

# **DW3000 Arduino Shield QSG (STM)**

**Version 2.2**

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## 1 INTRODUCTION

The DW3000 Arduino Shield-based kit consists of a pair of DW3000 boards, utilizing the DW3110 and DW3120 devices. Each of the DW3000-based boards can be configured to run the supplied applications, such as PDoA, Two Way Ranging, Continuous Frame mode, Continuous Wave mode, and more.

This document describes how to get started with the DW3000

- Description of the boards.
- Powering up the boards.
- Connecting to a PC and configuring boards to a desired application.

The UWB settings (i.e. Channel, Data Rate, PDoA Mode, etc.) can be configured using the command line interface. The instructions on how to do it, please refer to “Changing UWB Parameters” [4.1.2].

Supporting documentation and software which should be downloaded and studied are:

Document name	Description	Format
DecaRanging_PC_User_Guide_DW3000	How to use DecaRanging PC	Pdf
DecaPDOARTLS_PC_Source_Code_Guide	How to use PDoA GUI	Pdf
SW-DW3000-TWR-demo	Describes the operation of DW3000 TWR demo	Pdf

Table 1 DW3000 Eval Kit reference documents

Software	Description	Format
DecaPDOARTLS	PDoA GUI	.exe
DecaRanging_5p02	Two-Way Ranging demonstration application	.exe

Table 2 DW3000 Eval Kit software

## 2 ABOUT THE DW3000 ARDUINO SHIELDS

As shown in the picture below the DW3000 Shields are each attached to the ST NUCLEO-F429ZI at arrival to provide DW3000 PDoA NODE and DW3000 TAG functionality, respectively.

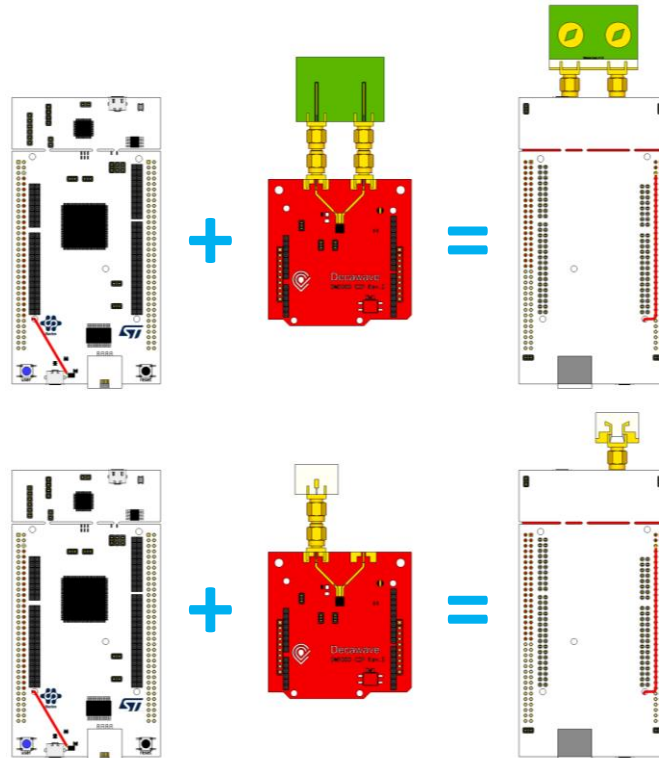


Figure 1 - DW3000 Arduino Shields

Both devices have, by default, channel 5 antenna attached in the required orientation. Please ensure that the antenna face each other during evaluation (Figure 2). The DW3000 Shields are mounted behind the NUCLEO Board to provide extra protection against interference.

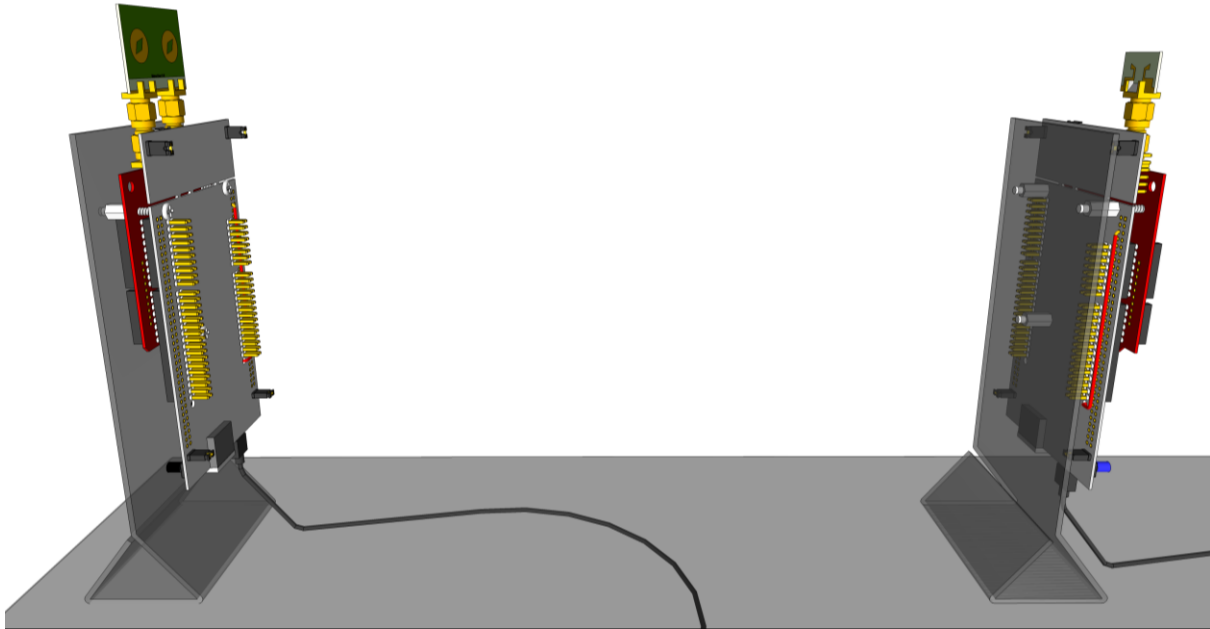


Figure 2 - Node antenna facing the Tag antenna

The boards are shipped preprogrammed. However, the firmware can be current or outdated. So powering the boards is all that is required. As an example, connect the Node board to the PC (allow time for the USB/serial comm port device to enumerate) and start the PDoA GUI executable. The Tag can be connected to the same PC via USB or to a power source such as a USB power bank or wall charger.

## 2.1 DW3000 Shield

There are two versions of a Shield included in the kit. The “NODE” makes use of the DW3120 WLCSP PDoA version of the UWB transceiver, it has two SMA RF connectors on the PCB. The “TAG” uses a DW3110 non-PDoA version (WLCSP) and has one SMA RF connector on the PCB.

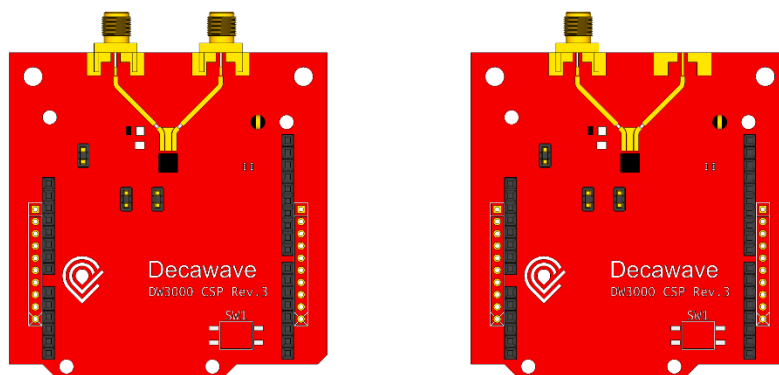


Figure 3 - DW3120 Shield and DW3110 Shield

## 2.2 Applying power to the ST Nucleo boards

The supplied STM32 Nucleo-144 board is divided into two parts: a small ST-LINK part, located on the upper part of the PCB and a target STM32. To power the board, connect the STM32 Nucleo-144 board to a PC with a USB ‘Type-A to Micro-B’ cable attached to the USB connector marked CN13.

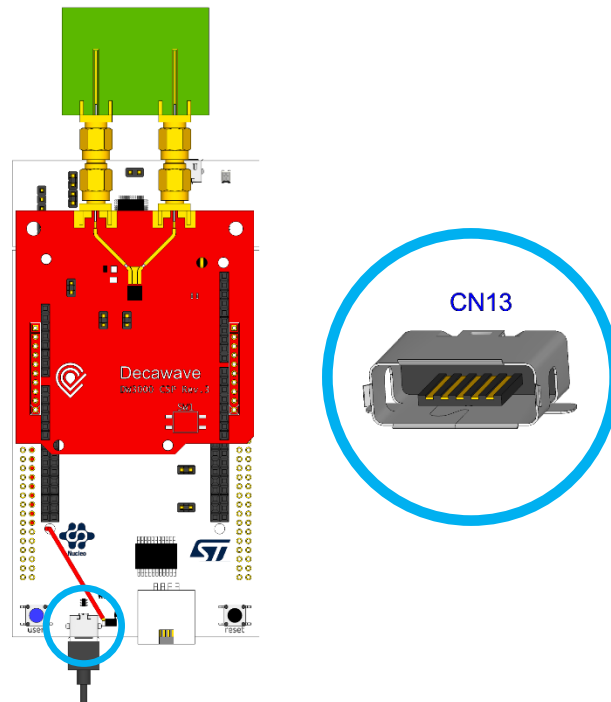


Figure 4 - Powering the boards

On the Nucleo board, the green LED LD8 (PWR) will be on and the RED LD4 will blink (these LEDs are on the STM board, under the Red shield). On the Shield you will see LED D2 (COM) light up (red) and the green LED D1 will begin to blink.

Since the boards are shipped pre-configured as PDoA TAG and NODE, the shield RX and TX LEDs will begin blinking continuously within a few seconds, indicating they are communicating over UWB. If the LEDs do not blink, the board is probably in another state. For example, the USPI state.

We recommend always to restart the boards before use, because the default application may have been changed by the previous user or session.

Confirmation of which application is running can be achieved by executing the 'STAT' command using terminal (i.e. Tera Term, Putty, etc.).

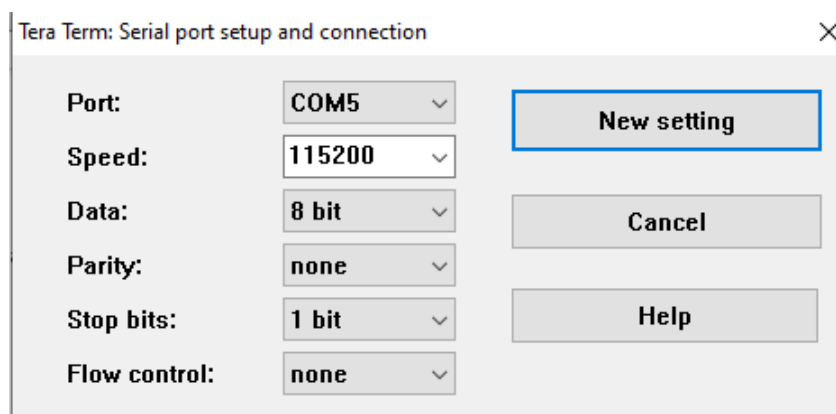


Figure 5 – Terminal configuration

### 3 PDoA EVALUATION

Connect the NODE to a PC via USB and start the DecaPDOARTLS application/GUI executable. The GUI should 'connect' to the NODE and a screen similar to the following should appear.



Once the GUI has started, power up the TAG; The TAG will start up, periodically indicating with its LEDS that it is transmitting.

If no LEDS are indicating activity than the board is in SPI mode. To change the mode to TAG, see section 4.2.

The TAG ID should appear in the table of the GUI. Click the "Joined" checkbox and Tag's position would be shown on the screen. See fig 5.

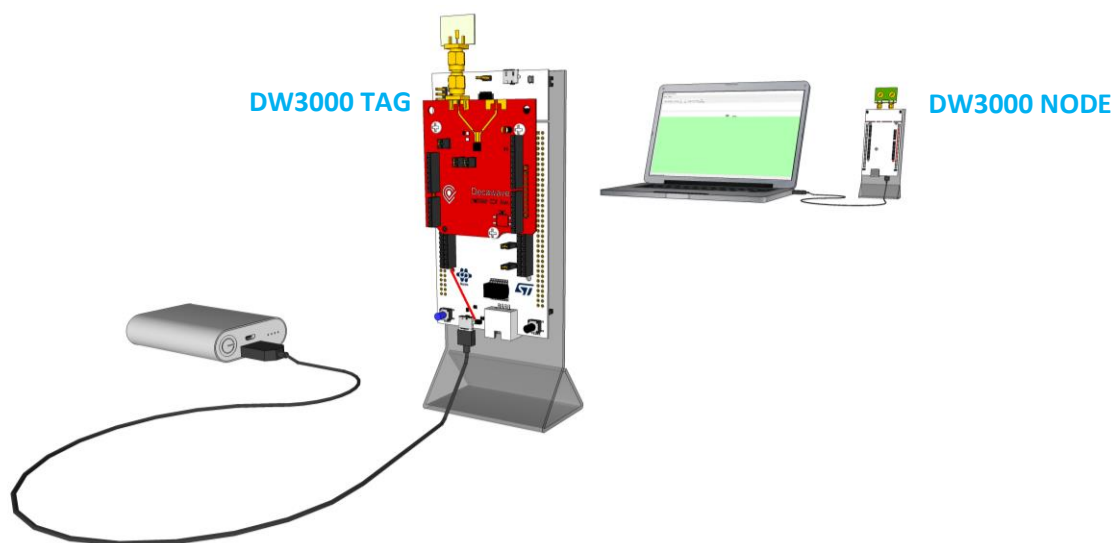


Figure 6 - PDoA System evaluation set-up



Figure 7 PDoA GUI Demonstration

For further information and detail on getting statistics see DecaPDOARTLS\_PC\_Source\_Code\_Guide and SW-DW3000-TWR-demo description.



## 4 APPENDIX 1 –SETTING AND SAVING REQUIRED APPLICATION

The DW3000 Shields are preprogramed with a selection of applications/modes, including a default or saved power- up mode. It may be necessary to switch the selected mode manually.

This can be done by execution of a command via a terminal emulator. Once a particular mode is selected by command, the mode can be made the default by ‘saving’ the new configuration, which will then be the mode of operation at power up and after a RESET.

### 4.1 *Setting the application by command*

It is possible to start different firmware applications on the boards using a PC-based terminal emulator, such as TeraTerm, while connected via USB. Note that only one virtual serial port connection is supported at a time, so be sure to close all PDoA GUI or DecaRanging-PC apps on the PC, if launched previously, before attempting to connect using a terminal emulator.

When using the terminal emulator, also be sure to configure the virtual serial port associated with the eval board to a 115200-8-N baud rate. Other settings should be left at their default settings. It is also recommended to set the end of line to <CR> (not <CR><LF>).

The main firmware applications for evaluating PDoA or Two Way Ranging proximity testing are:

- TAG– starts the PDoA TAG application.
- NODE – starts PDoA NODE application.  
And
- USPI – Enables SPI over USB communication (Required for DecaRanging-PC).

The following application are also supported in the firmware but not further documented here. Please see the source code descriptions:

- TCWM – Sets the board into Continuous wave mode.
- TCFM – Sets the board into Continuous Frame mode.
- TRILAT – starts trilateration app (NODE app + trilateration app) - requires 4 TAG boards.

Before entering an application command, the command “STOP” should always be used to force the unit into the idle mode. If the unit is not in the idle mode, it may be in an incompatible mode and produce the following error:

```
error incompatible mode
```

Again, starting of applications can only be done while in idle mode.

#### 4.1.1 Changing application to PDoA NODE, PDoA TAG or USB2SPI, using commands

Connect one of the boards to the PC via USB and start the terminal emulator program (again, we use TeraTerm).

Confirm that communication is established by typing STOP. Response should be “OK”.

```
stop  
ok
```

It is possible that TeraTerm will not be able to communicate with the board. In that case, RESET the board and try again. Also, be sure the port is configured for the 115200 baud rate.

Next, start the required application. For the PDoA NODE, the application is “NODE”.

```
node  
ok  
Found AOA DW3000 chip. PDoA is available.  
PDoA Node Top Application: Started
```

Type “**SAVE**” command while this app is running. This will set **NODE** as the **DEFAULT** to be executed after Reset.

Repeat the same steps to configure the TAG eval board as “**TAG**”.

Type “**SAVE**” command while this app is running. This will set **TAG** as the **DEFAULT** to be executed after Reset.

For DecaRanging-PC purposes, it may be necessary to run the USB2SPI application on both boards.

To start the USB2SPI application one needs to type “**USPI**” on the terminal emulator (after the **STOP** command).

Then “exit” the TERA TERM in order to start DecaRanging.

To set USPI as the default application, (unlike the Node and TAG modes), one should only type “**SAVE**” AFTER issuing the “**STOP**” command. This will set USB2SPI as the **DEFAULT** to be executed after Reset or power up.

```
stop  
ok  
save
```

When the default application is USPI, one can change the application to NODE or TAG by a combination of pushing and releasing of the user function button(blue) and reset button (black). How to set the boards to NODE application or TAG application when the default application is RESET is described in the next section.

#### 4.1.2 Changing UWB Parameters

The UWB Parameters are available and can be changed using the command “**UWB\_CFG**”. If typed with no arguments, the output will be the current UWB parameters:

```
uwbcfg
JS00BF{"UWB PARAM":{
  "CHAN":5,
  "PLEN":64,
  "PAC":8,
  "TXCODE":9,
  "RXCODE":9,
  "SFDTYPE":1,
  "DATARATE":6810,
  "PHRMODE":0,
  "PHRRATE":0,
  "SFDTO":65,
  "STSMODE":9,
  "STSLEN":256,
  "PDOAMODE":3}}
ok
```

To change parameters, the command must be followed by the values for all thirteen parameters, in the same order they appear in the output, separated by spaces.

i.e. Considering the previous output, to change the Channel from 5 to 9 keeping the other parameters the command must be: uwbcfg 9 64 8 9 9 1 6810 0 0 65 9 256 3

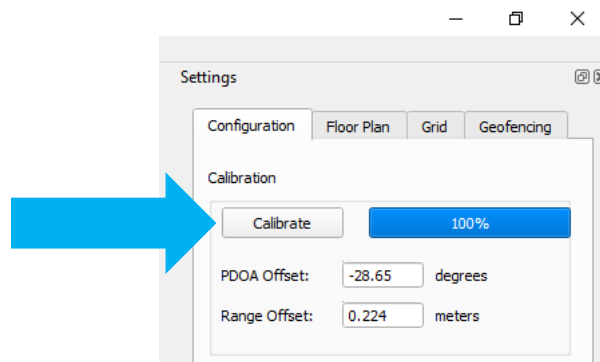
Like the other parameters, the **“SAVE”** command must be used to keep the configuration after reset.

For further information about the **“UWBCFG”** and parameters, please refer to the DW3000 TWR Demo Guide<sup>[3]</sup>.

#### 4.1.3 Enabling the Correction Algorithm

To enable the Correction Algorithm, follow those steps:

- Calibrate the Node using the DecaPDOARTLS “Calibrate” option; (directions to calibrate are simple, and displayed on screen)



- Close DecaPDOARTLS and open the terminal emulator choosing the Node UART;
- Use the **“STOP”** command to stop any app running, then start the Node app by typing NODE in the terminal;

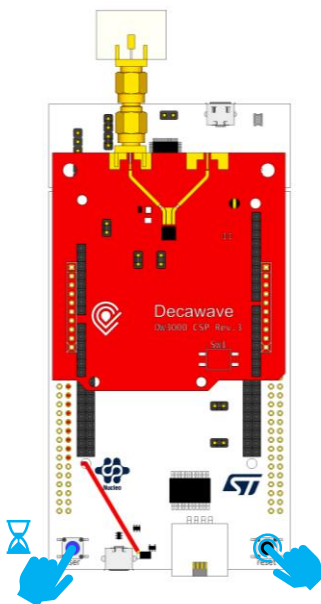
```
stop
ok
node
ok
Found AOA DW3000 chip. PDoA is available.
PDoA Node Top Application: Started
```

- Now, type “PHCORREN 1” and “SAVE” after that;

```
Found AOA DW3000 chip. PDoA is available.
PDoA Node Top Application: Started
phcorren 1
ok
save
ok
```

- Close the terminal emulator and start DecaPDOARTLS.

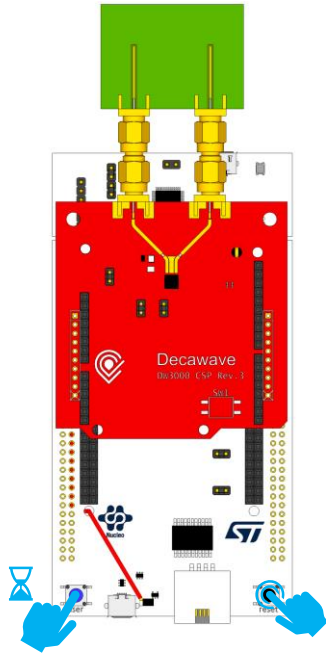
#### 4.2 Manual app selection using the User button and RESET button when default is USPI



##### To configure the non-PDoA version eval board to TAG mode:

Press and hold RESET **and** USER button simultaneously.  
Release RESET button first and then release USER button (within ~1sec).  
The board will start the “TAG” application.  
You’ll see the RX and TX LEDS flashing alternately on the Shield.

Figure 8 - Set DW3000 as PDoA TAG

**To configure the PDoA version eval board as a PDoA NODE:**

Press and hold RESET and USER button simultaneously.

Release RESET button but keep holding the USER button for more than 3 seconds before releasing it.

Board will start the PDoA “NODE” application and RX and TX LEDs will flash alternately.

**Figure 9 - Set DW3000 as PDoA NODE**

## 5 APPENDIX 2 USING DW3000 EVALUATION KIT WITH DECARANGING-PC

When evaluating and experimenting using the DW3000 Evaluation Kit, it is possible to use DecaRanging-PC for viewing and analysing the Channel Input Response (CIR) and to modify RF related settings like:

- Data Rates: 850 kbits/s or 6.8 Mbits/s.
- Mean nominal Pulse Repetition Frequencies (PRF) of 16 MHz, 64 MHz.
- Use of normal (Ipatov) and optionally STS modes.
- Preamble lengths or Preamble Symbol Repetitions (PSR) from 64 to 4096 symbols for Ipatov sequence and 64 to 2048 for STS.

Using the Eval kit for evaluation of Two-Way Ranging requires the use of two instances of the Windows-based DecaRanging-PC applications. It can be the same PC or two different PCs as illustrated below.

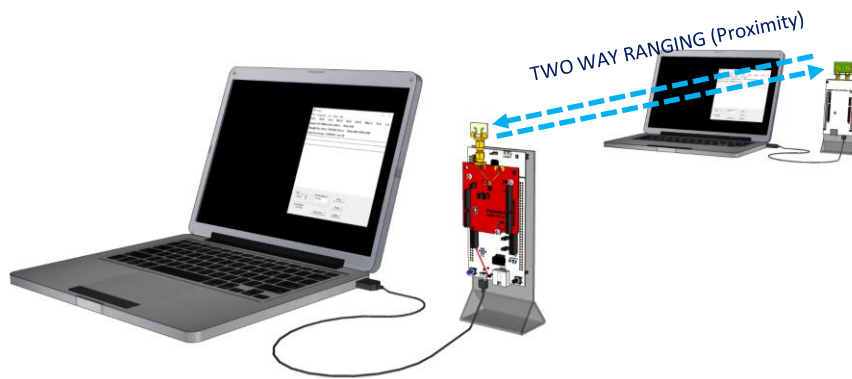


Figure 10 - DecaRanging-PC using 2 PCs

DecaRanging PC application requires a special USB2SPI mode to be run on the Eval board. Starting with Release 3.0, PC Deca-Ranging can change the configuration of the connected Eval board to the USB2SPI mode automatically, no manual actions are required.

If using a single PC and two instances of DecaRanging-PC, it is advisable to start the application for one board at a time (i.e. have the other board disconnected from the PC). This because when both boards are connected to the PC it might not be clear which instance is communicating with and controlling which board.



Figure 11 - Connect the NODE to the PC and start DecaRanging-PC

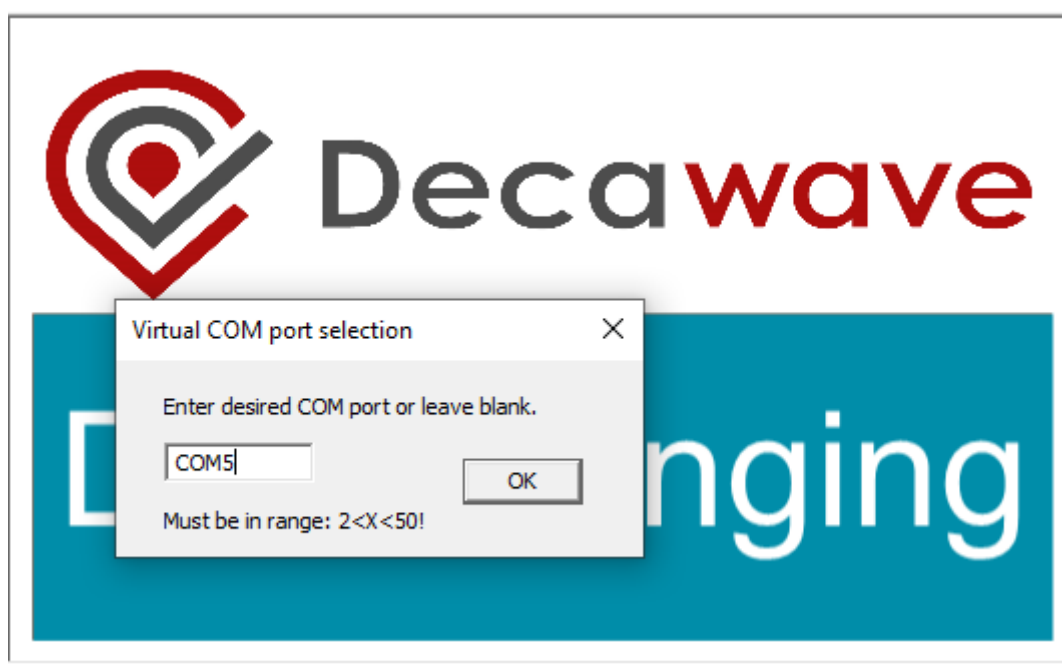


Figure 12 – The DecaRanging-PC requests the COM port

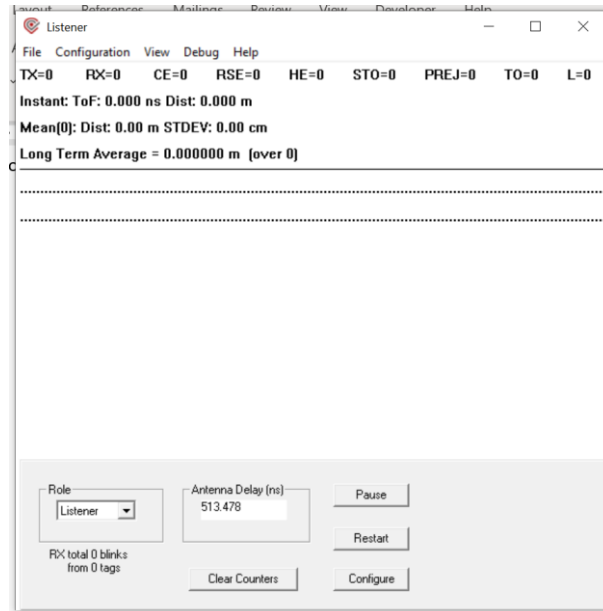


Figure 13 - The DecaRanging-PC GUI starts up in listener mode



Figure 14 - Start the second DecaRanging-PC for TAG board and it also will start in listener mode.

Select the Role for the TAG board as **TAG**. A few seconds later messaging should appear in the other GUI window indicating receipt of blink messages. Change the role from **Listener** to the **Node** Role in the second GUI.

For further and more detailed information see **DECARANGING (PC) USER GUIDE DW 3000**.



## 6 APPENDIX 3 UPGRADING FIRMWARE

Since the DW3000 is still under development, software updates will be made available for bug fixes, improvements, and/or new features.

The STM32 Nucleo-144 board is divided into two parts: ST-LINK and target STM32.

The ST-LINK part has the ST-LINK/V2-1 programming and debugging tool integrated and should be connected to the PC being used to program the boards.

### 6.1 Drivers

Before connecting the Nucleo-144 board to a Windows PC via USB, a driver for ST-LINK/V2-1 must be installed. It can be downloaded from the [www.st.com](http://www.st.com) website.

The STM32 Nucleo-144 part of the board and shield are by default powered from CN13 USER USB connection.

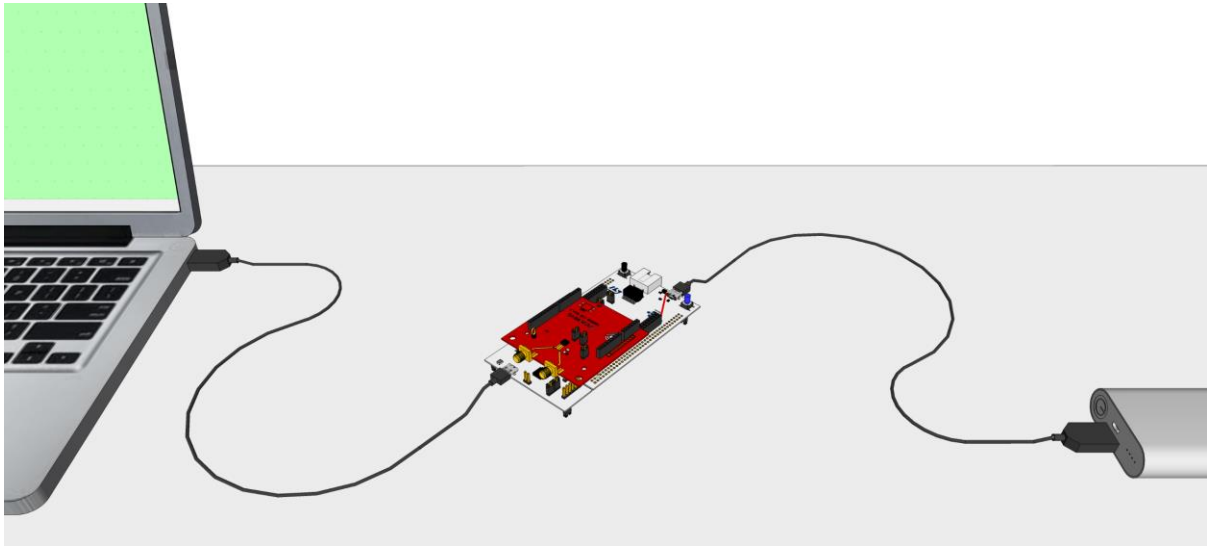
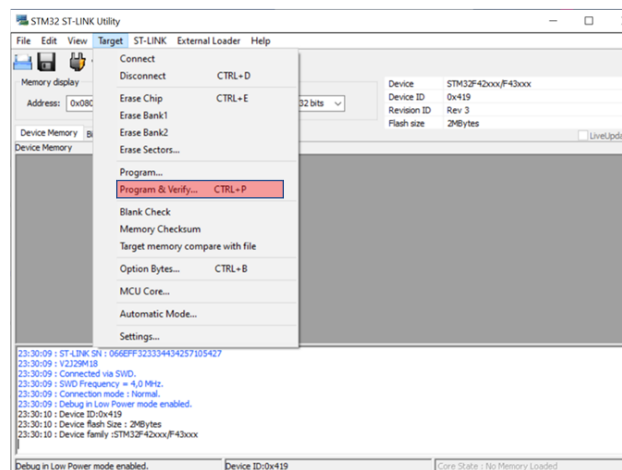


Figure 15 - Connect ST-Link (CN1) to PC and USER USB (CN13) to a power supply

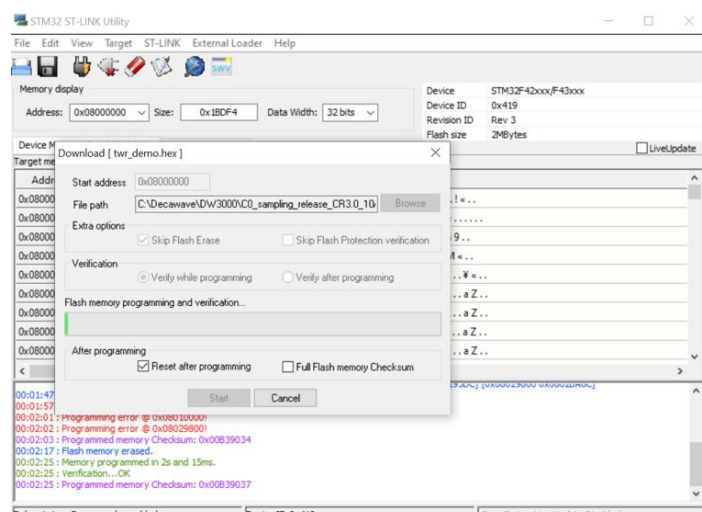
### 6.2 Programming the Nucleo board

To program the Nucleo-144 with user application firmware provided by Decawave, the ST-LINK section needs to be connected to a PC using the USB connector marked 'CN1'. This will power section and enable programming the board.

Run the ST-link "STM32 ST-LINK Utility". From the "Target" menu select "Program & Verify".



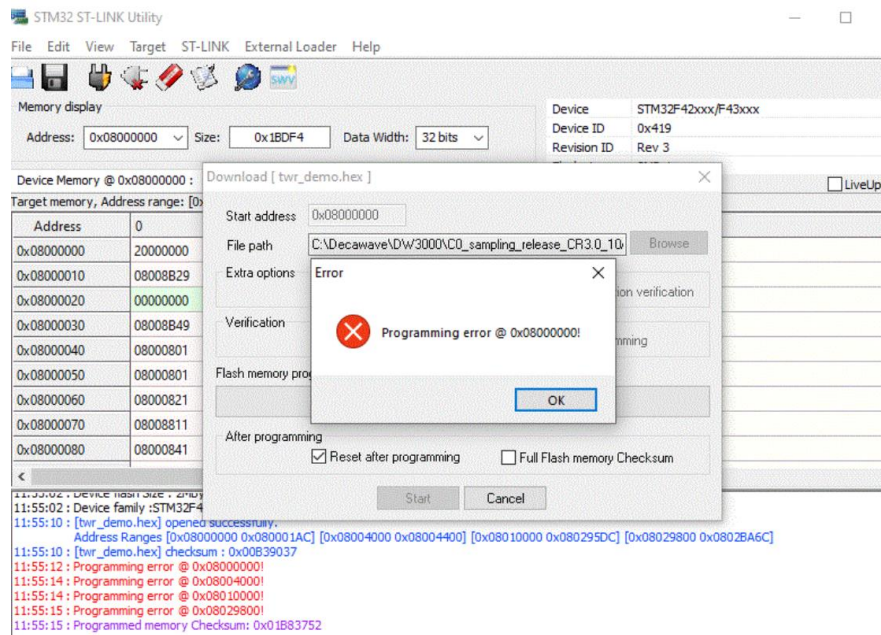
- Next, the “File” menu opens to enable you to browse and find the **.hex** file you would like to program the board with.
- The programming and verification will be done and the progress/status pane at the bottom will inform you of progress:
  - 00:04:17 : Memory programmed in 1s and 688ms.
  - 00:04:17 : Verification...OK
  - 00:04:17 : Programmed memory Checksum: 0x00B39037



- Once programming is complete, you can disconnect the ST-Link and reset the unit to begin execution of the newly loaded firmware.

### 6.2.1 Programming error

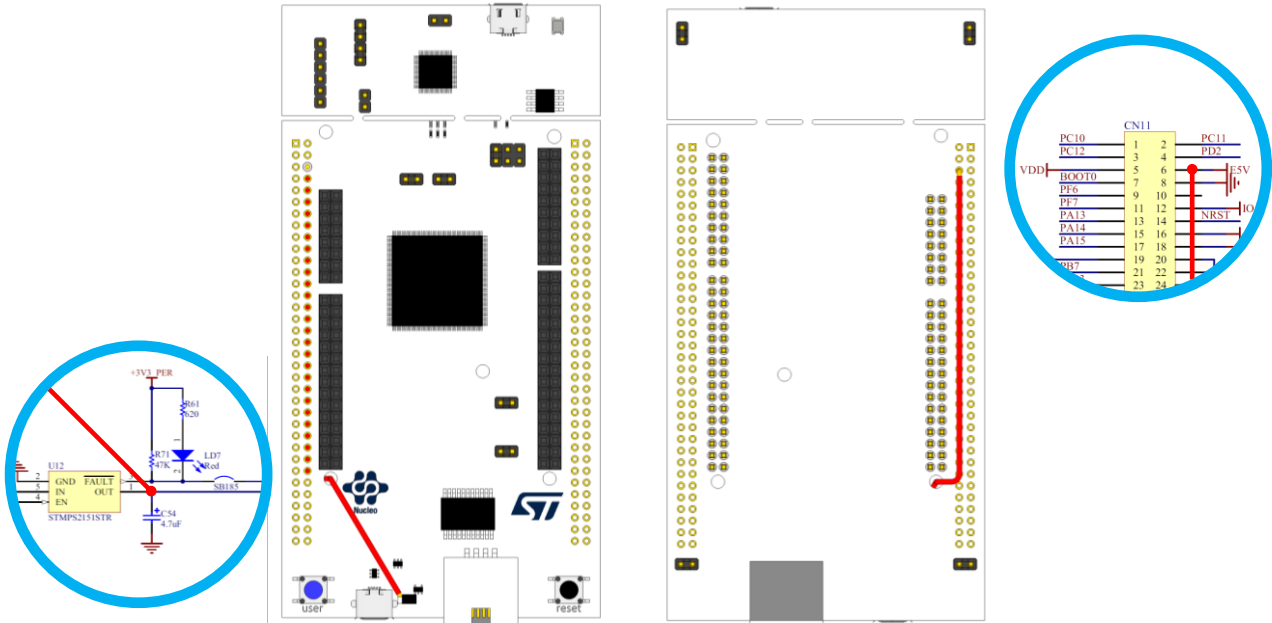
If a 'programming' error occurs, try to 'erase' the chip (Ctrl+E) first and then try again to program the board as described in previous section.



## 7 APPENDIX 4 HARDWARE MODIFICATION MADE

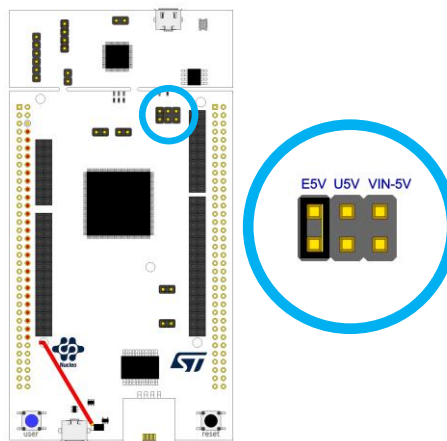
The following three modifications are made on the Nucleo Board at shipping.

- Red wire between cap C54 and 5V pin 6 of CN1.



This will enable the MCU to be powered from USB (CN13).

- JP3 jumper is moved to E5V position to enable the MCU to be powered from USB (CN13) only.



- To use SPI and ethernet port simultaneously in the future, solder-bridge SB121 should be removed and solder-bridge SB122 should be filled (OFF, ON).

SB121, SB122 (D11)	ON, OFF	D11 (Pin 14 of CN7) is connected to STM32 PA7 (SPI_A_MOSI/TIM_E_PWM1).
	OFF, ON	D11 (Pin 14 of CN7) is connected to STM32 PB5 (SPI_A_MOSI/TIM_D_PWM2).

The position OFF, ON will enable SPI communication with DW3000.

Note: the solder bridges are located at the back of the Nucleo board.

## 8 APPENDIX 5 REFERENCES

1. UM1974 User Manual ST32 Nucleo-144 boards. Available from [ST.com](http://www.st.com)

## REVISION HISTORY

Revision	Date	Description
1.0	17-Apr-2020	Initial release
2.0	1-Jul-2020	Node upgrade and Hardware chapter added
2.1	23-Apr-2021	Updating images and introducing the “UWBCFG” command

## 9 FURTHER INFORMATION

For further information on this or any other Decawave product, please refer to our website [www.decawave.com](http://www.decawave.com).