User Manual for TeraRanger Evo Mini

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1. Introduction

1.1. About Terabee

The smallest and lightest addition to the TeraRanger Evo sensor family provides versatile performance and value for money! Optimized for indoor distance sensing, Evo Mini offers ranging capabilities from just 3 cm up to 3.3 m using a 27 degree Field of View. Easily switch from single-pixel to multi-pixel modes, as well as close-range and long-range modes, to adapt to your sensing needs.

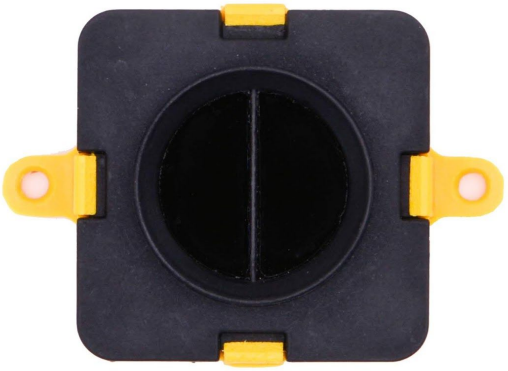

Figure 1. TeraRanger Evo Mini sensors, top view

Evo Mini has zero open electronics and provides an ABS protected enclosure, resulting into a dust-proof and robust operation. Benefit from Arduino & Raspberry Pi sample codes and free ROS packages to get your projects up and running in no time!

1.2. Symbols explanation

The following symbols are used within the document:

This symbol indicates specific recommendations in order to run the sensor in the intended way.

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1.3. Technical Specifications

Table 1 - Technical specifications of TeraRanger Evo Mini

Product codes	TR-EVO-MINI-USB / TR-EVO-MINI-I2C
Performance	
Detection Principle	Infrared Time-of-Flight
Light Source Wavelength	940 nm
Use Environment	Indoors
Repeatability	< 5 mm
Output Distance Resolution	1 mm
Field of View	27°
Projected Reception Area	48 cm x 48 cm @ 1 m
Operation	Pixel (px) modes: 1px, 2px, 4px (2x2) Ranging modes: short-range, long-range
Range	
Accuracy	Please see “Performance Matrix” table for more details
Update Rate	
Electronics	
Supply Voltage V_{DC}	5V DC +/-5%
Current Consumption (average)	50mA
Initialization Time	< 1 s
Communication	
Serial Interfaces	USB 2.0 Micro-B UART, +3.3V level, 115200,8,1, None I2C, +3.3V level, 400 kHz
Visual Notification	2 x LEDs (built-in backboard)
Mechanical data	
Dimensions	42 x 30 x 13 mm (incl. backboard)
Weight	9 g (incl. backboard)
Operating Temperature	-20°C to 75°C
Housing Material	ABS

Mounting Style	2 holes for M2 screws
Type of Connection	USB Backboard: USB 2.0 Micro-B I2C/UART Backboard: DF13-7p connector Hub Evo Backboard for use with TeraRanger Hub Evo
Conformity	
	CE, RoHS

1.3.1. Performance Matrix

Table 2 - Performance matrix for the different range and pixel modes

Range mode	Short-Range mode			Long-Range mode		
Pixel mode	1px mode	2px mode	4px mode	1px mode	2px mode	4px mode
Range	0.03m to 1.35m	0.03m to 1.35m	0.03m up to 1.35m	0.03m to 3.3m	0.03m to 2.3m	0.03m up to 1.65m
Accuracy	Up to +/-1.5cm	Up to +/-1.5cm	Up to +/- 2cm	Up to +/- 2cm	Up to +/-1.5cm	Up to +/- 3cm
Update Rate	Fixed 40Hz	Fixed 13Hz	Fixed 6Hz	Fixed 20Hz	Fixed 8Hz	Fixed 4Hz

Specifications are derived from tests in controlled conditions (target with 80% diffuse reflectivity, indoor fluorescent lighting, ambient temperature around 25°C). Note that bright sunlight, target surface reflectivity and other variables can affect sensor performance

1.3.2 Communication interfaces

Table 3 - Communication interfaces for the different range and pixel modes

Interface	Short-Range mode			Long-Range mode		
	1px mode	2px mode	4px mode	1px mode	2px mode	4px mode
USB	Yes	Yes	Yes	Yes	Yes	Yes
UART*	Yes	Yes	Yes	Yes	Yes	Yes
I2C*	Yes			Yes		
Hub Evo				Yes		

*Please note that UART and I2C data communication is supported by the same interface backboard

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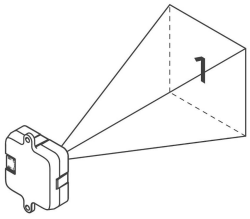
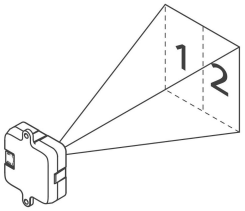
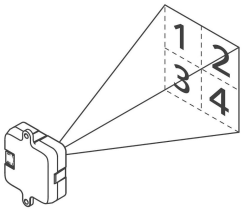
1.4. Pixel modes introduction

The TeraRanger Evo provides 6 operating modes: 3 pixel modes and 2 range modes. For more details on how to switch between the operating modes, please refer to section 5.

Benefit from 3 distinct pixel modes with 1 pixel resolution, 2 pixel resolution and 4 pixels (2x2) resolution. Please see table 4 for a visual example for each pixel mode.

Table 4 - TeraRanger Evo Mini operating modes introduction

1px mode	2px mode	4px mode (2x2)
		
Sensor outputs 1 distance.	Sensor outputs 2 distances.	Sensor outputs 4 distances on a matrix of 2x2.

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2. Mechanical integration

2.1. Modular design (clip-on, clip-off)

The mechanical design of the main sensor module (black) allows easy assembly to its backboard (yellow) using a simple 'clip-on' technique. When clipping the two together, please ensure there is no visible gap between the black and yellow parts.

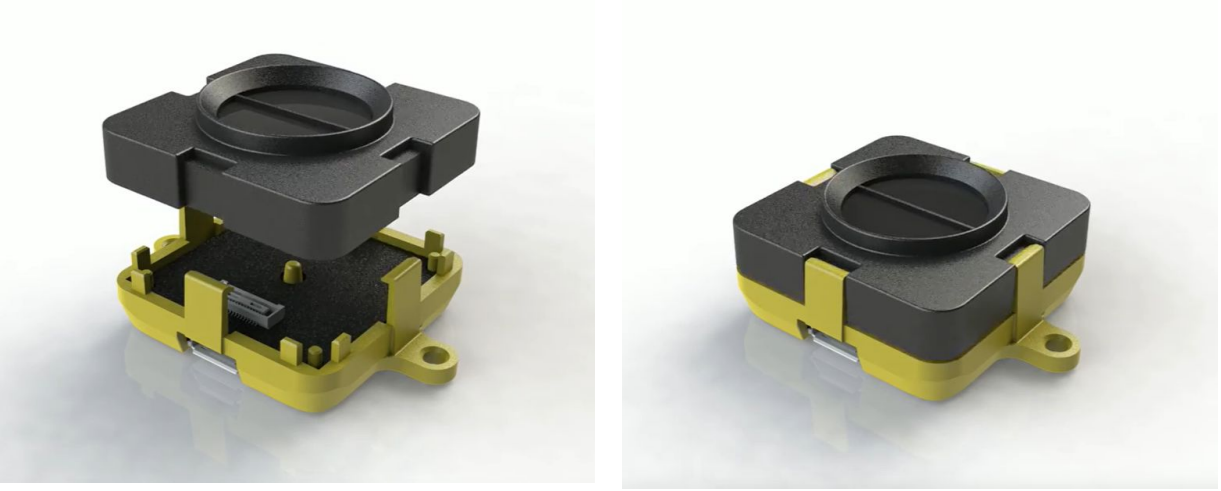

Figure 2 - modular design of the TeraRanger Evo Mini sensor

2.2. Mechanical design and mounting

TeraRanger Evo Mini distance sensor offers an ABS housing (both: sensor and backboard) with an option to mount the sensor using 2 holes compatible with M2 screws. Figure 3 illustrates external dimensions of TeraRanger Evo Mini sensor.

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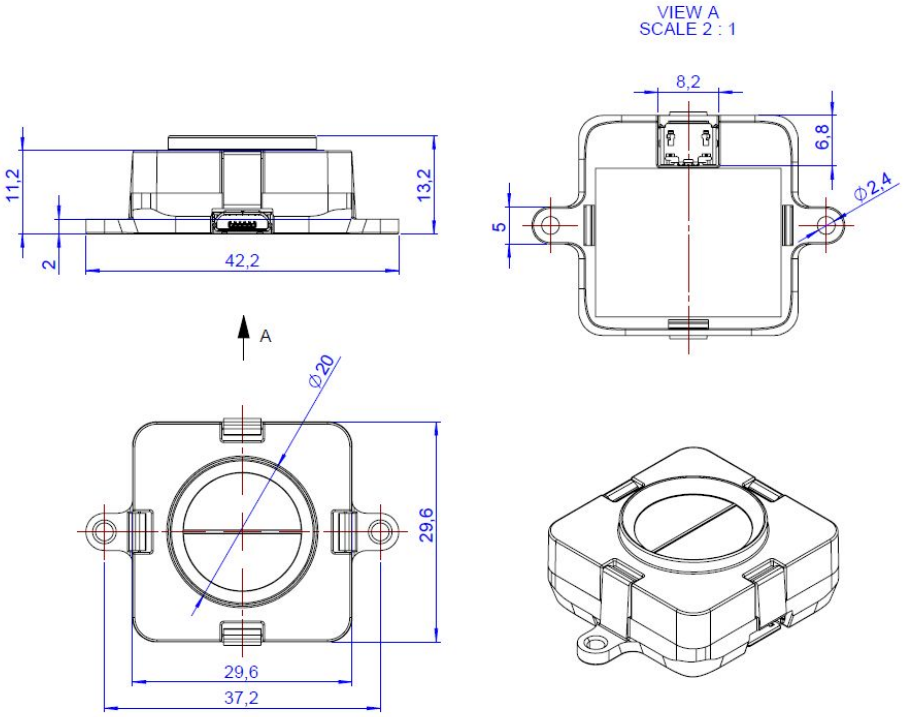

Figure 3 - TeraRanger Evo Mini external dimensions, USB backboard

Please note that the overall sensor dimensions remain unchanged when using the I2C/UART backboard. The only affected dimension is the opening of the connector.

Both USB and I2C/UART Backboards include two slots for mounting the sensor using standard M2 screws. The following methods can be used to mount the TeraRanger Evo Mini sensor:

1. Front-panel mount using the M2 screws
2. Back-panel mount using the 2mm ledge on the front side of the sensor

Figure 4 illustrates the two different mount methods. The prior solution allows for easy surface attachment and rapid evaluation of the sensor. The latter provides a more discreet installation and supports design-in projects by installing the sensor behind a surface (e.g panel), ideally with 2mm thickness.

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Figure 4. Front-panel mounting (left image); back-panel mounting (right images)

2.3. Mounting solutions

When choosing a place for mounting the TeraRanger Evo Mini, please consider the following recommendations:

- Mounting close to sources of heat or strong electromagnetic fields can decrease the sensing performance
- Do not mount anything directly in front of the sensor or in a cone of approximately +/-35° around the central optical axis of the sensor
- Within the first meter from the sensor, avoid objects with high surface reflectivity in a cone of approximately +/-45° around the central optical axis of the sensor
- It is better to avoid having other sources of Continuous Wave or modulated IR light close to the sensor
- Please consider that dust, dirt and condensation can affect the sensor performance
- It is not advised to add an additional cover in front of the sensor

During assembly and integration, please observe all common ESD precautions. All optical surfaces (sensor front) should be kept clean and free from contact with chemicals.

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3. USB backboard use

3.1. LED Indication

3.1.1. Normal operation

Three LED indicators are present on the USB backboard, and are visible through the back side of the yellow plastic case.

Table 5 - LED indicators of the USB backboard

LED designator	Description
PWR (ORANGE)	The Power LED is ON whenever the sensor is powered
RED	Flashes briefly on startup to indicate proper initialization; then switches off
GREEN	Blinks 8 times at power up. GREEN LED blinks every 5 seconds when the sensor is streaming distance data

Please note that the number of LEDs and their signalization logic differs between USB backboard and I2C/UART backboard

3.1.2. Error messages and troubleshooting

Table 6 - USB backboard LEDs troubleshooting

LED designator	Sequence	Signification	Corrective actions
RED	Continuous blinking	Sensor has detected a fault and has stopped functioning	Check that the sensor is properly connected to the backboard, then restart the sensor
RED / GREEN	Both LEDs blinking continuously	Sensor has detected a fault in the sensor initialisation process	Check USB output for details of Error Verify that the sensor is properly connected and re-power the unit

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RED / GREEN	Alternate blinking (red / green / red / green / etc) with 1 s intervals	Sensor is not initialized because previous firmware upgrade was interrupted Sensor can not be operated	Force a Device Firmware Upgrade by connecting the sensor to the Graphical User Interface and, without pressing **Connect**, hold "Shift" on your keyboard and click on **File > Upgrade Firmware**. The GUI will enter Upgrade Mode. For more details please refer to Section 3.2.3.

Please note that the number of LEDs and their signalization logic differs between USB backboard and I2C/UART backboard

3.2. Graphical User Interface (version 1.0.31)

A free Graphical User Interface (GUI) is available online, providing an easy way to visualize distance data on your Windows OS. This is useful for demonstration, testing purposes and checking some of the basic parameters of the sensor. It also provides a way to easily upgrade the firmware running on the device.

Please ensure you are using GUI version 1.0.3 or later (the current version only supports sensor's 1px mode) The TeraRanger Evo Mini GUI is available for download under the "Downloads" section of the Evo Mini product page, or by following the link below:

https://www.terabee.com/wp-content/uploads/2019/04/TeraRangerEvoInstaller_v1_0_3.exe

If the TeraRanger Evo Mini is used in 2px mode, 4px mode or in Text print out mode with the GUI, it will not stream any distance. Please refer to Section 5 for more information about the pixel and print out modes.

3.2.1. Prerequisites

For usage on Windows 7 and Windows 8, please download the Virtual COM Port driver from http://www.st.com/en/development-tools/stsw-stm32102.html and follow the ”ReadMe file” instructions given by the installer. After successful installation, unplug the interface for a few seconds, and plug it back in. The virtual COM port should now be available on your PC.

Users of Windows 10 do not need to download this driver as the built-in Windows driver is recommended.

3.2.2. Basic Operation with the GUI, supporting 1px mode

Make sure your TeraRanger Evo Mini is connected to a USB port on your computer. In the GUI select **File** > **Connect**. You should immediately see a distance reading in millimetres and the status change to ‘Connected’.

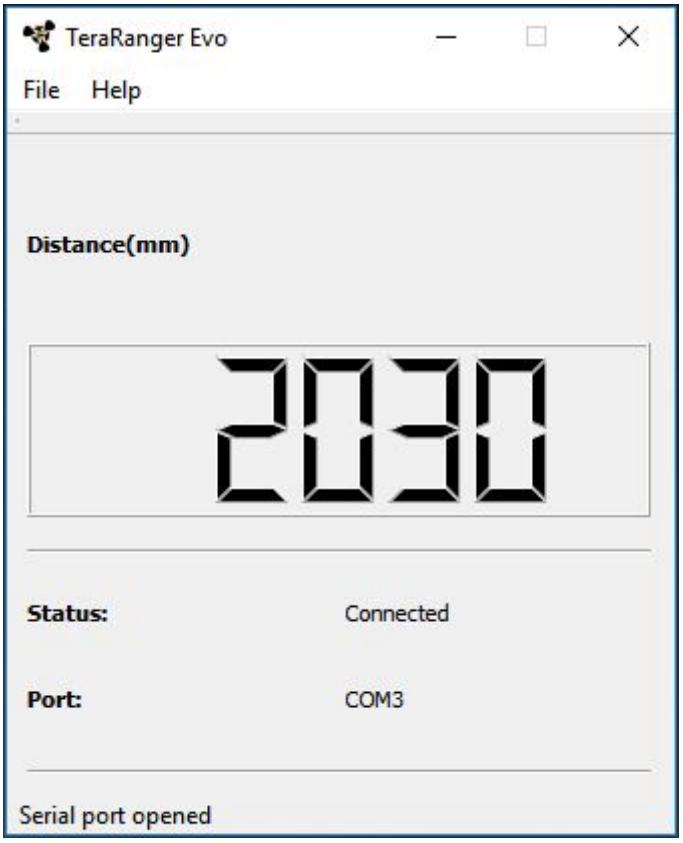

Figure 5 - TeraRanger Evo Mini GUI for 1px mode

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Each time the TeraRanger Evo Mini is connected to the GUI (powered), the sensor uses its default configuration parameters (1px mode, binary print out mode). To switch between other configuration modes please consult section 5 for more details.

In cases when the GUI is not streaming distance data, after successful physical connection to a personal computer, please reconnect the sensor to the computer by disconnecting and connecting the sensor. Should the issue persist, please contact Terabee team at support@terabee.com for further guidance.

3.2.3. Firmware Upgrade

The following section summarizes steps to upgrade the firmware running on your sensor. This can be helpful upon a new product firmware release (informed by Terabee) or should there be a necessity to re-flash your existing device firmware.

*The current firmware version on your TeraRanger Evo Mini can be found by selecting **Help > About** in the graphical user interface*

Please note that the Upgrade Firmware feature is only supported on Windows 7, 8 and 10 OS. Please carefully follow the steps outlined below to enable firmware upgrade and avoid permanently disabling your device.

Please be advised that wrongful execution of the upgrade functions can result into permanent sensor firmware deletion

Table 7 - Firmware upgrade instructions

Step	Action	Description
1	Download GUI	Download the latest version of the TeraRanger Evo GUI on your computer. The GUI is available from TeraRanger Evo Mini product page. Please refer to section 3.2 for more details
2	Install GUI	Install the downloaded version of the TeraRanger Evo GUI on your computer. Please refer to section 3.2 for more details
3	Download FW	Download the latest Evo Mini firmware file from the TeraRanger Evo Mini product page, or provided by the Terabee technical support team
4	Initiate upgrade FW procedure	In the GUI, select **File > Connect** and then **File > Upgrade Firmware**. Click 'Yes' in the dialog window to confirm the firmware

		upgrade procedure
5	Upgrade FW	A new dialog window will present instructions on selecting the firmware file and launching the upgrade process. Read the instructions carefully before continuing. Press *'Select File'* and select the new firmware file with Windows File Explorer Press *'Upgrade'* and wait until the operation finishes
6	Close upgrade FW procedure	Once the upgrade is over, the dialog box shows "Firmware upgraded" in the bottom left corner. Close the dialog. The sensor is ready to stream with the latest firmware. Note that the dialog box will automatically close after 5 seconds

Once initiated, the upgrade firmware procedure must follow all the steps. If the procedure exists before finishing, the sensor will switch to error mode. Please refer to section 3.1.2 for more details

3.3. Connecting the TeraRanger Evo to a Host Computer

3.3.1 Windows OS

In Windows it is also possible to use any terminal emulation software for data display. Terabee often works with and suggests using HTerm software. Please follow the provided link to download the software file (http://www.der-hammer.info/terminal/), and select the version **0.8.2** of the software.

Next, extract the downloaded zip file to the selected folder, open it and double click on the "HTerm.exe" document. Connect the TeraRanger Evo Mini to a computer and select the corresponding USB port (click "R" button to refresh the port list). Please configure the software with the following parameters:

Baud rate **:** 115200 bit/s
Data bits **:** 8
Parity bit **:** None
Stop bit : 1

For easier data reading, select the "LF" option from the "Newline at" drop-down field. See Figure 6 below for visual instructions.

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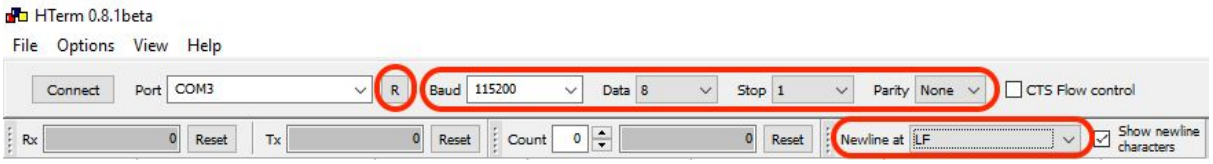

Figure 6 - HTerm parameters for TeraRanger Evo Mini

Once the USB port is selected and the parameters correctly set, click on the "**Connect**" button. The distance data will now appear in the "Received data" box (see Figure 7). Please note that the HTerm emulation software support data stream in all pixel modes, including 1px mode, 2px mode and 4px mode.

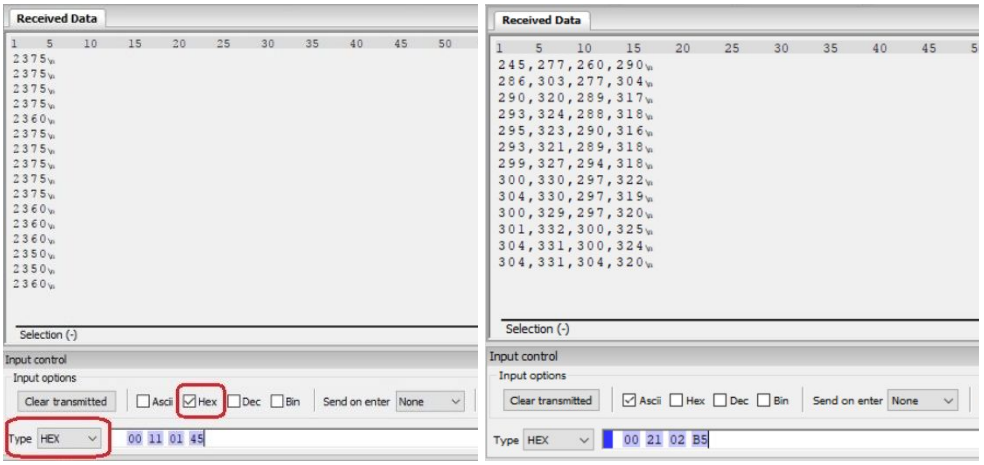

Figure 7 - Data stream on HTerm software:
1px mode (left); 4px mode (right)

To communicate with the terminal emulation software, a command in hexadecimal needs to be sent using the "Type" field. Make sure the "Hex" checkbox is selected (checked) and the "Type" field has "HEX" as an option selected. Figure 7 shows an example of the command which allows data to be shown in TEXT mode in 4px mode.

3.3.2 Mac Os

When using a Mac OS it is also possible to use any terminal emulation software for data display. Terabee often works with and suggests using the Coolterm software. Please follow the provided link to download the software file (https://freeware.the-meiers.org/).

Next, double click on the "CoolTermMac.dmg" file and then on the Coolterm icon. Connect the TeraRanger Evo Mini to a computer and click the "Options" button. Select the corresponding USB port (click "Re-Scan Serial Ports" button to refresh the port list). Please configure the software with the following parameters:

Baud rate **:** 115200 bit/s
Data bits **:** 8
Parity bit **:** None

Stop bit : 1

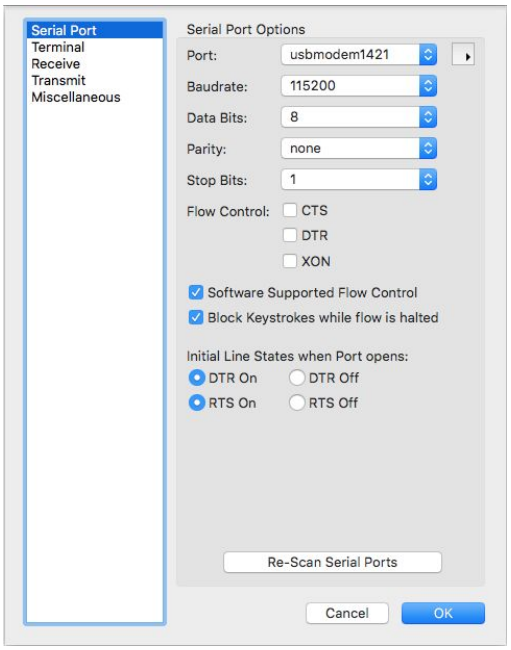

Figure 8 - Coolterm parameters for TeraRanger Evo Mini

Once the USB port is selected and the parameters correctly set, click on the "**Connect**" button. The distance data will now appear (see Figure 9). Please note that the Coolterm emulation software supports data stream for all pixel modes, including 1px mode, 2px mode and m4px mode.

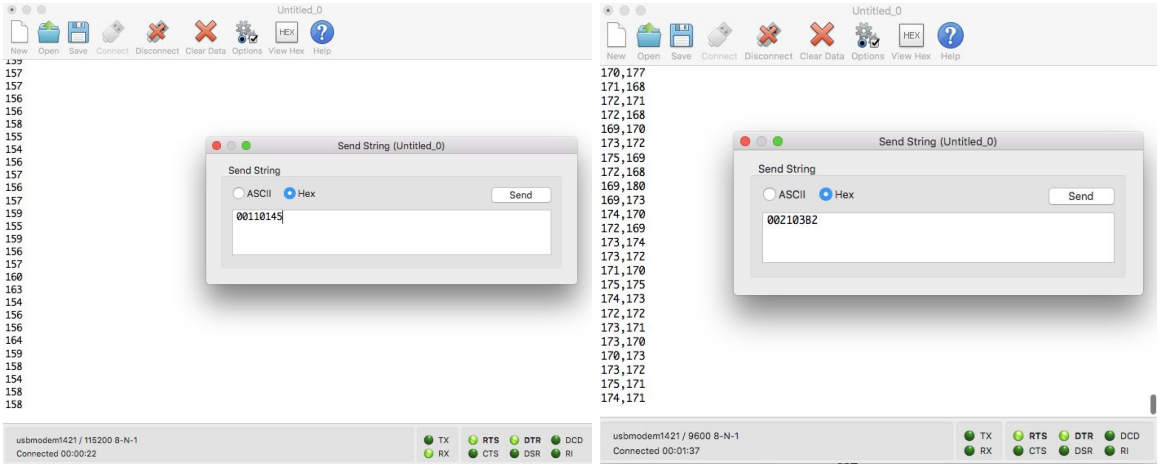

Figure 9 - Data stream on Coolterm software:
1px mode (left); 2px mode (right)

To communicate with the terminal emulation software, click **Connection > Send String**. A new window opens, allowing to send command to the Evo Mini. Make sure the "Hex" checkbox is selected (checked) as the command needs to be sent in hexadecimal, and then

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click the “Send” button. Figure 9 also shows an example of the command which allows data to be shown in 1px mode or in 2px mode.

4. I2C/UART backboard use

The TeraRanger Evo Mini sensor can be controlled through a UART interface using an I2C/UART backboard.

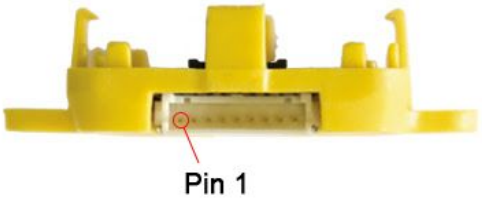

Figure 10 - I2C/UART backboard front view

4.1. I2C/UART pinout

The I2C/UART backboard uses a single 9 pin Hirose DF13 connector for interfacing to the host system. The mating connector is a Hirose DF13-9S-1.25C with crimping contacts DF13-2630SCF (tin) or DF13-2630SCFA (gold). Please consider the mechanical stability of the mated connectors and avoid any kind of excess force on the connector (during installation and once integrated) and follow the recommendations in the Hirose DF13 series datasheet (available here: https://www.hirose.com/product/en/products/DF13) to ensure a reliable connection.

Table 8 - Pinout and description (According to DF13 datasheet)

Pin	Designator	Description
1	Tx	UART transmit output. 3.3V logic
2	Rx	UART receive input. 3.3V logic
3	GND	Power supply and interface ground
4	SDA	I2C serial data line. 3.3V logic
5	SCL	I2C serial clock line. 3.3V logic
6	rfu	RESERVED FOR FUTURE USE
7	5V	+5V supply input
8	GND	Power supply and interface ground
9	rfu	RESERVED FOR FUTURE USE

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4.2. LED Indicators

4.2.1. Normal operation

The I2C/UART Backboard has three built-in LEDs behind the yellow case to visualise feedback of the sensor status. Table 9 lists the functionality of each LED of the I2C/UART backboard.

Table 9 - LED indicators of the I2C/UART backboard

LED	Description
PWR (orange)	Power indicator, constantly ON when 5V is supplied
Rx (red) **Tx (green)**	I2C/UART receive and transmit indicators. Single blink for each data received or sent

4.2.2. Troubleshooting

Table 10 - I2C/UART backboard LEDs troubleshooting

LED designator	Sequence	Signification	Corrective actions
RED	Continuous blinking	Sensor has detected a fault and has stopped functioning	Check that the sensor is properly connected to the backboard, then restart the sensor
RED / GREEN	Both LEDs blinking continuously	Sensor has detected a fault in the sensor initialisation process	Check I2C/UART output for details of Error Verify that the sensor is properly connected and restart
RED / GREEN	Alternate blinking (red / green / red / green / etc) with 1 s intervals	Sensor is not initialized because previous firmware upgrade was interrupted. Sensor can not be operated.	Run the Firmware upgrade. Please refer to Section 3.2.3 for more details

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4.3. Electrical characteristics

Table 11 - TeraRanger Evo Mini power consumption

Parameter	Minimum	Maximum	Average
Power supply			
Voltage input (V)	4.5V	5.5V	5V
Current consumption (mA)	25mA	75mA	50mA
Interface logic levels (referenced to +3V3)			
LOW	-	1	-
HIGH	2.3	-	-

5. USB/UART Normal operation

5.1. USB/UART list of commands

Table 12 - List of commands for TeraRanger Evo Mini

Command (HEX)	Command description	
00 11 01 45	PRINT OUT MODE	TEXT
00 11 02 4C	PRINT OUT MODE	BINARY
00 21 01 BC	PIXEL MODE	1PX MODE
00 21 03 B2	PIXEL MODE	2PX MODE
00 21 02 B5	PIXEL MODE	4PX MODE
00 61 01 E7	RANGE MODE	SHORT RANGE MODE
00 61 03 E9	RANGE MODE	LONG RANGE MODE

Please refer to Section 3.3 for instructions on how to send commands to the TeraRanger Evo Mini sensor using a host computer and the HTerm emulation software.

Each command message frame must be transmitted in a continuous stream, ie. not byte by byte

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It is advised to maintain a time interval of a few microseconds between two messages for proper command registration

5.2. Printout modes: text and binary

5.2.1. TEXT mode

This mode provides users with data transmission readable to a human eye. When streaming data using the HTerm software in single-pixel mode, the measured distances are displayed in millimeters under the form of a 3 to 5 bytes message: **xxxx\n** (the number of bytes is dependant on the number of digits in the distance reading)

Distance reading in mm **:** xxxx
New line character **:** \n (10 decimal / 0x0A hex)

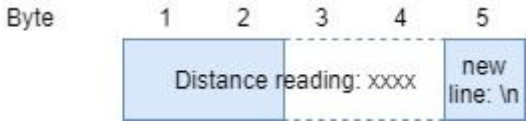

Figure 11 - Message frame in text mode for 1px mode measurements

Please refer to Section 5.5 for more details about error cases that lead to non numerical output.

Please note that there is no zero-padding for leading zeros.

When using 2px mode or 4px mode the measured distances are displayed in millimeters, separated from each other by a ",'" symbol. A new line character is only sent at the end of the measurements. For instance the 4px mode leads to a message of 9 to 17 bytes: **xxxx, xxxx, xxxx, xxxx\n** (the number of bytes depends on the number of digits in the distance reading)

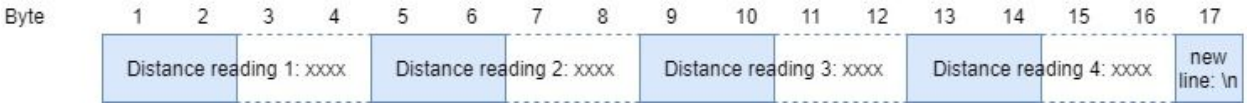

Figure 12 - Message frame in text mode for 4px mode measurements

The message frame for the 2px mode has the same structure as the 4px mode, except that it contains only 2 distance readings, thus resulting in a 5 to 9 bytes message.

5.2.2 BINARY mode (default)

This mode providers users with measured distances displayed in the form of binary messages using 4 bytes: **TXXCRC8**. Binary mode is the default printout mode of the sensor.

In 1px mode, the checksum byte is calculated out of the first 3 bytes of the message (header byte and distance reading bytes)

Header (1 byte) **:** T (84 decimal / 0x54 hex)
Distance reading in mm (2 bytes) **:** XX
Checksum (1 byte) **:** CRC8

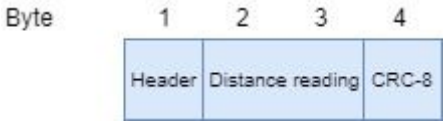

Figure 13 - Message frame in Binary mode for 1px mode measurements

The TeraRanger Evo Mini will output T01CRC (first distance byte set to zero and the second to one) as an error message if the sensor is unable to measure a distance. Please refer to Section 5.5 for more details about error cases.

In 2px mode and 4px mode, the measured distances (2 bytes each) are displayed in millimeters one after the other. The checksum is calculated at the end of the distance measurements out of the first bytes of the message. For instance the 4px mode leads to a message of a 10 bytes: **TXXXXXXXXCRC8**

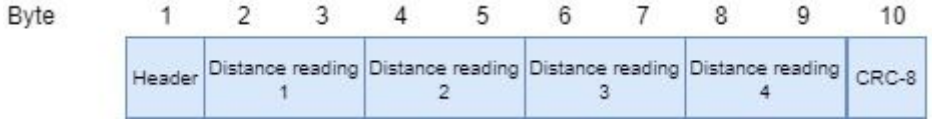

Figure 14 - Message frame in Binary mode for 4px mode measurements

The message frame for the 2px mode has the same structure as the 4px mode, except that it contains only 2 distance readings; thus resulting in a 6 bytes message.

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5.3. Pixel modes: 1px, 2px and 4px

5.3.1 1px mode

In this pixel mode, the TeraRanger Evo Mini returns a **single distance measurement** in millimeters, calculated on the entire 27° Field of View of the sensor. It is a default parameter of all pixel modes.

5.3.2. 2px mode

When in 2px mode, the TeraRanger Evo Mini returns **2 distance measurements** in millimeters, with a 20° Field of View in the diagonal. Figure 15 shows the pixel layout and the order in which the measurements are streamed from the sensor.

5.3.3. 4px mode

When in 4px mode (2x2), the TeraRanger Evo Mini returns **4 distance measurements** in millimeters. Each measurement (pixel) has a 13.5° Field of View, which represents an area of 24 cm x 24 cm at 1 m range. Figure 15 shows the pixel layout and the order in which the measurements are streamed from the sensor.

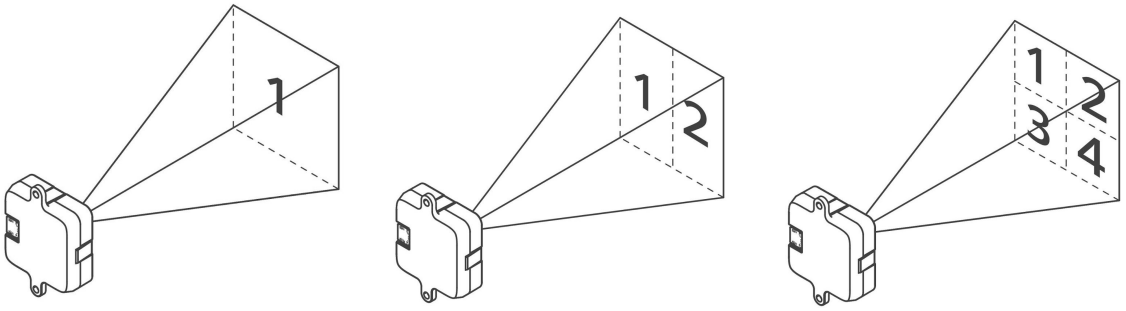

Figure 15 - 1px mode (left), 2px mode (center), 4px mode (right)

The pixel layout shown in Figure 15 both gives information regarding the position of each pixel in space, and regarding the order in which the distances are displayed (Pixel 1 = first distance output, Pixel 2 = second distance output,...)

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5.4. Range modes: short-range and long-range

5.4.1. Long range mode (default)

When in long range mode, TeraRanger Evo Mini will allow for distance measurements starting from 0.03m up to 3.3m range. This is the default range mode of the TeraRanger Evo Mini.

5.4.2. Short range mode

When in short range mode, TeraRanger Evo Mini will sample data at a higher update rate and return more accurate distance readings, at the expense of maximum range, which corresponds to 1.35 m range. Please note that the short range mode does not support applications that require measurements above 1.35 meters.

When the TeraRanger Evo Mini is powered off, it automatically returns into its default configuration modes: ***Binary print out mode, 1px mode, and long range mode****.*

5.5. Error cases

Table 13 - TeraRanger Evo Mini data output for error cases

Error cases output	BINARY	TEXT
Detection below sensors minimum range	0X0000	-Inf\n
Detection beyond sensors maximum range	0XFFFF	+Inf\n
Invalid reading: - Ambient light too high - Target surface too reflective	0x0001	-1\n

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6. I2C normal operations

Please note that streaming distance data via the I2C communication protocol (using the I2C/UART interface backboard) is possible only using the 1px mode of the sensors - in both: short-range and long-range modes.

6.1. I2C Protocol information

The I2C data protocol supports the following communication parameters:

Frequency: 400kHz

Primary Address Length: 7-bit

Primary Slave Address: 0x31

Built-in pull-up resistors: 10 kOhms on SDA and SCL (avoid additional pull-up resistors on the same bus to prevent transmission problems)

The TeraRanger Evo Mini sensor is 'free running'. This means that it will restart a new measurement as soon as the last one is finished. The displayed data via I2C protocol is always updated at the end of a measurement. Nevertheless, it can always be read at any time.

Reading the distance is done by first writing a Trigger Reading command to the sensor - send 0x62 (this is a 7 bit address 0x31 followed by the Write bit '0') and then reading from the sensor by sending 0x63 (the base address with the Read bit '1') followed by three byte read operations. The first two bytes you receive are a 16 bit word containing the latest measurement in mm, the third byte is the CRC8 checksum.
For more details regarding the error messages regarding the I2C communication, refer to Section 6.2.

6.1.1. Write protocol

To write commands to the TeraRanger Evo Mini, please follow the protocol described in table 14.

Table 14 - Write protocol in I2C

Step	Action	Description
1	Send address	Send the address byte consisting of a 7 bit base address and the last bit indicating write ('0') e.g: 0x62 for base address 0x31

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2	Send command	Send the desired command listed in the table below (see table below in the next paragraph)
3	Read answer	In case the command creates an answer, read it back immediately

Three commands are available to the user to perform some basic actions with the sensors. All four commands, that are exclusively "Write" operations, are listed in table 15. To get an answer from the "write" operation, the user needs to perform a "Read" operation. For more details about reading protocol, please refer to the next sub-section.

Table 15 - List of I2C commands for the TeraRanger Evo Mini

Command (HEX)	Command name	Command description
0x00	TRIGGER READING	Write this command to the TeraRanger Evo Mini and after 0.5 milliseconds, read three bytes from the sensor. The first two bytes received are a 16 bit message containing the latest measurement in mm, the third byte is the CRC8 checksum.
0x01	WHO_AM_I	Write this command to the TeraRanger Evo Mini via I2C and the Device responds with 0xa1. This functions to uniquely identify a TeraRanger Evo Mini on the I2C bus.
0x02 0x0**W**	CHANGE_MODE	Write this command to the TeraRanger Evo Mini to switch between the range modes : The value of W depends on the Mode : **W= 1 : SHORT DISTANCE MODE** **W= 3 : LONG DISTANCE MODE**
0xA2	CHANGE_BASE_ADDR	Write this command followed by the new base address that needs to be set to the TeraRanger Evo Mini.

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6.1.2. Read protocol

To read commands from the TeraRanger Evo Mini, please follow the protocol described in table 16.

Table 16 - Reading protocol in I2C

Step	Action	Description
1	Send address	Send the address byte consisting of 7 bit base address and the last bit indicating read (‘1’) e.g: 0x63 for base address 0x31
2	Read	Read back the number of bytes imposed by the command e.g: three bytes for a distance reading in 1px mode

6.2. Error cases

Table 17 - I2C error cases

Error cases output	BINARY	TEXT
Detection below sensors minimum range	0X0000	-Inf\n
Detection beyond sensors maximum range	0XFFFF	+Inf\n
Invalid reading: - Ambient light too high - Target surface too reflective	0x0001	-1\n

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7. Build multi-sensor applications

TeraRanger Evo Mini is compatible with the TeraRanger Evo Hub accessory board for multi-sensor applications. Available in kits with 4 or 8 Evo Mini sensor modules, benefit from a plug and play approach to building custom sensor arrays addressing specific sensing needs! The kit includes a central Hub that features built-in crosstalk avoidance system for efficient multi-sensor use, and outputs all sensor data using a single UART or USB interface.

For more information regarding the Evo Mini Array Kits, please visit terabee website.

Please note that TeraRanger Evo Mini only supports the 1px mode in long range mode for compatibility with the TeraRanger Evo Hub accessory board.

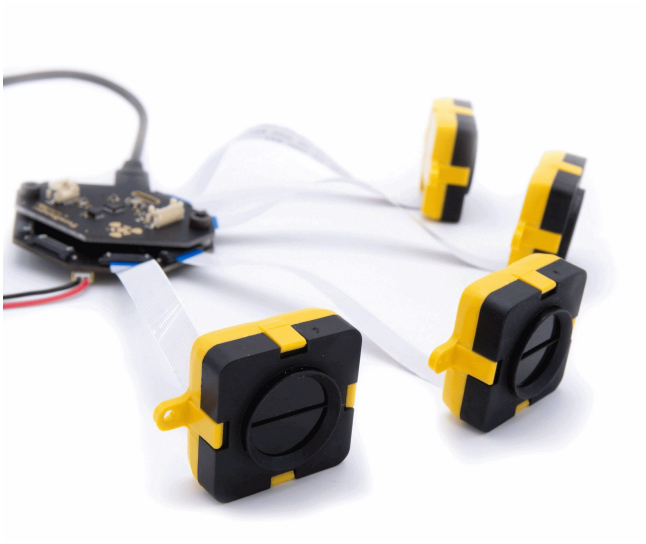

Figure 16 - Four TeraRanger Evo Mini sensors connected to Hub Evo

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8. Optical characteristics

8.1. Projected reception area

TeraRanger Evo Mini is an optical distance measurement sensor, that uses infrared Time-of-Flight principle. The sensor features a 27° degree Field of View, which corresponds to a detection area of 48 cm x 48 cm (projected reception area) at 1 m range. Figure 17 illustrates spotlight geometry of the sensor at different reference distances, when using 1px mode.

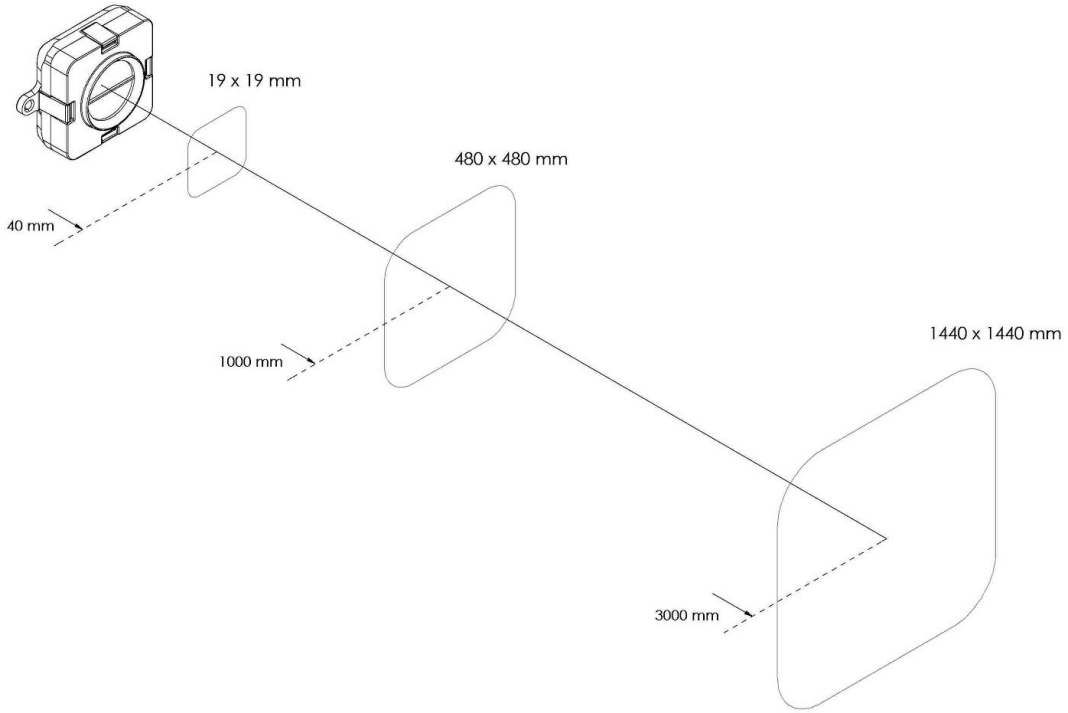

Figure 17 - Projected reception area for 1px mode.

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