UWB Two Way Ranging

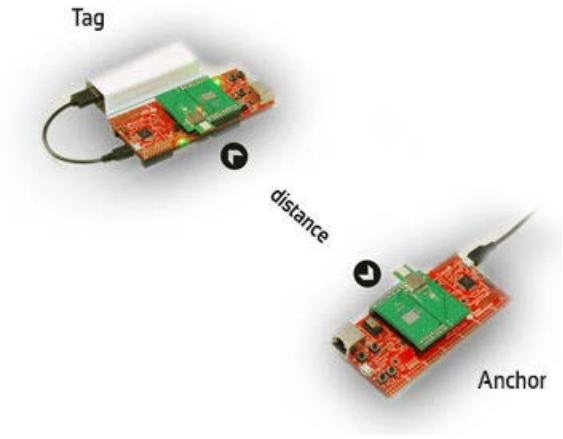
Datasheet

Evaluation and Development Platform

Plug and play solution

- Precise wireless distance measurement
- Unaffected by light conditions, weather or vibration
- COM (USB) for measurement and configuration compliant with IEEE 802.15.4a UWB PHY
- UWB PHY 110/850/6800 kbps
- Wide ecosystem of extension modules such as Wi-Fi, sensors, LCD
- JTAG programmer/debugger included
- **Source code in C includes Two Way Ranging project for Code Composer Studio**

Easy start with UWB technology



UWB Two Way Ranging (TWR) kit is the first full-featured platform for Ultra Wide Band distance measurement evaluation and its further development. Knowledge of precise distance might bring added value for many applications such as protection system, real-time localization and tracking system, robots navigation, etc.

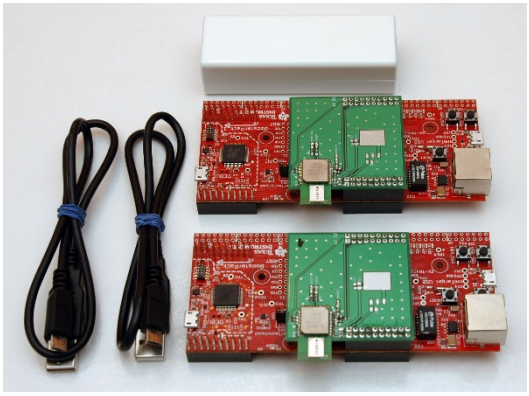
Kit is built on the top of Tiva C microcontroller ecosystem, which brings various sensor, communication and actuator boards together with extensive open-source C library supported directly from Texas Instruments. This platform includes all the required communication interfaces for backhaul system such as Ethernet, USB and socket for WiFi module. All source codes for those interfaces are available.

UWB radio is configurable from a terminal where user may set one of six channels, preamble length or device role. The device might act in mode Anchor or Tag. According to settings, the communication might be fully set u to comply with IEEE 802.15.4a standard

Platform Features	
MCU platform	ARM-M4 Cortex TM4C1294
Radio	UWB 802.15.4a, DWM1000
Accuracy	+/- 15 cm *
Distance	Up to 50m (LOS)

*depends on radio configuration, calibration and environment

Package Content	
1x	UWB Tag (preloaded firmware)
1x	UWB Anchor (preloaded firmware)
1x	Li-ion USB Battery 2200mAh
1x	Access to source code
2x	USB Micro cables



Requirements
Windows XP or higher
USB port
Terminal Program

v0.1

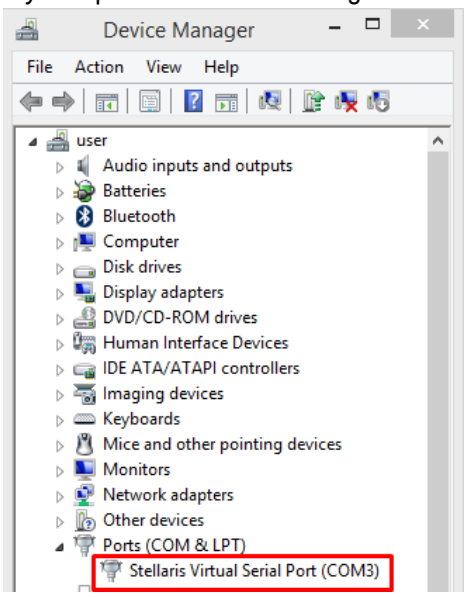
Sewio Networks, s.r.o
www.sewio.net, email:info@sewio.net

Getting Started

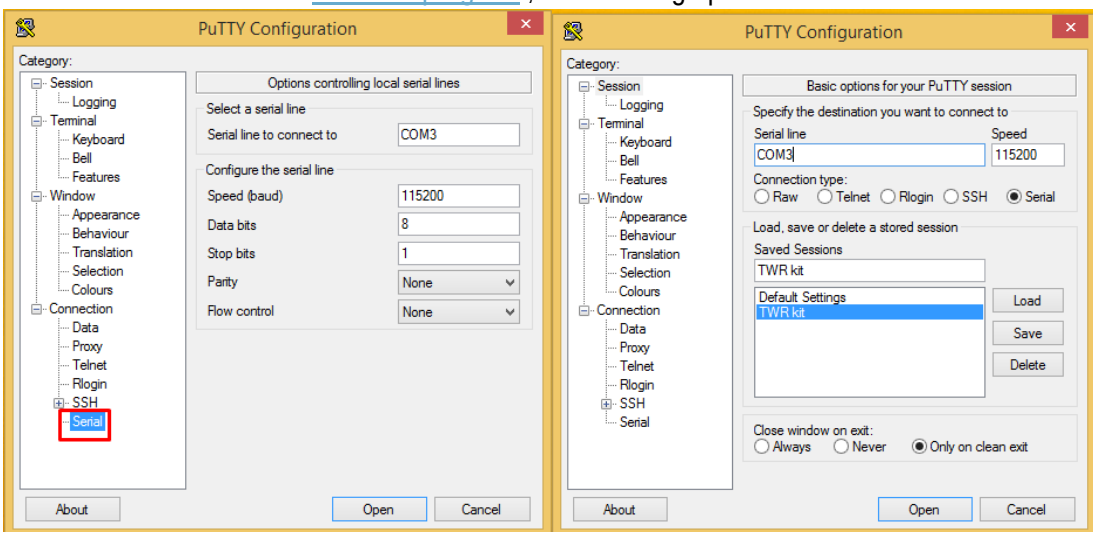
1. Connect UWB Anchor to micro USB port.
   There are two ports available, the USB port farther from Ethernet connector must be used.

2. Install Virtual COM Port drivers
   In case of problems please follow this guide.

3. Identify COM port number
   My computer -> Device Manager

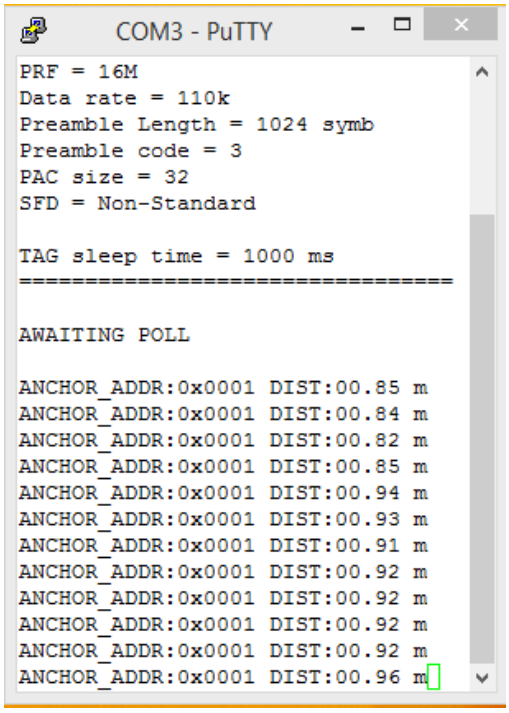


4. Download and run PuTTY Terminal program , set following options:



5. Connect battery to UWB Tag

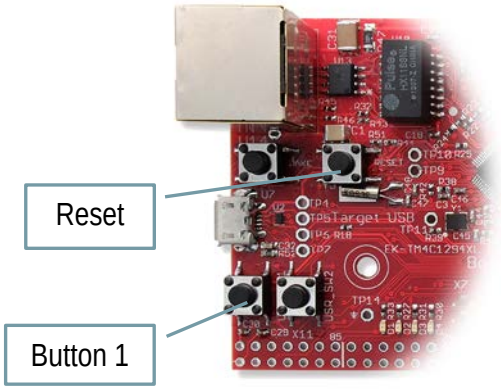
6. Address of Anchor and its distance from Tag should be immediately displayed in Terminal



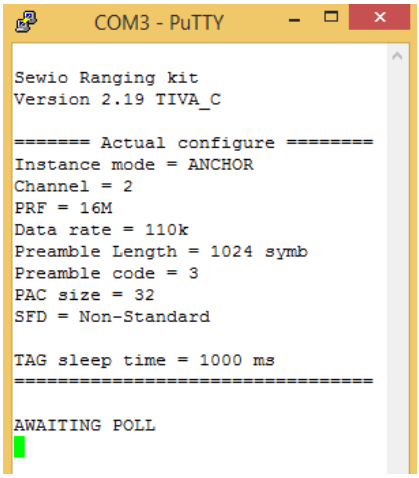
TAG / ANCHOR Communication Settings

To enter the Configuration mode, please follow these steps :

1. Connect Tag or Anchor to USB port of PC
2. Run terminal program, set appropriate COM port
3. Hold USER_BUTTON1 and press RESET for a short while



4. Current settings should be written in the terminal



5. Follow the instruction in order to change configuration.
   Settings are automatically stored in MCU Flash memory

Default Settings

Channel = 1
Data rate = 110k
Preamble Length = 1024
Preamble code = 1
PAC size = 32
SFD = Non-Standard
TAG sleep time = 1 s

Configurable Options

- Channels

Channel	Center Frequency (MHz)	Band (MHz)	Bandwidth (MHz)
1	3494.4	3244.8 – 3744	499.2
2	3993.6	3774 – 4243.2	499.2
3	4492.8	4243.2 – 4742.4	499.2
4	3993.6	3328 – 4659.2	1331.2 (real approx. 900)
5	6489.6	6240 – 6739.2	499.2
7	6489.6	5980.3 – 6998.9	1081.6 (real approx. 900)

- Preamble length
  2048, 1536, 1024, 512, 256, 128, 64

- Data Rate
  110 / 850 / 6800 kbps

- TAG sleep time
  0.1 – 30s (step of XXX ms)

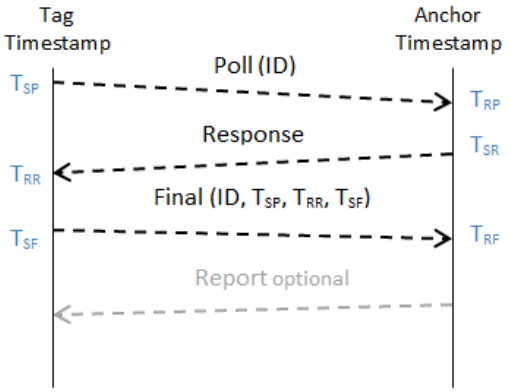
- Device Role
  TAG / ANCHOR

Brief Principle of Distance Measurement

Three messages Poll, Response, Final are exchanged between Tag and Anchor in order to get a precise distance. Distance is calculated based on Tag (TSP, TRR, TSF) and Anchor (TRP, TSR, TRF) timestamps. Calculation is done by Anchor therefore Report message might be employed in order to transmit distance measurement from Anchor back to Tag.

Distance = ToF * speed of light

ToF = ((T_{RR} - T_{SP}) - (T_{SR} - T_{RP}) + (T_{RF} - T_{SR}) - (T_{SF} - T_{RR})) / 4



Ranging messages are encapsulated within 802.15.4 frame, see details in picture below:

IEEE 802.15.4 Frame

2 Bytes	1 Byte	2 Bytes	2/8 Bytes	2/8 Bytes		2 Bytes
Frame Control	Sequence Number	PAN ID	Destination Address	Source Address	Payload	FCS

Poll Message

1 Byte	0-85 Bytes		
Packet ID	User Payload		
0x21	-	-	-

Response Message

1 Byte	1 Byte	2 Byte	0-85 Bytes
Packet ID	Activity	Activity Parameter	User Payload
0x10	0x02	0x0000	-

Final Message

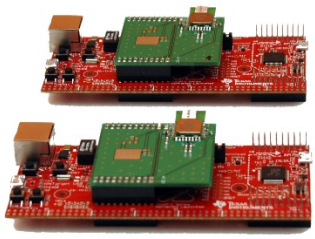
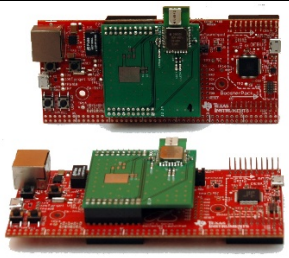
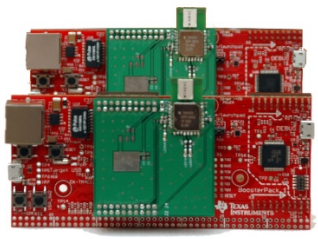
1 Byte	6 Bytes	6 Bytes	6 Bytes	0-85 Bytes	
Packet ID	Poll Message Tx Timestamp	Response Message RX Timestamp	Predicted Final TX Timestamp	User Payload	
0x29	-	-	-	-	-

Report Message

1 Byte	6 Bytes	0-85 Bytes			
Packet ID	Calculated ToF	User Payload			
0x2A	-	-	-	-	-

Practical Aspects for Consideration

Chip Antenna Orientation vs Distance Measurement Performance

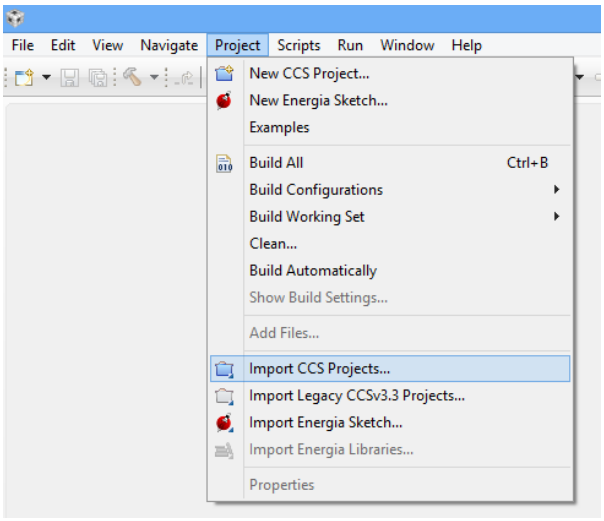
Worst Case	Medium Case	Best Case
		

UWB Communication Parameters Tradeoff

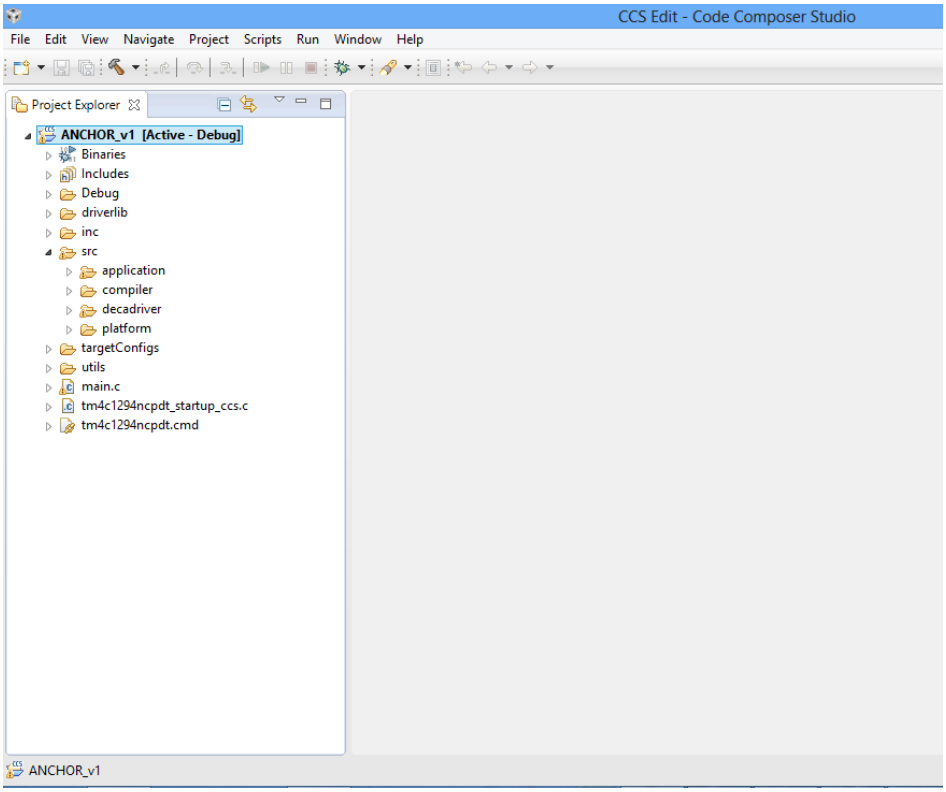
+ High Data Rate & Low Preamble Size	− Low Data Rate & Big Preamble Size
− Short Communication Range	+ Long Communication Range
+ Low Power Consumption	− High Power Consumption

Ranging Source Code

1. Download, install and run Code Composer Studio for Tiva platform.
2. Download and extract TWR source code, *link is provided within TWR kit*
3. Import TWR source code project named ANCHOR to Code Composer Studio



4. See project folder structure



Useful Documentation

Creating IoT Solutions with the TM4C1294XL Connected LaunchPad Workshop Step by step video tutorial describing all MCU peripheries within 16 chapters 1. Intro to TM4C Devices, LaunchPad and Cloud Services 2. Intro to Code Composer Studio 3. TivaWare, Initialization and GPIO 4. Ethernet Port 5. Interrupts and the Timers 6. ADC and the Educational Boosterpack 7. PWM and QEI 8. I2C, SensorLib and GUI Composer 9. SPI and the QSSI 10. UART 11. USB 12. Memory, Security and the MPU 13. Floating Point Unit 14. DMA 15. Low Power Modes 16. Graphics Library	link
TivaWare drivers for peripherals, USB (Host, Device and On-the-Go), Graphics Library and Examples	link
UWB Radio DWM1000 Datasheet	link
IEEE 802.15.4a (2011)	link

EVALUATION BOARD

Sewio provides the enclosed product under the following conditions:

This evaluation board/kit is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY and is not considered by Sewio to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-,marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies Sewio from all claims arising from the handling or use of the goods.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Sewio assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

No license is granted under any patent right or other intellectual property right of Sewio covering or relating to any machine, process, or combination in which such Sewio products or services might be or are used.

FCC Warning. This evaluation board/kit is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY and is not considered by Sewio to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.