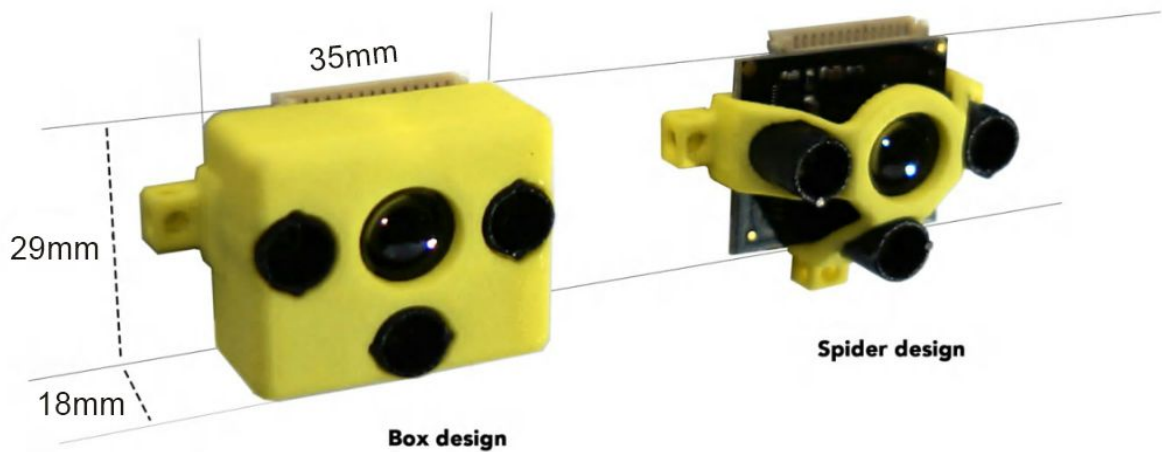


TeraRanger One

by TERABEE 

Installation and Operation Manual

Firmware 4.0.0 STD



Technical Specifications:

Principle:	Infrared Time-of-Flight (ToF)
Range:	Up to 14m indoors (At least 5 to 6m in sunlight)
Update rate:	1000Hz in fast mode (Up to 600Hz in precision mode)
Range resolution:	0.5cm
Accuracy:	± 4cm in precision mode
Field of view:	3°
Supply voltage:	12V DC recommended (10 to 20V DC accepted)
Supply current:	50mA average (110mA peak @12V)
Interfaces:	UART, +5V level, up to 115200,8,N,1. (Factory default when shipped) TWI (I2C compatible) +5V level (Firmware available on request)
Connector:	15 pin DF13 (open-ended cable provided)
Weight:	8g (Spider) or 10g (Box)

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Safety Notes

The TeraRanger One is eye-safe in all conditions, including system failure. However, please keep a minimum of 20cm distance from your eye when handling the sensor under power and do not look into the LEDs with any kind of optical instruments.

Table of Contents

- [1 About the TeraRanger One](#)
 - [1.1 Inside the Package](#)
 - [1.2 USB adapter](#)
 - [1.3 Dimensions and Mounting](#)
 - [1.4 About the Connector](#)
 - [1.5 UART Data Interface](#)
 - [1.6 TWI \(I2C\) Data Interface](#)
 - [1.7 USB Interface](#)
 - [1.8 Details on Supply Voltage](#)
- [2 Connecting the TeraRanger One Using a Computer With a Serial Console](#)
 - [2.1 Windows](#)
 - [2.2 MacOS](#)
 - [2.3 Linux](#)
- [3 Running the TeraRanger One in ROS](#)
- [4 Operating Modes](#)
- [5 Printout Modes](#)
- [6 Flashing Firmware](#)

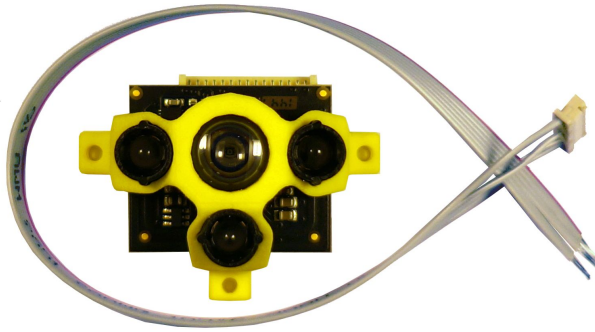


1 About the TeraRanger One

1.1 Inside the Package

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

- a fully assembled and calibrated sensor
- a connector cable with open ends that can be soldered to your device



1.2 USB adapter

An optional USB adapter is available for simple plug & play connection to a PC or MAC. The USB adapter provides power to the sensor and data transfer to and from the sensor. It is ideal for evaluation and testing and for making firmware updates to the sensor.

The USB adapter can be purchased at:

<http://www.teraranger.com/product/teraranger-usb-adapter/>

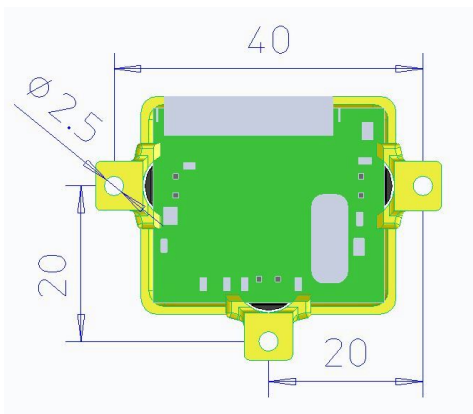
If you have purchased a USB adapter in addition to your TeraRanger One, you will also receive the following items:

- the USB adapter board
- a connector cable that connects your USB adapter board to your TeraRanger One
- a Mini-USB cable that connects the USB adapter board to your computer



1.3 Dimensions and Mounting

The TeraRanger One provides three mounting holes, which are designed for M2.5 screws. The individual distances between the holes are shown in the following figure which is valid for the box and spider design of the yellow outer plastic part. Moreover, the following aspects should be taken into consideration when mounting the TeraRanger One:

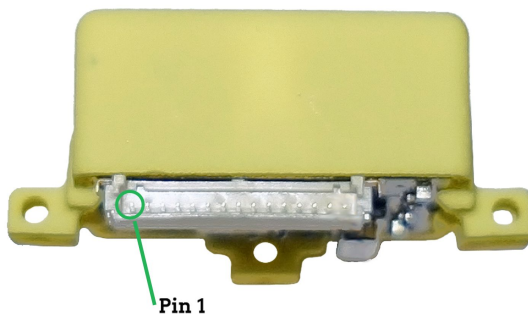


- Do not remove the plastic cover as this will misalign the optics and degrade the sensor's performance
- Mount the TeraRanger One in a well ventilated location
- Take the usual precautions for sensitive electronics such as maintaining a suitable distance to strong electric and magnetic fields, strong radio emitters, strong heat sources, etc.

1.4 About the Connector

The TeraRanger One connects to your equipment using a 15pin connector of the Hirose DF13 series. (The part number of the corresponding female connector is DF13-15S-1.25C.) The cable assembly delivered with the TeraRanger One comes with six wires installed: Ground (GND, pin 1 and 15), positive supply voltage (Vcc, pin 14), UART receive (RXD, pin 12)*, UART transmit (TXD, pin 13)* and reset (pin 7). Please use the following image and table to identify the pins:

Pin	Function
15	GND
14	Vcc (10V, accepts 10-20V)
13	Serial out (TXD), 5V level
12	Serial in (RXD), 5V level
11	TWI** SDA
10	TWI** SCL
9	User I/O 1
8	User I/O 2
7	Arduino compatible reset in (to DTR)
6	Reset in (pull to GND to reset)
5	MOSI (for SPI or flashing)
4	MISO (for SPI or flashing)
3	SCLK (for SPI or flashing)
2	+5V out (use only to provide voltage levels to programming devices, max. 10mA!)
1	GND



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Note:

- 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 do not apply shear forces to the connector when pushing it in the socket. Ideally, press the socket down to the PCB with your thumb and push the connector in with your other hand. Do not use tools like pliers etc.! You can find good instruction videos on DF13 plugging and unplugging on YouTube.
- Additional cables can be purchased from the TeraRanger website or your preferred TeraRanger reseller.
- Please follow basic rules on ESD*** safety when connecting and touching the TeraRanger One!
- Do not apply force to the TeraRanger One PCB while handling and installing it.
- Do not plug or unplug the sensor under power. Hot plugging and unplugging may damage the sensor.

* UART is the default interface

** TWI (I2C compatible) is supported by flashing our I2C firmware (available on request) to the sensor

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



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1.5 UART Data Interface

The default interface is UART on pins 12 and 13. It needs an input voltage level of 5V (logic high) to run reliably, the output voltage level is 5V. Please use a serial to USB interface (e.g. FTDI breakout boards or the TeraRanger USB adapter) to connect the TeraRanger One to your PC. DO NOT connect the TeraRanger One to a real RS-232 port of a PC, the voltage levels are different and might destroy the sensor's electronics.

The UART is configured to send and receive at 115200 bit/s, 8 data bits, no parity bit and one stop bit (115200-8N1).

To transfer data, select one of the operating modes and printout modes that are explained in chapters 4 and 5 in this manual.

1.6 TWI (I2C) Data Interface

Another way to connect to your TeraRanger One is the TWI (or better known as NXP's I2C) interface. Using this interface, you can connect multiple TeraRanger Ones to a TWI master on the same bus. The TWI mode offers external triggering of a measurement via the bus to exclude crosstalk, allowing the use of multiple TeraRanger Ones at the same time. Please keep in mind that the TeraRanger One has a relatively narrow field of view. Hence, multiple TeraRanger Ones looking into opposite or perpendicular directions can be triggered at the same time, allowing a significantly increased readout speed!

Please refer to chapter 1.4 for the the electrical connections to be made for using TWI. The signal levels are 5V, the maximum bus speed is 100kHz and the pull-up resistors (10kOhms) are already integrated in the TeraRanger One. If you have a 3.3V system as TWI master, you can try a direct connection if the inputs of your system are 5V tolerant. This configuration can work, but we do not recommend it since it is not reliable. An I2C adapter for reliable voltage-level-translation is available from our website at: <http://www.teraranger.com/product/teraranger-i2c-adapter/>.

To prepare the TeraRanger One for TWI operation: Please email support@teraranger.com, mention the serial number of your sensor and specify which TWI base address you need. Multiple addresses are possible if you want to use more than one TeraRanger One on the same TWI bus. We will then send you the new firmware with I2C and all the necessary operating instructions. Once you have the firmware file, please upload it to the TeraRanger One as described in chapter 6 of this manual.

In addition you have the option to purchase the TeraRanger Hub. This accessory board allows you to connect up to eight TeraRanger One sensors and read the data from the



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sensors via a single serial or USB link. See more at:
<http://www.teraranger.com/products/teraranger-hub/>

1.7 USB Interface

If you have purchased the TeraRanger One USB adapter, you can directly connect the TeraRanger One to your PC without the need of any additional power supply. In most modern operating systems, a driver for this interface is already present and the interface will appear as an FTDI virtual COM port to which you can connect using the settings that were previously mentioned in the subchapter Data Interface.

In case your computer asks you to provide a driver, please download the driver for your operating system from <http://www.ftdichip.com/Drivers/VCP.htm> and follow the installer. 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.

Note: Do not plug/unplug the TeraRanger One from the USB interface while the device is powered, disconnect the USB plug from the PC first!

1.8 Details on Supply Voltage

TeraRanger One works with clean, spike and interruption free voltages ranging from 10V to 20V and 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.

TeraRanger One is equipped with a safety shutdown to prevent damage from excessive currents or board temperatures arising from eventual internal failures due to incorrect mounting, misuse or externally provoked short-circuits. In case of shutdown triggering, the sensor resets automatically after reaching normal working conditions and a power cycle of the external power supply.



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2 Connecting the TeraRanger One Using a Computer With a Serial Console

Your TeraRanger One can interact with any serial console using the following configuration: 115200 bit/s, 8 data bits, no parity bit and one stop bit.

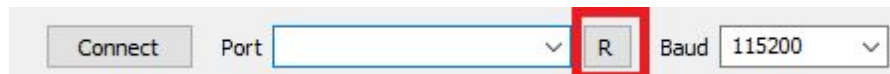
2.1 Windows

In Windows you can use terminal emulation software. We typically use HTerm. If you do not already have terminal software download HTerm from this link:

<http://www.der-hammer.info/terminal> before plugging in the TeraRanger One in to your USB port via the TeraRanger USB adaptor.

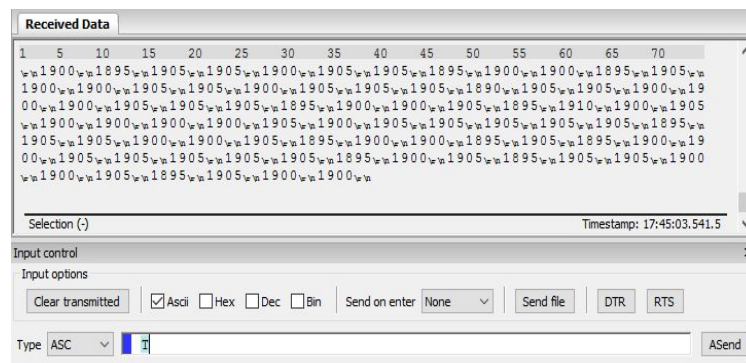
Extract the downloaded zip file to the folder of your choice, open it and double click on the “HTerm.exe” document.

Now connect the TeraRanger One to your computer via the USB adaptor. In order to select the USB port on which the TeraRanger One is plugged, refresh the port list by clicking on the “R” button as shown on the following image:



Once you have selected the port, click on the “Connect” button.

The data will now appear in the “Received data” box.



To show the data in “Text” mode, (as shown above) simply type “T” in the “Type” box. For Binary mode, type “B”.

If you want to change the sensors measurement mode type in the type box: “F” for the fast mode; “P” for the precision mode. In order to stop measurements simply press the disconnect button in HTerm and then unplug the USB cable.

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To change the sensor from its fast mode to its precision mode, press:

Shift+F for “Fast Mode”

Shift+P for “Precision Mode”

Once you are finished using your TeraRanger One and want to stop the data measurement, press:

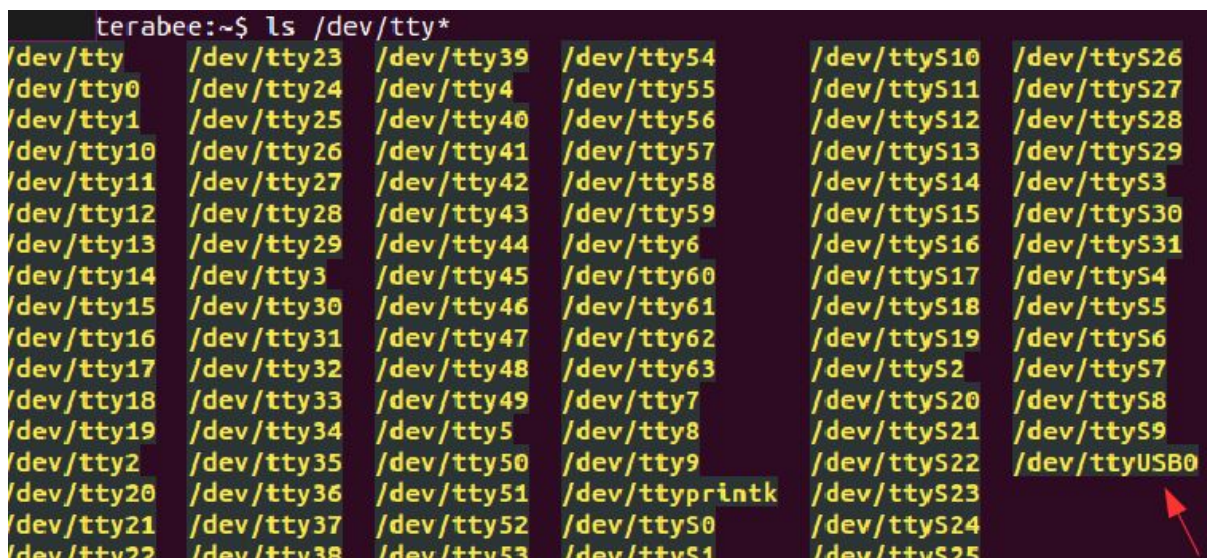
Ctrl+A then K

2.3 Linux

Linux, it is very similar to MacOS and also works with terminal.

Open a terminal (shortcut: ctrl+alt+t):

type: `ls /dev/tty*`



```
terabee:~$ ls /dev/tty*
/dev/tty      /dev/tty23  /dev/tty39  /dev/tty54  /dev/ttyS10  /dev/ttyS26
/dev/tty0     /dev/tty24  /dev/tty4   /dev/tty55  /dev/ttyS11  /dev/ttyS27
/dev/tty1     /dev/tty25  /dev/tty40  /dev/tty56  /dev/ttyS12  /dev/ttyS28
/dev/tty10    /dev/tty26  /dev/tty41  /dev/tty57  /dev/ttyS13  /dev/ttyS29
/dev/tty11    /dev/tty27  /dev/tty42  /dev/tty58  /dev/ttyS14  /dev/ttyS3
/dev/tty12    /dev/tty28  /dev/tty43  /dev/tty59  /dev/ttyS15  /dev/ttyS30
/dev/tty13    /dev/tty29  /dev/tty44  /dev/tty6   /dev/ttyS16  /dev/ttyS31
/dev/tty14    /dev/tty3   /dev/tty45  /dev/tty60  /dev/ttyS17  /dev/ttyS4
/dev/tty15    /dev/tty30  /dev/tty46  /dev/tty61  /dev/ttyS18  /dev/ttyS5
/dev/tty16    /dev/tty31  /dev/tty47  /dev/tty62  /dev/ttyS19  /dev/ttyS6
/dev/tty17    /dev/tty32  /dev/tty48  /dev/tty63  /dev/ttyS2   /dev/ttyS7
/dev/tty18    /dev/tty33  /dev/tty49  /dev/tty7   /dev/ttyS20  /dev/ttyS8
/dev/tty19    /dev/tty34  /dev/tty5   /dev/tty8   /dev/ttyS21  /dev/ttyS9
/dev/tty2     /dev/tty35  /dev/tty50  /dev/tty9   /dev/ttyS22  /dev/ttyUSB0
/dev/tty20    /dev/tty36  /dev/tty51  /dev/ttyprintk /dev/ttyS23
/dev/tty21    /dev/tty37  /dev/tty52  /dev/ttyS0  /dev/ttyS24
/dev/tty22    /dev/tty38  /dev/tty53  /dev/ttyS1  /dev/ttyS25
```

Usually the name is `/dev/ttyUSB0` but it can also be `ttyUSB1`, `ttyUSB2`, etc...

In order to view the data stream from the teraranger, type:

```
screen /dev/ttyXXX 115200 (replace ttyXXX with the correct serial device like
ttyUSB0)
```

To see different operating modes, refer to the Mac OS section. The commands are the same.



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3 Running the TeraRanger One in ROS

We provide a ROS (Robot Operating System, <http://www.ros.org>) node which provides a topic to access the TeraRanger One data stream. Please note that the *sensor has to be configured to work in Binary mode*. You can download the ROS node from:

https://github.com/Terabee/TeraRanger_one-ROS-package/tree/master/teraranger_one

To use the ROS node you need to:

1. Create a ROS Workspace
2. Copy the node terarangerone package into the workspace src directory
3. Compile using: `catkin_make`
4. Run using: `roslaunch terarangerone terarangerone_node _portname:=/dev/ttyUSB0`

Note: Remember to execute the daemon `roscore` before running the `roslaunch` command and change the USB port to the appropriate one!



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4 Operating Modes

Two operating modes can be selected by sending the corresponding uppercase character to the TeraRanger One via the serial port. In TWI mode, the sensor is in precise mode by default and cannot be changed for the moment:

P	Precise mode	The TeraRanger One adapts its internal parameters to achieve best accuracy. NB: this function can reduce measurement repetition rates and thus reaction times.
F	Fast mode	This mode ensures the fastest measurement repetition rate and reaction time, even if the accuracy of the readings is decreased.

There is the potential for more operating modes to be implemented in future firmware versions. If you have suggestions, please contact us on support@teraranger.com.

5 Printout Modes

Two printout modes can be selected by sending the corresponding uppercase character to the TeraRanger One:

T	Text mode	The distance information is a message of four to six bytes followed by a carriage return character and a newline character: <code>xxxxx\r\n</code> . This message corresponds to the measured value in millimeters. Please be aware that there is no zero-padding for leading zeros! If the TeraRanger One is unable to measure a distance, it will output <code>-1\r\n</code> as an error message. Valid measurements are decimal and between <code>200\r\n</code> and <code>14000\r\n</code> .
B	Binary mode	The distance information is a message of exactly 4 bytes, the header is the character T (84 decimal/ 0x54 hex) followed by two bytes for the distance value in millimeters and message (first three bytes including the T) checksum CRC8 byte at the end. If the TeraRanger One is unable to measure a distance, it will output <code>T00CRC</code> (both distance bytes set to zero) as an error message. Valid outputs are from 200 decimal to 14000 decimal.

Please note that the default mode is binary. If you need any other output format, speed or protocol, please contact us on support@teraranger.com.



6 Flashing Firmware

The sensor includes an Atmel ATmega328 MCU, which can be updated using “avrdude” as part of the firmware bundle. Please follow the instructions below to update the TeraRanger One’s firmware:

1. Ensure you have the flashing tool for your operating system. You can download this from <http://www.teraranger.com/support>. Please make sure that you use the avrdude version provided in the firmware update bundle (Version 5.1.1)!
2. Uncompress the bundles and make sure that all the files are in the same directory
3. Run the following commands:

- **MacOS / Linux**

```
cd DIRECTORY_WHERE_YOU_DECOMPRESSED_BUNDLE [Enter]
```

```
./avrdude -Cavrdude.conf -pm328p -P/dev/ttyXXX -b57600 -D  
-Uflash:w:TROne.VERSION.hex [Enter]
```

NB: (1) replace ttyXXX with the name of the USB Serial device
(Linux: ttyUSBx, MacOS: tty.usbserial-xxxxxxx)
(2) TROne.VERSION.hex is the name of the firmware file you
have received

- **Windows**

From start menu write “cmd” in the “Search Programs and Files”
cd DIRECTORY_WHERE_YOU_DECOMPRESSED_BUNDLE [Enter]

```
avrdude -Cavrdude.conf -pm328p -P\\.\COMx -b57600  
-D -Uflash:w:TROne.VERSION.hex [Enter]
```

NB: (1) replace COMx with the name of the USB Serial device (to list available
COM goto “Device Manager” and check “Ports (COM&LPT)”
(2) TROne.VERSION.hex is the name of the firmware file
you have downloaded



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