

Application User Guide for Social Distancing Reference Design Development Kit

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1 INTRODUCTION

This guide will explain the software and hardware setup of the ultrasonic social distancing reference design development kit. Using Chirp CH101 sensor modules, two social distancing devices can interact with each other to notify the users that they need to socially distance, including early distance detection. With two devices there is a 360° field of view (FoV). Using different LED lights, chimes and buzzer vibration notifications, the user will be alarmed that they need to socially distance within a detection latency of 1 second.

1.1 SCOPE

- Learn all the interactions of the social distancing device
- To debug H/W and S/W setup issues
- Basic understanding of the social distancing device and how it works

1.2 REQUIRED HARDWARE AND SOFTWARE

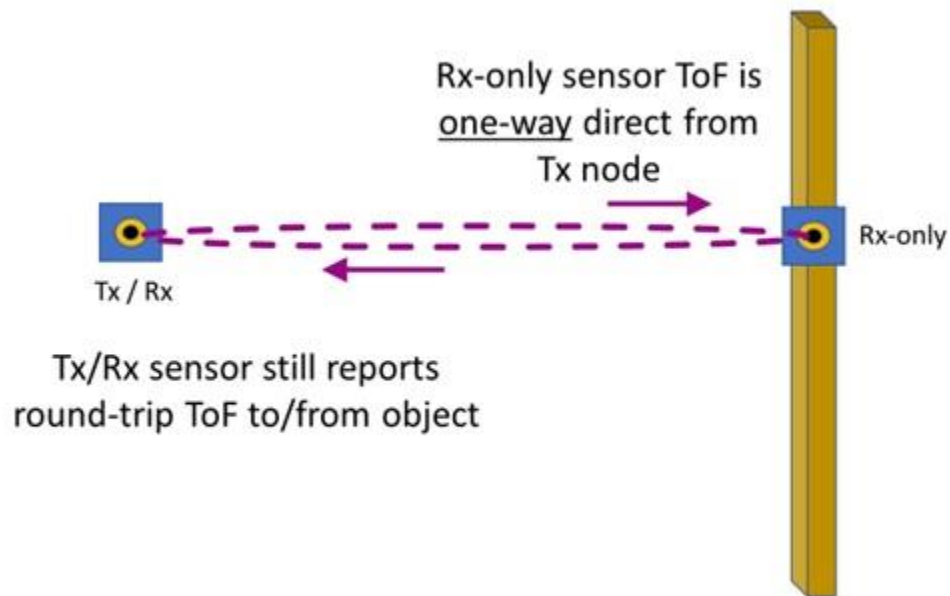
The hardware list may differ if a different type of module is used. Use the latest or desired software package along with the proper hardware. Download instructions are in the setup section.

1. Hardware
 - Social Distancing Tag System
 - Android or iOS smartphone (for flashing FW)
 - Internet connection (for downloading/installing files)
2. Software
 - nRF Connect for Mobile Application (for flashing FW)

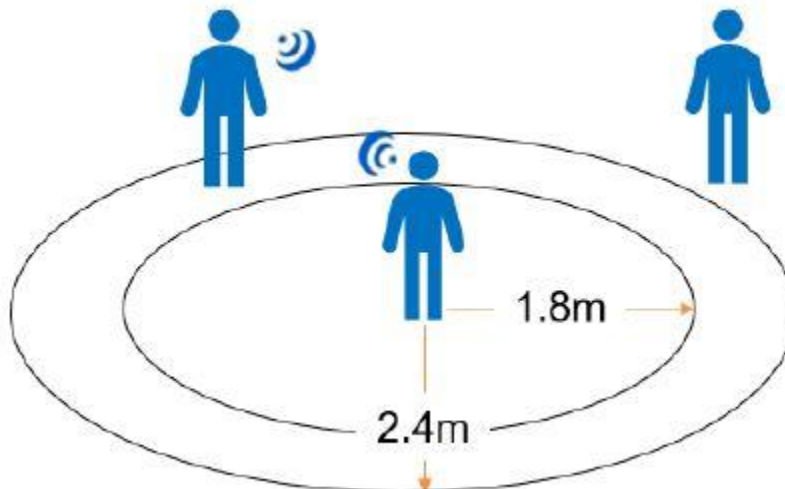
1.3 THEORY

A CH101 sensor is an ultrasonic transceiver that can transmit and receive ultrasound signals. These sensors measure the round-trip time that it takes for sound to be transmitted and returned to determine the distance. This also known as the Time of Flight (ToF). Combining multiple CH101 sensors, a pitch-catch operation can be used to interact with each other. One sensor generates an ultrasonic pulse (Tx mode) and waits for an echo (Rx mode), as is done in pulse-echo operation. One or more other sensors are operated in “receive-only” (Rx-only) mode, so do not generate ultrasonic pulses as they simply are listening for the pulse from the first device. All devices (the transmitting sensor and all receive-only sensors) are synchronized so that the receive-only nodes will start their sampling when the first sensor transmits. All devices then process the received signal, calculate the ToF, and report to the host system.

The image below shows an example of the how the pitch catch operation transmits and received with multiple devices. Using the data received, the distance can be distinguished. For a more in-depth explanation of ultrasonic sensing and hardware, refer to the support application notes listed in Section 1.4.



Using the concept above, the CH101 sensor can then be used as a social distancing device by measuring the distance from another sensor and warning the users if two sensors are within the configurable boundary distance (2.4m or 8ft maximum). These devices will toggle LED indicators when another user approaches within the boundary. The distance is calculated from the ToF from one sensor to another, and an alert can be issued to a user to maintain a safe distance from another as displayed below. This can also be used as an early warning system for any sensor that is within 10m (33ft) using Bluetooth Low Energy (BLE).



1.4 REFERENCE DOCUMENTATION

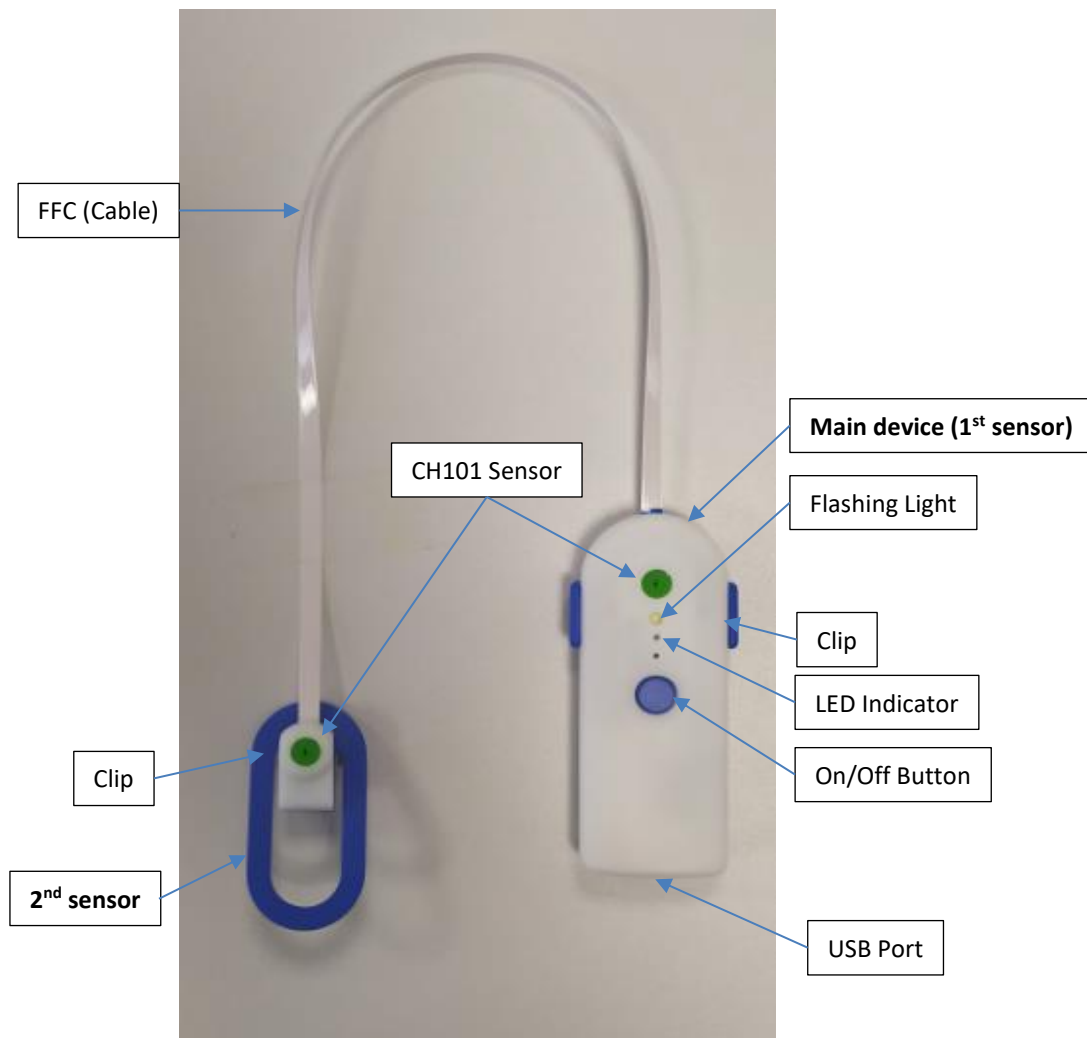
- Social Distancing Tag System: PB-000090
- Overview of the CH101 ultrasonic ToF sensor product
 - Link: invensense.tdk.com/products/ch101/
 - Includes Application Note documentation and product specific designs
- Ultrasonic Sensor Peer to Peer Detection and Rangefinder User Guide: AN-000237
 - How to use Chirp's SmartSonic development kit boards with CH101 sensors to measure distance and notify users
- CH101 and CH201 SmartSonic Evaluation Kit Users Guide: AN-000180
 - Basic concepts of ultrasonic sensing
- CH101 Mechanical Integration Guide: AN-000158
 - Mechanical design (including geometry, part and assembly tolerance, material, and PIF)
- CH101 Module: EV_MOD_CH101-03-01
 - Product specific specifications
 - User Guide: AN-000231

2 SOCIAL DISTANCING TAG SYSTEM DEVICE

Before using the social distancing tag system device, the hardware needs to be prepared to the desired setup. Two sensors will need to be used to get a 360° FoV. The following sections will highlight the device, device placement and device connections.

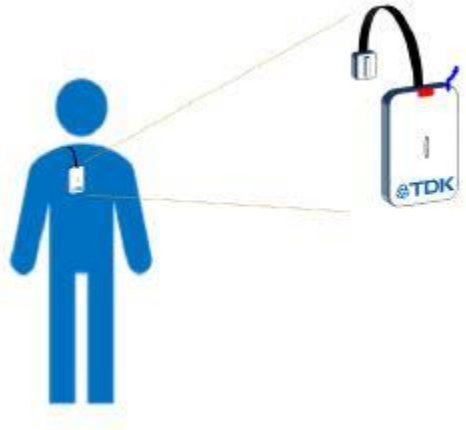
2.1 SETUP

Below is a two-sensor social distancing tag system device setup for a 360° FoV:



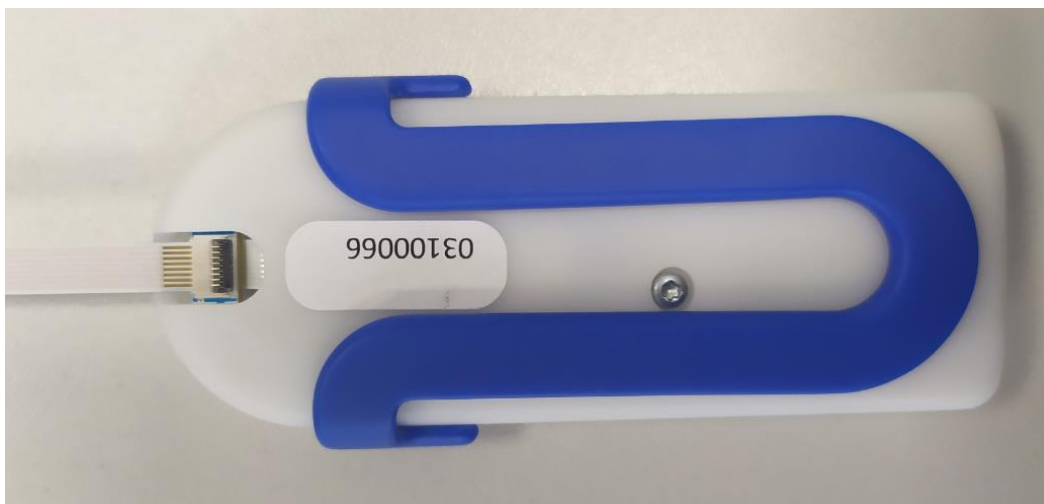
Device Placement

To get a 360° FoV, two devices need to be used in the front and back of a person. One device housing can be in the front (ie. person's chest) and the other in the back (ie. behind the person's shoulder). This setup can be clipped to a clothing. See example below:



Second Sensor Setup

Open the connector latch on the back of the main device. Take the flat flexible cable (FFC) from the second sensor and insert into the main device. Refer picture below to see the orientation to ensure proper insertion. Close the connector latch to prevent disconnection.



2.2 POWER ON/OFF

- Power on (2 ways):
 - Press the (blue) power button for 2 seconds
 - Inserting a powered USB cable in the USB port of the main device
- Power off:
 - Press and hold the power button for 5 seconds, a haptic feedback will trigger and then release the button
 - Note: Unplug any powered USB cable or the device cannot be turned off

2.3 IDLE

- Entry:
 - Device will automatically go into idle when no activity is detected
 - Buzzer and low-pitched sound will go off to indicate idle entry
 - Device must be motionless for approximately 15 seconds
 - e.g. the user lays the device flat on a tabletop; about 15 seconds later the device will go into idle (low power) mode
- Wake-up (3 ways):
 - Move idled device
 - Press power button of idled device
 - Plug in USB cable

2.4 USER INTERACTIONS

See table below to determine the LED indicator color notifications:

Blue LED	Slow blink	Device on and no other device in BLE range
	Normal blink	Device on and device in BLE range
	Fast blink	Device paired with phone/PC
Green LED	Normal blink	Battery charging
	Permanent ON	Battery charged
Red LED	Normal blink	Low battery
Alarm (White) LED	Blink + medium buzzer	Contact <2s with another device detected
	Blink + loud buzzer	Contact >=2s with another device detected

3 APPENDIX

3.1 UPGRADING FW WITH SMARTPHONE

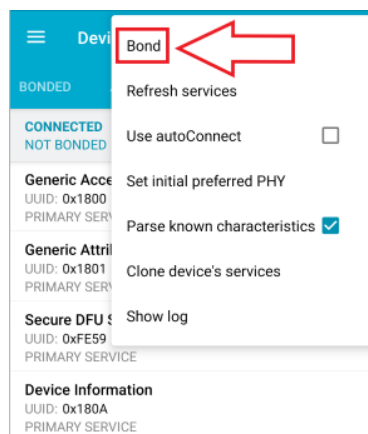
Install and download nRF Connect app:

- In the Android or Apple app store: search and download “nRF Connect”
- Copy the latest FW file “app_ble_dfu_package.zip” in a folder on the phone that can be retrieved.

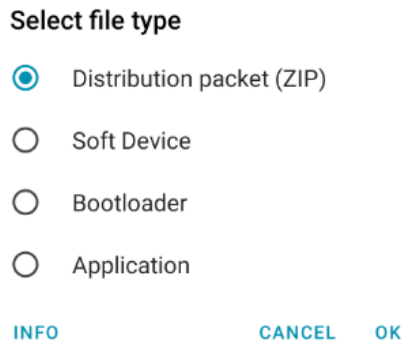


To upgrade the social distancing device with a newly released FW, follow the steps below:

1. Plug in devices to a computer to detect them.
2. Enable BLE on the smartphone and open the nRF Connect app.
3. In the app, click ‘SCAN’ to see the discovered devices.
4. Search for device whose MAC address is of format “50:CD:15:00:xx:yy” and press ‘CONNECT’
 - You should now see a list of available services
5. Next step is to bond to the device. Click the 3 dots (android) or settings and click “Bond”



6. Once module is bonded to APP click the DFU button.
 - You are now prompted to select a file type.
7. Select “Distribution packet (ZIP)” and then press ‘OK’



8. The upgrade automatically starts. A progression bar is shown during new FW flash
9. The upgrade is automatically started. This step can take time so be patient. You’ll see a progression bar during new FW flash. After upgrade is finished the APP is reconnecting to the device.
10. To discover all available services just click and then select “Refresh services.” You’ll now see the entire supported services.
11. To ensure upgrade was successful you can open service “Device Information” and read “Software Revision String” characteristic.
12. Click on ‘Disconnect’. Device is ready for use.

4 REVISION HISTORY

Revision Date	Revision	Description
10/21/2020	1.0	Initial Release

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