# TeraRanger Duo

by **TERABEE**

## *Manual*

*Firmware 4.0.0 DUO, September 2015*

## *Technical Specifications:*

| | |
|---|---|
| Principle: | Infrared Time-of-flight (TOF), Ultrasound |
| Range: | 14m (in non-direct sunlight conditions ≥ 6m otherwise) for ToF, Sonar up to 7.65m |
| Update rate: | 1kHz (in speed mode) - up to 600Hz (in precision mode), Sonar 1-20Hz |
| Range resolution: | 0.5cm for ToF, 1cm for Sonar |
| Accuracy: | ± 2cm (in precision mode) for ToF |
| Field of view: | ±1.7° |
| Supply voltage: | 10-20V DC |
| Supply current: | 50mA@12V = average consumption, 100mA@12V = peak consumption |
| Possible interfaces: | UART, +5V level, up to 115200,8,N,1, user programmable* |
| | SPI (shared with JTAG), one CS line, +5V level (with SDK only) |
| | Two user I/O lines, +5V level, e.g. for PWM, interrupts, LEDs etc. (with SDK only) |
| Auxiliary interface: | +5V output available on connector (max. 20mA) |
| Expansion & upgrade:: | SDK available, firmware upgradable by user |
| Connector: | 15 pin DF13 |
| Weight: | 16g |

\* The USB adaptor works perfectly with your PC and Mac and provides easy Plug & Play data-connectivity and direct power supply. For more information please visit: http://www.teraranger.com/product/teraranger-usb-adapter/

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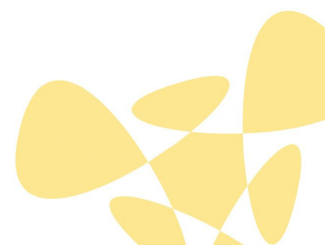
## Safety Notes

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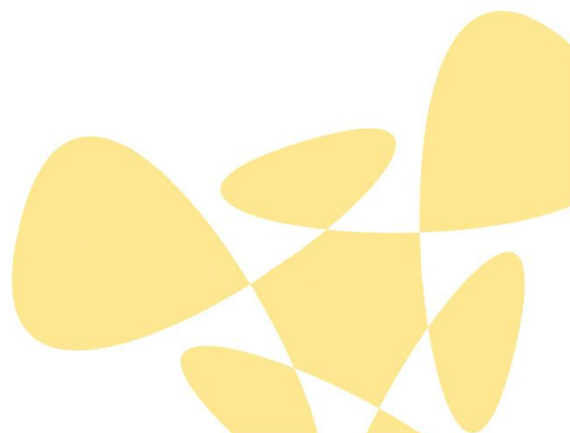
## Table of Contents

# 1   About the TeraRanger Duo

## 1.1   Inside the Package

You will receive the following items when purchasing a TeraRanger Duo:
- a fully assembled and calibrated sensor
- a connector cable with free ends that can be soldered to your device
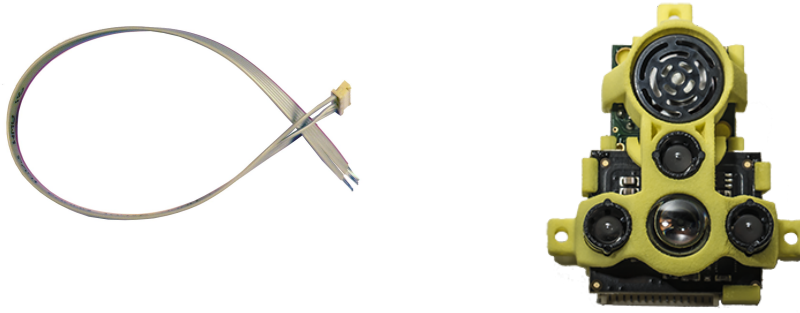
If you have purchased a USB adapter in addition to your TeraRanger Duo, you will also receive the following items:
- the USB adapter board
- a connector cable that connects your USB adapter board to your TeraRanger Duo
- a Mini-USB cable that connects the USB adapter board to your computer

## 1.2    Dimensions and Mounting

The TeraRanger Duo provides two mounting holes, which are designed for M2.5 screws. The individual distances between the holes are shown in the figure below. Moreover, the following aspects should be taken into consideration when mounting the TeraRanger Duo:
- Do not remove the plastic cover as this will misalign the optics and degrade the sensor's performance.
- Do not mount the TeraRanger Duo to hot surfaces or near other sources of heat. If possible, allow the sensor to properly radiate its heat or mount it at a ventilated place.
- Take the usual precautions for sensitive electronics such as keeping distance from strong electric and magnetic fields, strong radio emitters, strong heat sources, etc..
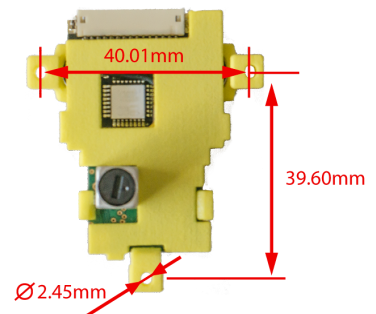
## 1.3    About the Connector

The TeraRanger Duo 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.

Moreover, the cable assembly delivered with the TeraRanger Duo comes with six wires installed: Ground (GND, pin 1,15), 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), 3.3-5V 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 voltages levels to programming devices, max. 10mA!) |
| 1 | GND |

Pin 1
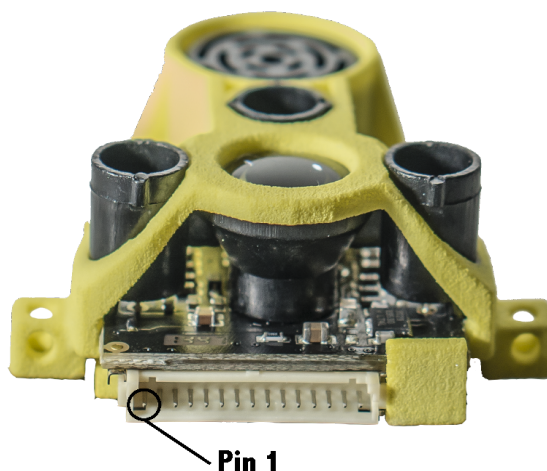
Note:
- DF13 connectors are very reliable once installed, they are a perfect match in environments with vibrations like robots and drones. Nevertheless, those connectors are not made for infinite plugging and unplugging operations. If you need to plug and unplug the sensor very often, consider adding another more suitable connector afterwards.
- 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.
- The TWI interface is only used internally for the sonar/ToF communication and is not available for user readouts
- Please obey basic rules on ESD*** safety when connecting and touching the TeraRanger Duo!

*Up to this current version, only UART is supported by the current firmware - next versions will include TWI** slave and SPI support.
** TWI is fully compatible to NXPs I2C or IIC bus system
*** See for example http://en.wikipedia.org/wiki/Electrostatic_discharge

## 1.4 Data Interface

The default interface is UART on pins 12 and 13. It accepts input voltage levels from 3.3V up to 5V, 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 Duo to your PC. DO NOT connect the TeraRanger Duo 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 print out modes that are explained in chapters 4 and 5 in this manual.

## 1.5 USB Interface

If you have purchased the TeraRanger Duo USB adapter, you can directly connect the TeraRanger Duo to your PC without the need of any additional power supply. In most modern operating systems, a driver for this interface is already pre-installed 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 Duo from the USB interface while the device is powered, disconnect the USB plug from the PC first!

## 1.6 Details on Supply Voltage

The TeraRanger Duo can work with voltages ranging from 10V to 20V and has an internal voltage regulator for an optimised functioning. However, to minimise unnecessary heating, we advise the use of a preregulator down to 12V or 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.

In any case, the TeraRanger Duo is equipped with a safety shutdown to prevent damage from excessive currents or board temperatures; in case of shutdown triggering, the sensor resets automatically after reaching normal working conditions.

## 2    Connecting the TeraRanger Duo Using a Computer With a Serial Console

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

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

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

**Windows**
In Windows you can use HTerm (http://www.der-hammer.info/terminal) or any other terminal software of your choice.

## 3    Running the TeraRanger Duo in ROS

The ROS (Robot Operating System) node for the TeraRanger Duo is currently under development and will be available soon.

## 4    Operating Modes

The current firmware (4.0.0 Duo) supports two operating modes which can be selected by sending the corresponding uppercase character to the TeraRanger Duo:

| P | **Precise mode** | The TeraRanger Duo adapts its internal parameters to achieve best accuracy.  The sonar reading is updated approximately once per second, the output stays unchanged until a new reading is acquired. NB: this function can slower measurement repetition rate and thus reaction time |
|---|---|---|
| F | **Fast mode** | This mode ensures the fastest measurement repetition rate and reaction time, even if the accuracy of the readings is decreased. The sonar reading is updated approximately once per second, the output stays unchanged until a new reading is acquired. |

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

The current firmware (4.0.0 Duo) supports two printout modes which can be selected by sending the corresponding uppercase character to the TeraRanger Duo via the serial port. In TWI mode, the sensor is in precise mode by default and cannot be changed for the moment:

| T | Text mode | The distance information is contained in two messages of four to six bytes with a blank space in between and followed by a newline character: '*Txxxxx Sxxxx\n*' This message corresponds to the measured values in millimeter, the first part is the reading of the TeraRanger (starting with 'T') and the second part is the reading of the sonar (starting with 'S). Please be aware that there is no zero-padding for leading zeros! If the TeraRanger Duo is unable to measure a distance, it will output '*0*' as an error message in the part of the message which is concerned. Valid measurements are decimal and between 200 and 14000 for the TeraRanger and 0 to 7650 for the sonar. |
|---|---|---|
| B | Binary mode | The distance information is a message of exactly seven bytes, the headers are the character T (84 decimal/ 0x54 hex) at byte one and S (83 decimal/ 0x53 hex) at byte four. Each header is followed by two bytes for the distance value in millimeter (a 16bit word). Byte seven is the checksum (CRC8) of all six bytes before.  If the TeraRanger Duo is unable to measure a distance, it will output *T00S00CRC* (both distance bytes set to zero) as an error message. |

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.We also have available a software development kit, please let us know if you are interested in this.

# 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 Duo's firmware:

1. Download the TeraRanger Duo firmware bundle and the corresponding flashing tool for you operating system from http://www.teraranger.com/support/
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
   ./avrdude -Cavrdude.conf  -pm328p  -P/dev/ttyXXX -b57600 -D
   -Uflash:w:TRDuo.VERSION.hex
   ```

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

   - **Windows**
   From start menu write "cmd" in the "Search Programs and Files"
   ```
   cd DIRECTORY_WHERE_YOU_DECOMPRESSED_BUNDLE
   avrdude -Cavrdude.conf  -pm328p -P\\.\COMx -b57600
           -D -Uflash:w:TRDuo.VERSION.hex
   ```

       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) TRDuo.VERSION.hex is the name of the firmware file
           you have downloaded

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.