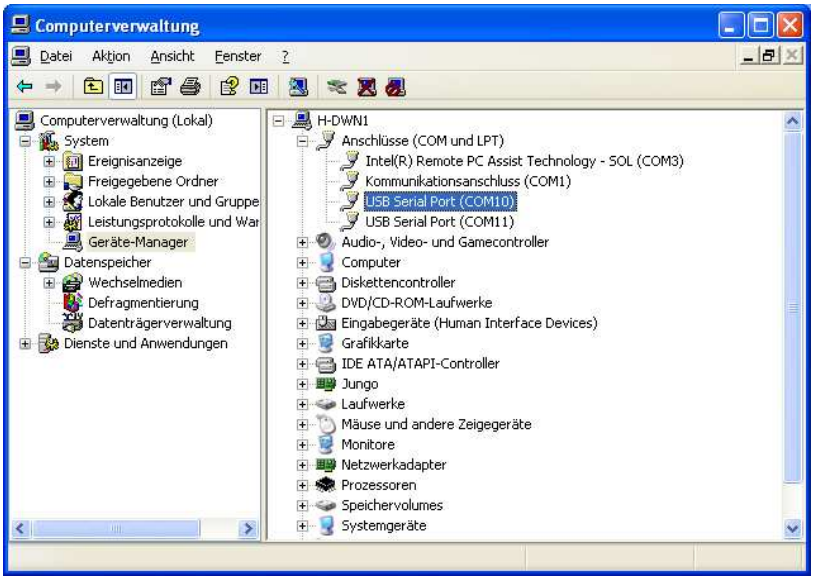


Figure 31 Windows device manager

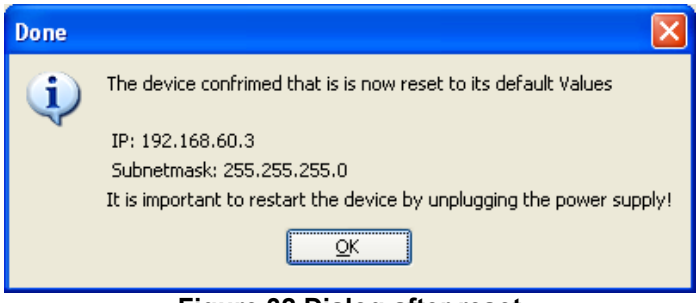
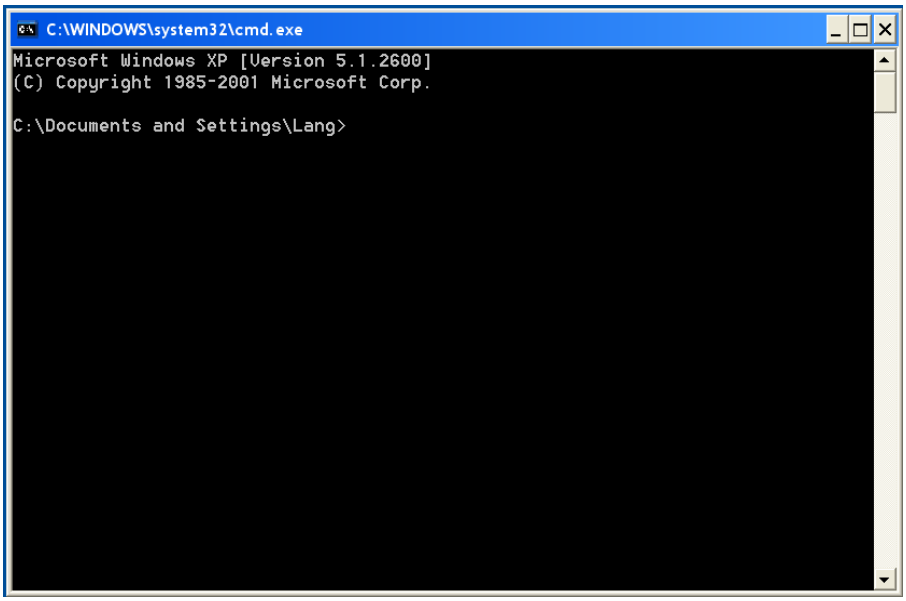


Figure 32 Dialog after reset

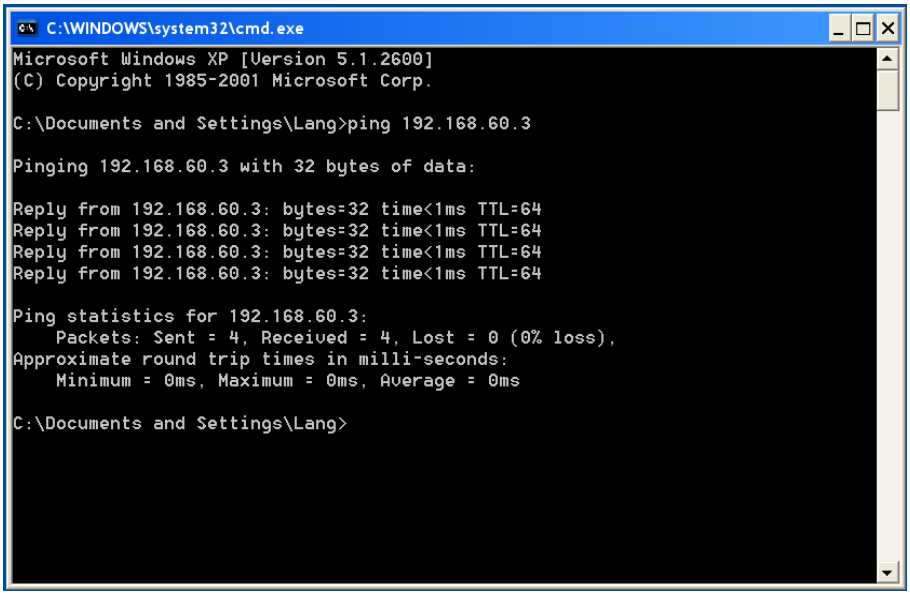
5.3 How to ping the radarTOUCH

If you want to know if the connection between your computer and the radarTOUCH works you can ping the measurement device:

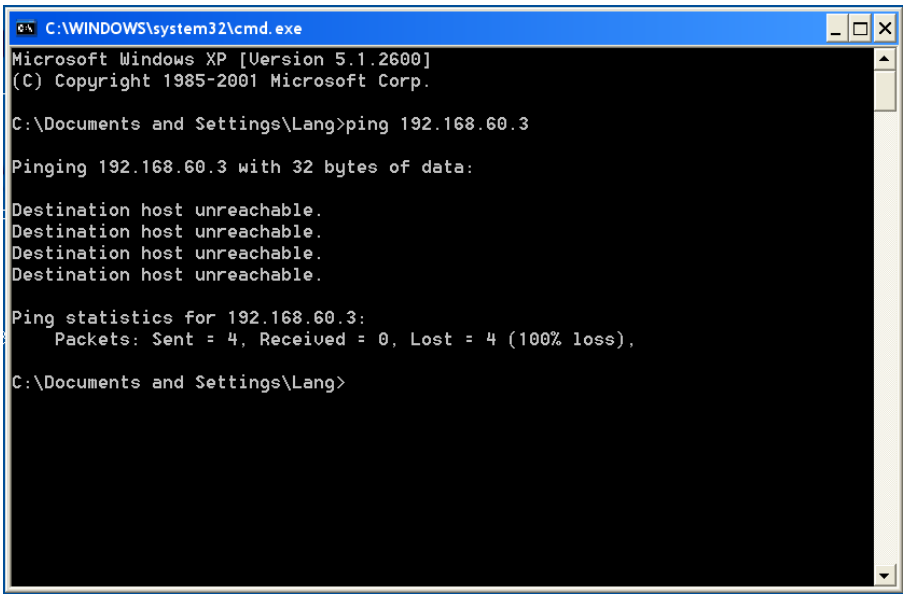
» Go to the windows Start button and click on “run”
» If you have Windows 7 there is no run button, in this case go on with the next step:
» Type cmd and approve with enter
» Now the following window should appear:



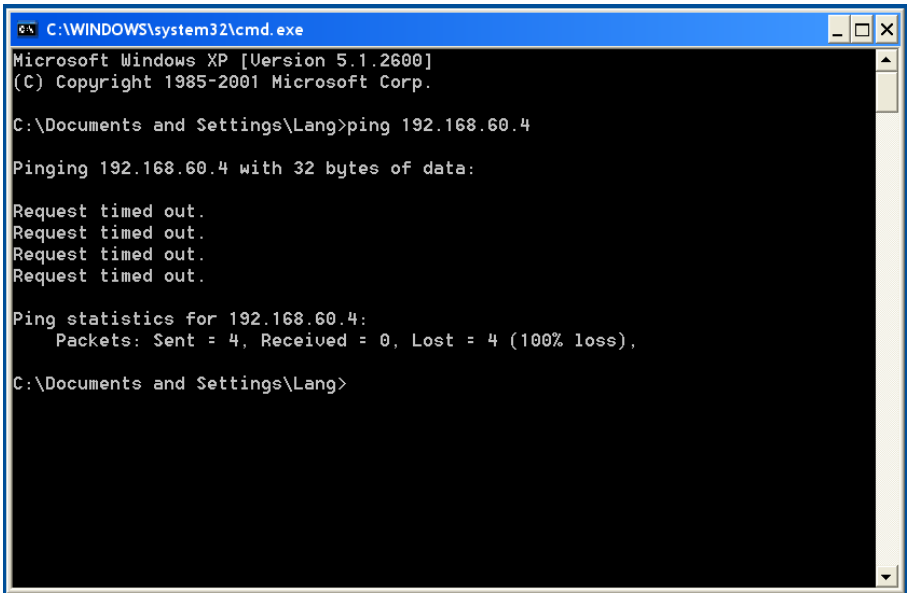
» Type “ping” and the IP you want to ping with a space between and approve with enter
» The default IP address of the radarTOUCH is 192.168.60.3
» Now this IP will be pinged four times and if the ethernet connection is available there will be a response like it is shown in the following picture:



» If the radarTOUCH is not connected or the ethernet connection is interrupted the following response will appear:



» If the IP address you want to ping is wrong, the following response will appear:



» In both of this cases please check the connection and the IP of your PC. (Please refer to chapter “5.1 Changing the IP address of your computer”)

5.4 Solving Problems

Problems that might appear are:

» The system detects obstacles that are physically not located in front of it
→ Clean the front window of the measurement device with a dry soft cloth.

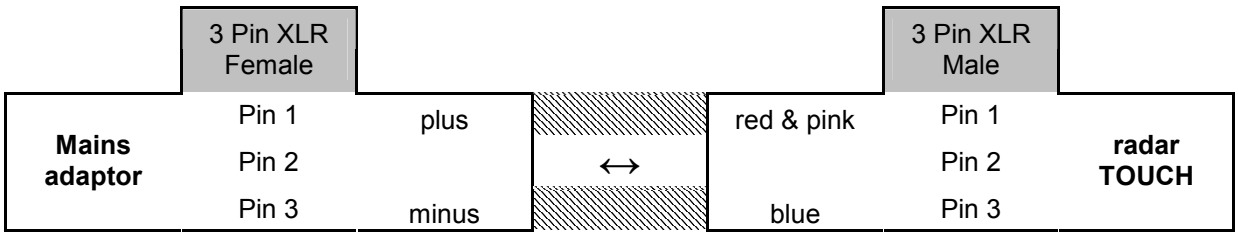
» The measurement data seems to be disturbed/ defective
→ Surfaces like glass or anything shiny can cause these effects.

» The red LED flashes the whole time and nothing else happens
→ The mains adapter is too weak
→ Power supply cable might be damaged, check connectors

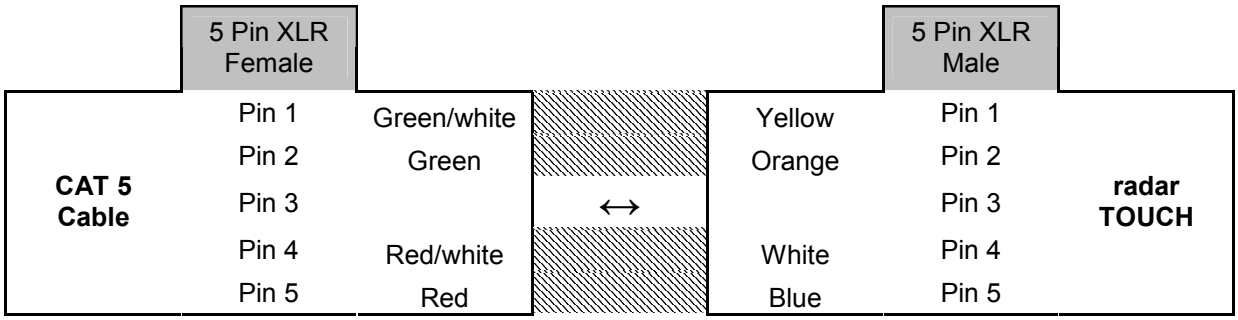
» The pointer is not precise.
→ The measurement device should be as close as possible to your screen.
→ Maybe you also have to readjust the active area.

5.5 Pin Assignment

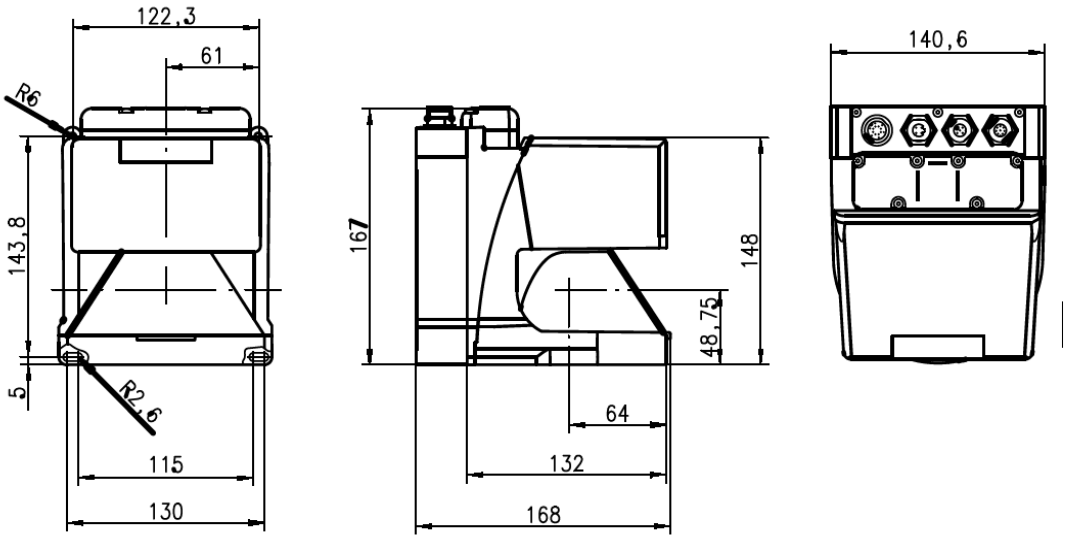
Power supply



Ethernet connection



5.6 Technical Data



Optical data

Angular range	max. 190°
Angular resolution	0,36°
Scanning rate	25 scans/s or 40 ms/scan
Transmitter	infrared laser diode, laser class 1 (EN 60815-1), wavelength = 905nm, Pmax = 15W, pulse duration: 3ns, average output power: 12µs
Response time	approx. 40 ms (corresponds to 1 scan)

Electrical data

Voltage supply	+24VDC +20% / -30%
Overcurrent protection	via fuse 2.5A semi-time-lag in the switching cabinet
Current consumption	approx. 1A (use power supply with 1.5A), approx. 2.5A with heating
Power consumption	< 75W at 24V including the outputs
Overvoltage protection	overvoltage protection with protected limit stop

Mechanical data

Housing	diecast aluminium, plastic
Weight	2,3 kg
Connection type	4 connectors (to be plugged from above)

Environmental data

Ambient temp.	0°C…+50°C/-20°C…+50°C
(operation/storage)	-20…+50°C/-20°C…+50°C (RTouch-500plus – with heater)
VDE safety	class II, all-insulated
Laser class	1 (acc. To EN 60825-1)
Protection class	IP 65
Standards applied	IEC 60947-5-2