TeraRanger Tower
by TERABEE

Manual

Version 1.0.0, May 2016

Technical Specifications:

Mounting:	4 mounting holes in the base for M3 screws
Size:	Diameter 150mm x H 45mm
Weight:	130g fully assembled with 8 sensors
Supply voltage:	12V DC recommended (10-20V accepted)
Supply current:	345mA @12V in general environment
Possible interfaces:	UART, +3.3V level, 921600,8,N,1. Connector: 4 pin Molex Picoblade
	Micro-USB port (2.0)
Range:	Up to 14m indoors (reduced range in sunlight)
Update range:	Fixed 270 Hz in fast mode and up to 270 Hz in precision mode
Range resolution:	0.5cm
Accuracy:	± 4cm in precision mode
Field of view:	3° for each sensor, 45° between each sensor axis

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Table of Contents

1   About the TeraRanger Tower

1.1   Inside the Package

You will receive the following items when purchasing a TeraRanger Tower:

- eight or four TeraRanger One sensors
- mounting hardware (TeraRanger Tower frame + black top ring + two M2,5x6mm screws + four 4 M3x8mm screws)
- one TeraRanger Hub
- one power cable with open ends (10cm long)
- cables to connect the TeraRanger One sensors to the TeraRanger Hub (22cm long)
- one micro USB cable (50cm long)
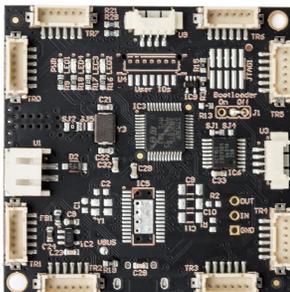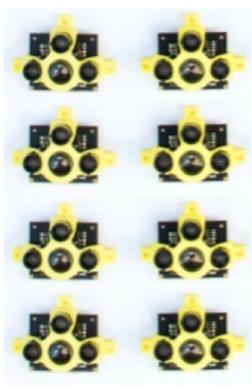
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2   Assembly

A video tutorial showing how to build your TeraraRanger Tower is available at https://www.youtube.com/watch?v=GmUCgM4NplM. Or you can follow these instructions.

Before the assembly the TeraRanger Tower frame is fragile, so please do take extra care when handling it and avoid exerting any excessive pressure or bending, as this may damage the frame.

2.1   Securing the TeraRanger Hub to the TeraRanger Tower frame

Lay the TeraRanger Tower frame on a flat surface with the sensor sockets facing upwards. In this position, the four inside corners of the Tower frame should be resting on the surface.

Place the TeraRanger Hub in the middle of the Tower frame, as shown in the picture. The two mounting holes of the Hub should be aligned with the two holes on the frame. Secure it with two M2,5x6mm screws, paying attention not to overtighten them as this might cause stripping of the tapped thread.
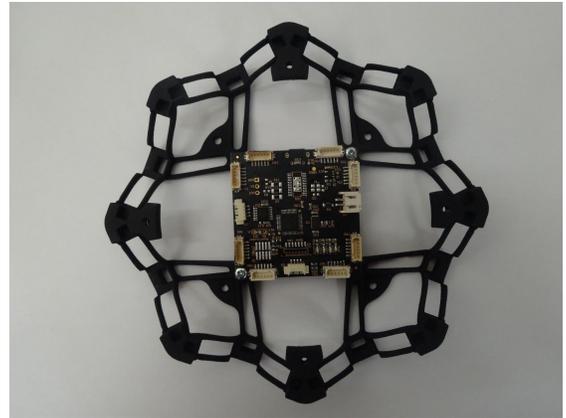
2.2   Mounting the TeraRanger One sensors

Gently fit your TeraRanger One sensors inside the sensor sockets, applying a light pressure with your fingers. Make sure that the connector is facing upwards and that the sensor yellow frame faces outwards, as shown in the picture. When properly mounted, the mounting hole in the yellow sensor frame opposite the connector should perfectly align with the horizontal hole in the lower part of the Tower frame's sensor socket. Please take extra care not to exert any excessive pressure on the connector.
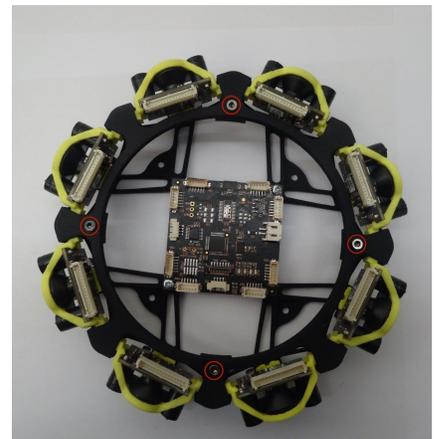
Removing the TeraRanger One sensors from the TeraRanger Tower frame is a delicate operation. Please refer to section 3.1.1 of this manual for instructions.

The following picture shows the Tower with all eight TeraRanger sensors mounted.

2.3   Fitting the top ring

Position the top ring so that its flat surface faces upwards, ensuring that the holes in the top align with the holes in the Tower frame. To close the Tower press the end of each top ring branch so that the endpoints of the sensors fit smoothly within the grooves of the top ring. Secure the top ring with four M3x6mm screws, paying attention not to overtighten them.

2.4   Mounting the TeraRanger Tower

Four holes for M3 screws enable you to screw the Tower to the support of your choice.

Depending on the application, you may consider connecting the TeraRanger One sensors before mounting your TeraRanger Tower. Please refer to section 3 of this manual for instructions on how to connect the TeraRanger One sensors.
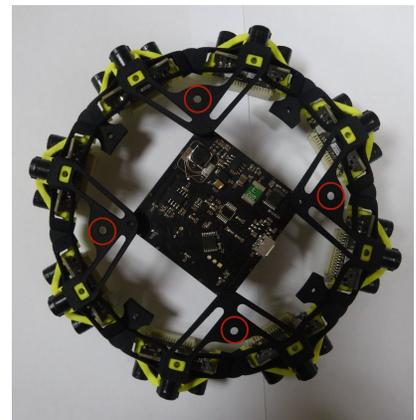
3 Connection

3.1 Connecting the TeraRanger One sensors to the TeraRanger Hub

Up to eight TeraRanger One sensors can be connected to the TeraRanger Hub using a 6 pin connector of the Hirose DF13 series. The part number of the corresponding female connector is DF13-6S-1.25C. Eight or four cables are included with the TeraRanger Tower. Additional cables can be purchased from our website if needed.

Pin	Function
6	GND
5	Reset out
4	Serial in (RXD), 3.3-5V level
3	Serial out (TXD), 5V level
2	TeraRanger power supply
1	GND
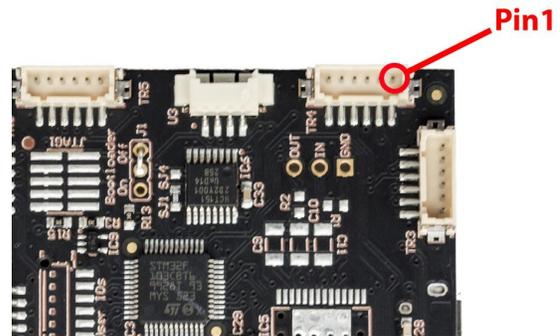
Use the cables to connect the TeraRanger One sensors to the TeraRanger Hub, as shown in the picture below. When you are facing the sensor, the red wire of the cable should be on the left side.
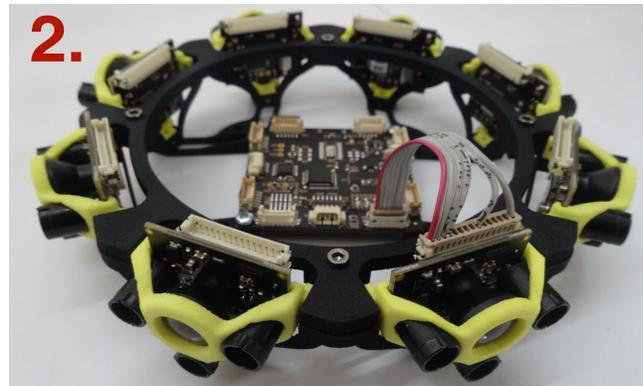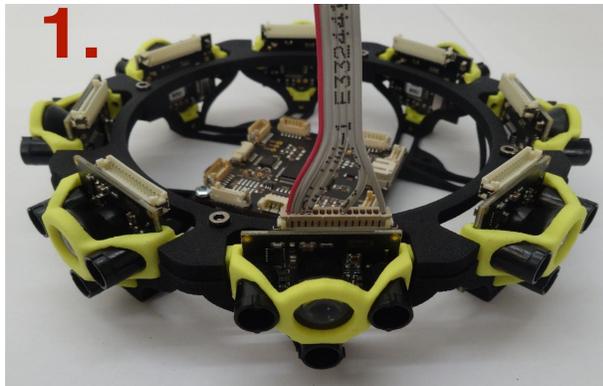
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The following picture shows the TeraRanger Tower with all eight TeraRanger sensors connected.

Important notes:

- **To be compatible with TeraRanger Hub 1.1.0 firmware version you must use TeraRanger One sensors with version 5.0.0 or later firmware version. For earlier firmware versions (Hub 1.0.0 and TeraRanger One 4.0.0 sensors), please refer to section 4.7 of this manual.**
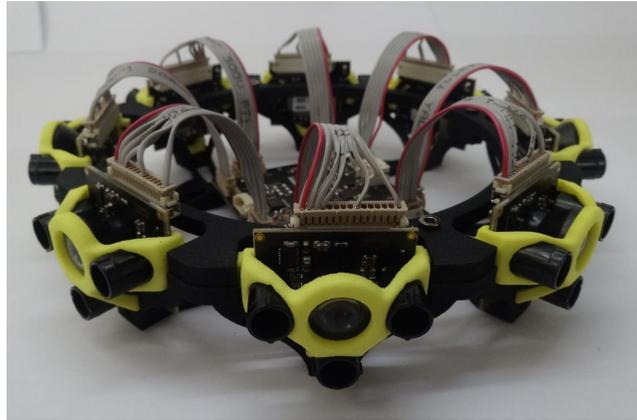- **Do not plug/unplug TeraRanger One sensors from the TeraRanger Hub while the device is powered. Always disconnect the power supply first!**
- Once connected, DF13 connectors are very reliable and are perfect for robotics and drone environments where vibrations are common. However, these connectors are not made for infinite plugging and unplugging. If you need to plug and unplug the sensors frequently, consider adding a more suitable connector in-line.
- Please follow basic rules on ESD* safety when connecting and touching the TeraRanger Hub!

* See for example http://en.wikipedia.org/wiki/Electrostatic_discharge

3.1.1 Removing the TeraRanger One sensors from the TeraRanger Tower

If for any reason you need to remove your sensors, please follow these instructions:

- Unplug the connector from the TeraRanger One sensor. **Do not pull directly on the cable,** use the plastic case of the connector instead.
- Remove the screws of the top ring and remove the top ring.

- **DO NOT pull directly on the TeraRanger One sensor** to remove it from the TeraRanger Tower frame. (Without sensors the frame is fragile and direct force may damage it.) Instead, insert a flat screwdriver at the bottom of the sensor socket and use it as a lever, as depicted in the images below.
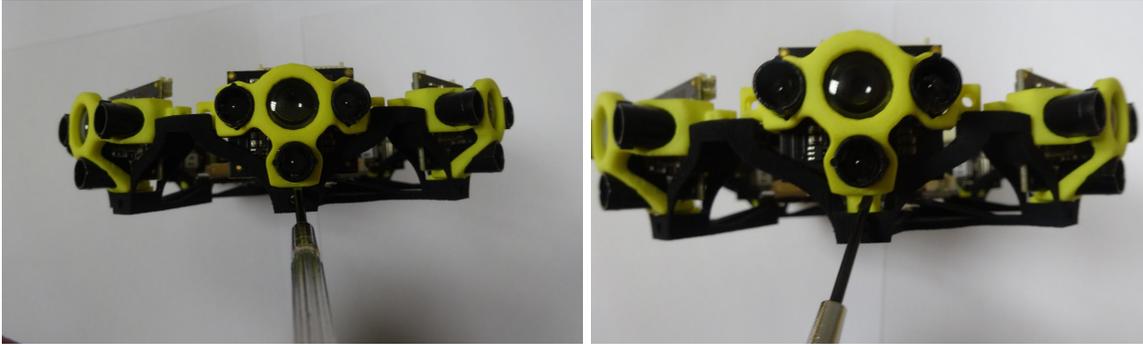
3.2 Details on Supply Voltage to the TeraRanger Hub

The TeraRanger Hub needs an external power supply with voltages ranging from 10V to 20V. It has an internal voltage regulator for optimal performance. However, to minimise unnecessary heating, we advise the use of a preregulator down to 12V, and ideally 10V. For optimal efficiency, this should be a switching regulator (either buck or boost, depending on the supply voltage available on your system) with a large output capacitor and good filtering.
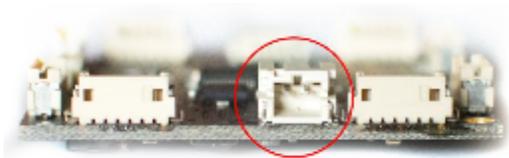
To have a better access to the connectors (voltage, UART, USB), you can flip your TeraRanger Tower upside down. Ensure that the cables are not physically placed in the field of view of the TeraRanger One sensors.

3.3 UART interface

UART is available from the 4 pin connector (Molex PicoBlade series) labelled **U3** on the TeraRanger Hub board. It accepts input voltage levels from 3.3V up to 5V, the output voltage level is 3.3V. Please use a serial to USB interface (e.g. FTDI breakout boards) to connect the TeraRanger Hub to your computer. DO NOT CONNECT the TeraRanger Hub to a real RS-232 port of a PC, the voltage levels are different and this might destroy the board's electronics.

The UART interface is configured to send and receive data at a transfer speed of 921600 bit/s with 8 data bits, no parity bit and one stop bit (921600-8N1). More information on the different operation modes can be found in sections 4.3 and 4.4 of this manual.

Pin   Function
4   GND
3   Serial in (RXD), 3.3 level
2   Serial out (TXD), 3.3V level
1   +3.3V out (use only to provide voltage levels to programming devices, max.10mA)
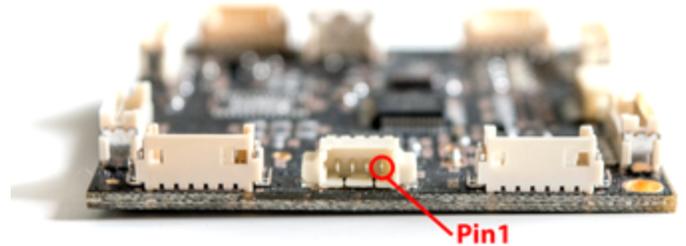
3.4 USB interface

You can directly connect the TeraRanger Tower to your computer using the USB interface of the TeraRanger Hub and a micro-USB cable. Be aware that you cannot power the TeraRanger Hub via USB. In Linux and MacOS, a driver for this interface is already installed and the interface will appear as a virtual COM port. It is configured to send and receive at 115200 bit/s with 8 data bits, no parity bit and one stop bit (115200-8N1).

If you use Windows, please download the driver from http://www.st.com/web/en/catalog /tools/PF257938 and **follow the instructions given by the installer and the *readme* file**. After successful installation, unplug the interface for a moment and plug it back in. The virtual COM port should now be available on your PC.

3.5 Normal Operation

Each time the TeraRanger Hub is powered-on it will detect how many TeraRanger One sensors are connected. The GREEN LED will blink once for each sensor detected by the TeraRanger Hub. It can take a few seconds before the distance values become available on the UART and/or USB interfaces. Once available, a BLUE LED will start blinking, indicating that the distances are sent continuously to both interfaces.

4   Operation

4.1   Connecting the TeraRanger Tower using a Computer with a Serial Console

Your TeraRanger Tower can interact via the TeraRanger Hub with any serial console using the following configuration:

- Using directly the USB:
  115200 bit/s, 8 data bits, no parity bit and one stop bit.
- Using the UART:
  921600 bit/s, 8 data bits, no parity bit and one stop bit.

MacOS/Linux

In Linux* and MacOS you have a utility called "screen" which should be executed from the console using the following code:

- For the USB interface:
  $ screen /dev/ttyXXX 115200 (replace ttyXXX with the correct serial device like ttyUSB0)
- For the UART interface:
  $ screen /dev/ttyXXX 921600 (replace ttyXXX with the correct serial device like ttyUSB0)

*Be aware that *screen* might not be installed in your Linux operating system, so you might need to install it. Please follow the installation procedure recommended for your Linux distribution.

Windows

In Windows you can use HTerm (http://www.der-hammer.info/terminal) or any other terminal emulation software of your choice. Use 'text' display mode in the terminal software to see the array of distance values in mm.

For more details on how to use the serial console with your operating system, please refer to the TeraRanger One manual available from the support page of our website.

4.2 Running the TeraRanger Tower in ROS

We provide a ROS (Robot Operating System) node which provides a topic to access the TeraRanger Hub data stream. Please note that the TeraRanger Hub _has_ _to_ _be_ _configured_ _to_ _work in Binary mode_. You can download the ROS node from:
https://github.com/Terabee/terarangertower-ros

To use the ROS node you need to:

- Create a ROS Workspace
- Copy the node teraranger_tower package into the workspace src directory
- Compile using: catkin_make
- Setup environment: source devel/setup.sh
- Run** using: rosrun teraranger_tower teraranger_tower_node _portname:=/dev/ttyACM0

If you want to change the operating mode, run**:

- rosrun rqt_reconfigure rqt_reconfigure

** Remember to execute the daemon roscore before running the rosrun command.

4.3 Operating modes

The current TeraRanger Hub firmware (1.1.0) supports two operating modes which can be selected by sending the corresponding uppercase characters to the TeraRanger Hub:

PPP	Precise mode	TeraRanger Hub uses the TeraRanger One sensor Precise mode to provide the greatest available accuracy. This improved accuracy results in a decrease of the measurement repetition rates, and therefore in increased reaction times.
FFF	Fast mode	This mode ensures the fastest measurement repetition rates and reaction times. This improvement comes at the expense of the reading accuracy and maximum range which is limited to 4.5m in this mode.

4.4 Display modes

The current firmware (1.1.0) supports two display modes which can be selected by sending the corresponding uppercase characters to the TeraRanger Hub:

TTT	Text mode	Data output (28 - 52 bytes message): TH\txxxx\txxxx\txxxx\txxxx\txxxx\txxxx\txxxx\txxxx\r\n - Header (two characters): T (84 decimal / 0x54 hex) and H (72 decimal / 0x48 hex) - Tabulation: \t (9 decimal / 0x09 hex) - Distance reading in millimeters* (maximum 5 bytes per sensor): xxxx - Carriage return character: \r (13 decimal / 0x0D hex) - New line character: \n (10 decimal / 0x0A hex) *if a sensor is not connected or the TeraRanger Hub is unable to obtain the distance measurement from the TeraRanger One sensor, the associated distance value is replaced by -1.
BBB	Binary mode	Data output (19 bytes message): THXXXXXXXXXXXXXXXXXCRC8 - Header (two characters): T (84 decimal / 0x54 hex) and H (72 decimal / 0x48 hex) - Distance reading in millimeters** (2 bytes per sensor): XX - Checksum (1 byte) of previous 18 bytes: CRC8 **if a sensor is not connected or the TeraRanger Hub is unable to obtain the distance measurement from the TeraRanger One sensor, the associated distance value is replaced by the hexadecimal value 0xFFFF.

Please note that the default mode is binary. If you need any other output format, speed or protocol, please email your request to support@teraranger.com.

4.5 Additional commands

The current firmware (1.1) provides additional parameters to configure the TeraRanger Hub as needed:

CXX	Allows selection of specific sensor(s) to get measurements from. - Header character: C (67 decimal / 0x43 hex) - Specific sensor choice: XX XX is the hexadecimal conversion of a byte where each bit represents one of the eight TeraRanger One sensors. If the bit value is 1 the corresponding sensor will be polled, otherwise it will be ignored. For example, *C01* will select sensor #0, *C80* will select sensor #7, *C0F* will select sensors #0 to #3, and *CA1* will select sensors #0, #5 and #7.
TWR	Allows to switch between crosstalk and non-crosstalk options. - *Non-crosstalk:* green LED OFF. The TeraRanger Hub ensures that sensors are not activated simultaneously. This can result in a decrease of measurement repetition rates. - *Crosstalk:* green LED ON. Allows simultaneous activation of sensors. To optimize distance measurement reliability it is strongly recommended to choose a sensor configuration that avoids interaction between sensors.
TNXXX	Enables selection of the timeout during which the TeraRanger Hub waits for a distance value from a TeraRanger One sensor. This feature is only available in Precise mode (refer to section 4) operating in the non-crosstalk option. - Header character: T (84 decimal / 0x54 hex) - Sensor number (0 to 7): N - Timeout value in milliseconds* (0 to 500): XXX *this value is not saved and will need to be re-set after the next TeraRanger Hub power-on.

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4.6   Graphical interface

A free graphical user interface is available for Windows. This is useful for demonstration, testing purposes and setting some of the basic parameters for the connected sensors. It provides a clear readout of the distance values being obtained by each TeraRanger One sensor, displayed as a bar graph.
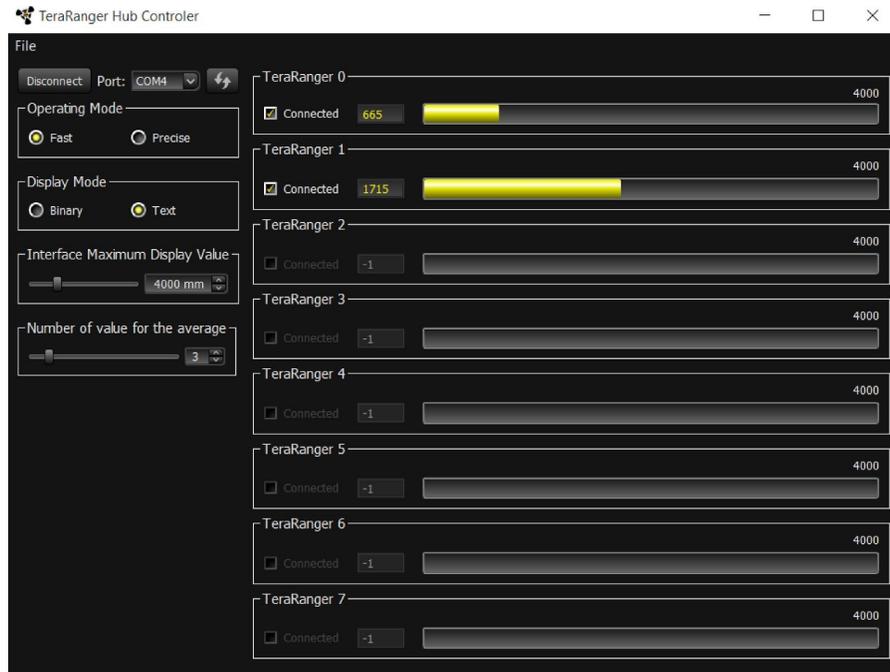
4.6.1 Basic configuration

First of all connect the powered TeraRanger Hub via USB to your computer. Select the Com port which corresponds to the Hub in the list. If this one is not present, press the refresh button. Next, click on the connection button. You might need to wait few seconds after powering the TeraRanger Hub to allow it to boot up.
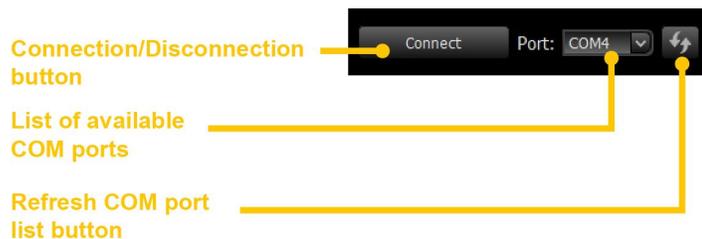
Connection/Disconnection button

List of available COM ports

Refresh COM port list button

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For each of the eight sensors, the distance value and a bar which is a graphical representation of the distance value are available. A checkbox allows you to determine if you want to display or not the value of that sensor.
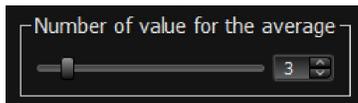

The maximum value of the graphical representation bars can be set using the control below:


The graphical interface allows you to choose the operating mode and the display mode that you want the hub to run in.
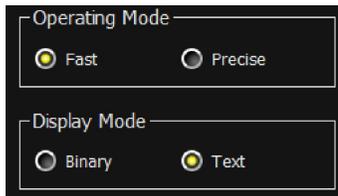

In Fast mode you can set the number of measurement values that the graphical interface uses to average the displayed distances.

Fore each sensor, you can set the time the TeraRanger Hub will wait before receiving a distance. This feature is only available in Precise mode operating in the non-crosstalk option (refer to sections 4 and 6 of the present manual).
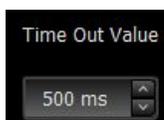
To switch between crosstalk and non-crosstalk mode, simply check or uncheck the checkbox:
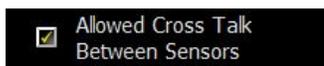
4.6.2 Firmware Upgrade of TeraRanger Hub

The current firmware version of you TeraRanger Hub can be found by selecting *File → About* in the graphical interface. If you need to upgrade the TeraRanger Hub firmware please follow this procedure:

- Select *File → Upload Firmware*.

- Unplug and replug the USB cable, and then press "OK".

- Press "Select FW" and select the new firmware with the file explorer.

- Press "Upgrade" and wait until the operation finishes.

- Close the update assistant and unplug and replug the USB cable to set the Hub in normal operation.

4.7　Firmware compatibility

The TeraRanger Hub 1.1.0 is designed to be used with TeraRanger One sensors with version 5.0.0 or later firmware versions. Both type A and type B versions of the TeraRanger One 5.0.x sensors are compatible with Hub 1.1.0. For other firmware versions please follow the instructions below.

4.7.1 TeraRanger Hub 1.0.0

TeraRanger Hub 1.0.0 is designed to be used with TeraRanger One 4.0.0 sensors (those with serial numbers starting in 1508).

- If you are using TeraRanger One 4.0.0 sensors, you will need to manually flash the TRG firmware version on your sensors before connecting them to the TeraRanger Hub. To flash the TRG firmware you will require a [TeraRanger USB adapter](), which can be purchased from our website. To request the firmware please send an email to support@teraranger.com

- If you are using TeraRanger One 5.0.x sensors, you can upgrade your TeraRanger Hub 1.0.0 by flashing the 1.1.0 firmware (refer to section 4.6.2 of this manual for firmware upgrade using the graphical interface). To request the firmware please send an email to support@teraranger.com

4.7.2 TeraRanger One 4.0.0 sensors

TeraRanger One 4.0.0 sensors can only be used with the TeraRanger Hub 1.0.0.

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