Qorvo NI Background SDK Quick Start Guide

Introduction

Qorvo DW3000 chip series are approved by Apple® for the purpose of evaluating UWB enabled accessories to leverage Apple's Nearby Interaction framework. Qorvo DWM3000 and DWM3001C modules can interact with Apple® products that include the U1 chip by performing a Two-Way-Ranging with them. With iOS 16 release, new features were added to Apple NI framework, including background mode, providing developers new ways to interact with iOS devices.

Apple® Nearby Interaction framework with Third Party Accessories has two phases:

- First, is the initial Out Of Band discovery, BLE is mandatory to use background mode. The Qorvo device needs to be paired with the Apple® device, before exchange configuration settings between U1 enabled device and an Accessory device. During this phase, the Accessory is sending the preferred configuration data (Accessory Configuration Data) to the Apple® device. Apple® unit provides its configuration of choice back to the Accessory (Apple Shareable Configuration Data).

- After exchanging of settings, the U1 enabled device starts the UWB session and runs the Two-Way-Ranging between U1 chip and Accessory.

The Qorvo NI Background iOS application supports the background operation mode as described in WWDC22 (video below):

https://developer.apple.com/videos/play/wwdc2022/10008/

The Two-Way-Ranging protocol used in Apple® Nearby Interaction with Third Party is powered by FiRa© standard. In this standard either side shall be configured as a Controller+Initator and another side shall be configured as a Controlee+Responder. The Accessory can be pre-configured for a specific role.

The Apple® approved Nearby Interaction Qorvo Development Kits are equipped with Nordic BLE SoCs, which provide the Out Of Band discovery over BLE, while the communication with U1 enabled device is provided with the Qorvo DW3000 series chip.

Qorvo offer a UWB module variant (DWM3001CDK) or an Arduino™ compatible Shield (DWM3000EVB), which can be connected to the Nordic Development Kit. Supported Nordic Development kits:

- nRF52 DK: https://www.nordicsemi.com/Products/Development-hardware/nRF52-DK

- nRF52833 DK: https://www.nordicsemi.com/Products/Development-hardware/nrf52833-dk

- nRF52840 DK: https://www.nordicsemi.com/Products/Development-hardware/nrf52840-dk

This document describes how to get started with the Qorvo solutions for Apple® Nearby Interaction, featuring background mode.

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Overview

Qorvo UWB solutions of DWM3000 and DWM3001C integrated modules allows the exploration of Nearby Interaction out of box and using these modules in the end-product designs.

DWM3000EVB Shield

The DWM3000EVB Shield is an Arduino^{TM} form-factor compatible shield designed for the evaluation of the DWM3000 UWB module, which is composed by a DW3110 UWB IC and a Ceramic UWB antenna.
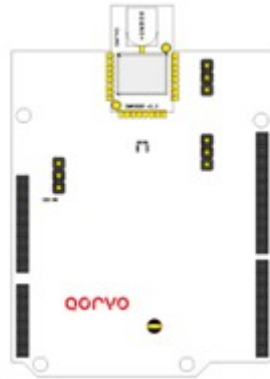

Figure 1.1: DWM3000EVB

As shown below, the DWM3000EVB is attached to the Nordic DK's Arduino^{TM} Interface to provide the UWB functionalities.
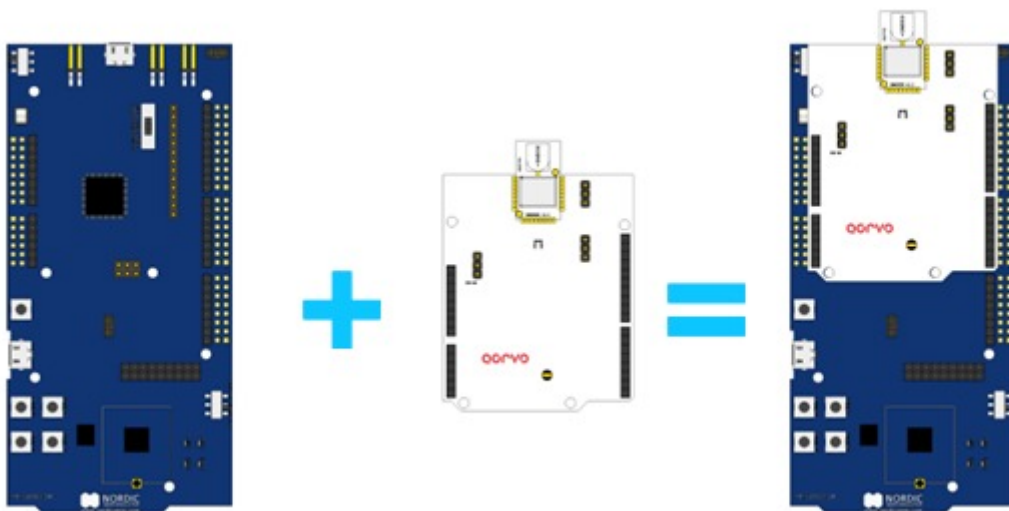

Figure 1.2: DWM3000EVB Arduino and a nRF52840/833 DK

DWM3001CDK Design Kit

The DWM3001CDK is a Qorvo Design Kit designed for the evaluation of the fully integrated DWM3001C UWB module, supporting a DW3110 UWB IC, PCB UWB antenna, accelerometer and powered by a nRF52833 BLE SoC.
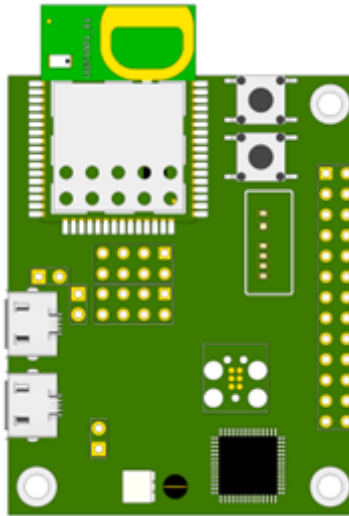

Figure 1.3: DWM3001C Design Kit

The DWM3001CDK has an on-board J-Link for flash and debugging via USB (J9), and a direct connection to the DWM3001C USB Interface (J20).

Board Connections

Applying power to the Nordic DKs

The Nordic nRF52840 DK and nRF52833 DK boards have similar layouts, they are divided into two parts: A J-LINK part, located on the upper part of the PCB, and the target nRF52840/833 microcontroller. To power the board, connect the Nordic nRF52840/833 DK board to a USB power supply with a USB 'Type-A to Micro-B' cable attached to the USB connector marked J2.
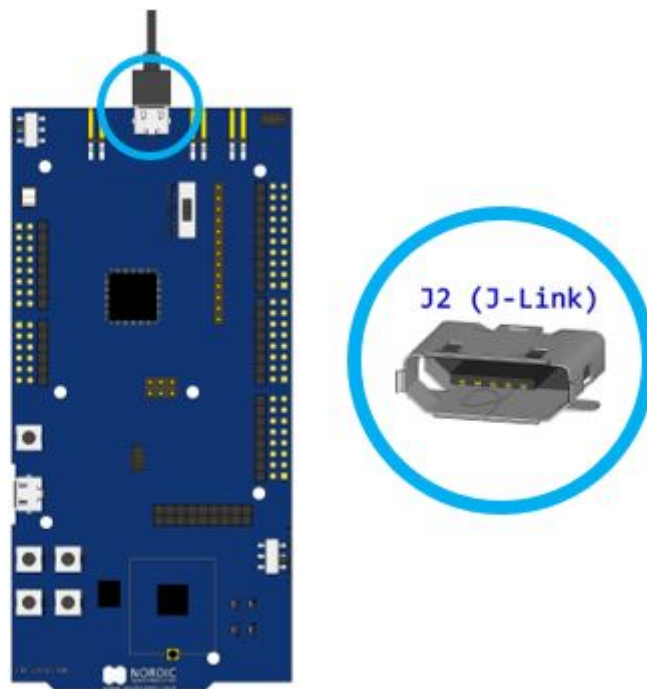
Figure 1.4: Powering the boards (J2 USB connector)

The nRF52840/833 DK has two switches, *SW8 and SW9*, that define the power supply for the board:

- SW9 (up in the middle): Switches the power supply between Li-PO (J6), VDD (from J-Link) or USB (from nRF USB).
- SW8 (top left): ON/OFF Switch.

To work from J2 (J-Link) power, SW9 must be switched to VDD (middle position) and SW8 should be in the position ON.

Note: For more details on the power modes, check the User Manual of your Nordic Development Kit

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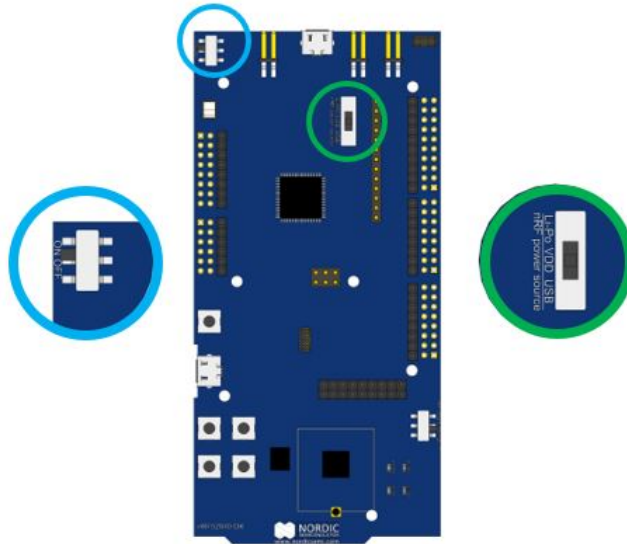Qorvo® Proprietary Information

Figure 1.5: SW8 (blue) and SW9 (green) position

DWM3001CDK

Connect the two micro-USB connectors available on the board as in *DWM3001CDK connections*

- J9 (interface MCU): used for flashing/debugging via J-Link OB and UART communication with MCU through a virtual COM port.
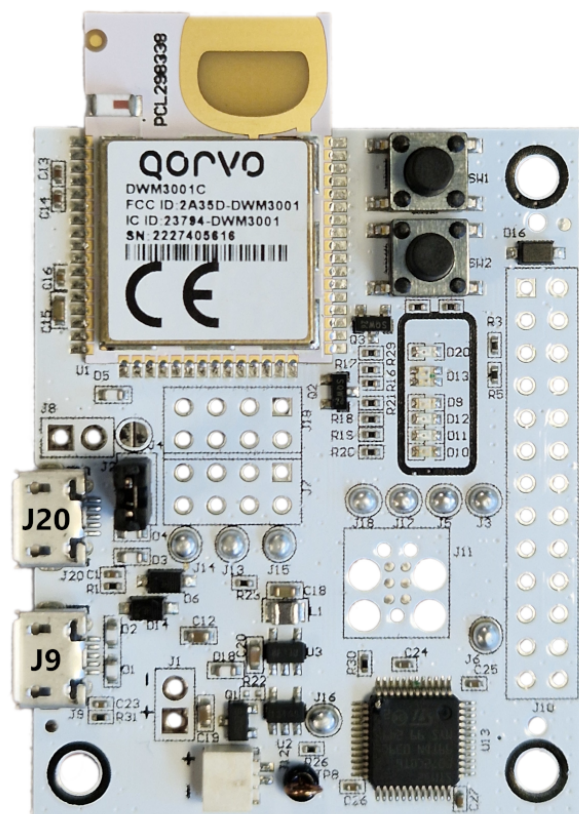- J20 (nRF USB): used for UART/USB communication with MCU.

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Figure 1.6: DWM3001CDK connections

Communication Interfaces on DWM3001CDK

In SDK for DWM3001CDK, two different communication interfaces can be utilized for the communication:

- UART over USB (USB CDC ACM) allows for the communication with the MCU over USB connection, enabled by default.

- UART allows for the communication with the MCU through the UART pins, disabled by default.

Applying power to the DWM3001CDK

Like the Nordic DKs, the DWM3001CDK has an on-board J-Link and a User USB. The board can be powered by both USBs (J20 or J9), or via the RPI interface (from the Raspberry Pi compatible IO) and/or the VBAT connector.
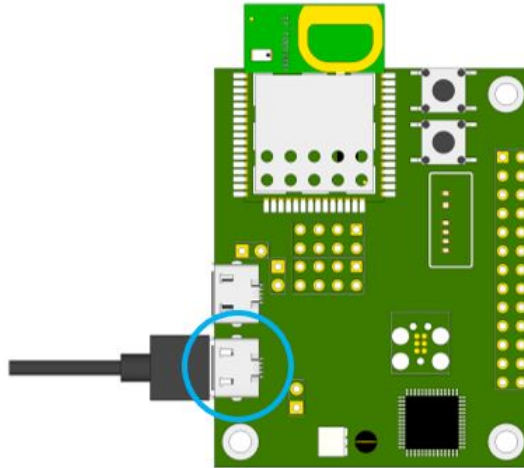
Figure 1.7: Powering the DWM3001CDK (J9 USB connector - J-Link OB)

By default, the power supply for the DWM3001CDK is the J9 USB connector, which is also the J-Link OB USB connection used for programming and debugging.

Flashing Firmware

The Nordic nRF52840/833/832 DKs and the DWM3001CDK have an on-board SEGGER J-LINK debugger, allowing to program and debug the target microcontroller. The J-LINK should be connected to a PC, to program the Nearby Interaction example firmware in the boards.

Application and Drivers

The application to program the Nordic SoCs is the "J-Link Software and Documentation pack", it is available free of charge for any SEGGER J-LINK devices at:
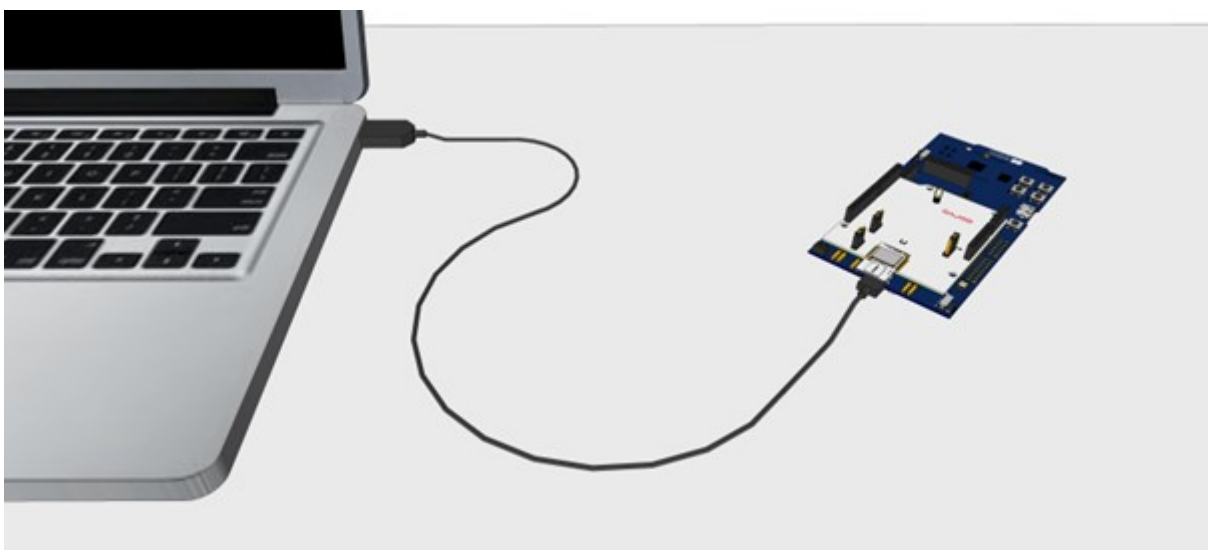
https://www.segger.com/downloads/jlink/

Figure 1.8: Connect J-Link (J2) to PC

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The Nordic DK, JTAG-OB and DWM3000EVB shield are by default powered from J2 (J-Link) connection (*Applying power to the Nordic DKs*). Connecting J2 to the PC will provide both, power to nRF52840/833/832 SoC and connectivity for the J-Link.
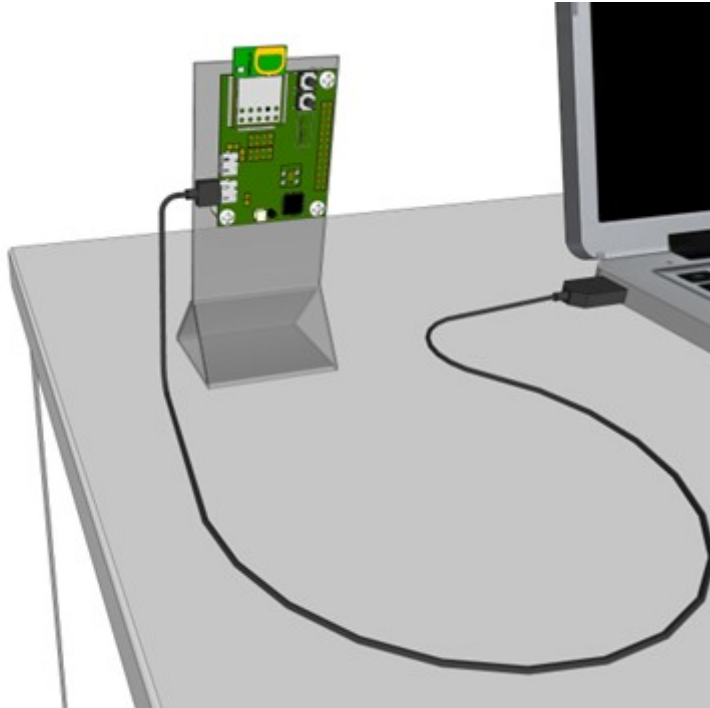

Figure 1.9: Connect J-Link (J9) to PC, it will also power the DWM3001CDK

In the DWM3001CDK, the J-Link is connected to the USB (J9) connection, the board can be powered from there6 and it is the only connection required.

Programming/Upgrading firmware

To program the Nordic nRF52840/833/832 SoCs with the Nearby Interaction firmware provided by Qorvo, the board must be powered and the J-LINK section needs to be connected to a PC using the USB connector (Figure 7 and Figure 8). This will enable the programming of the development board. Open the SEGGER J-Flash Lite application, it will detect a J-LINK connected to the PC. Check the device selected, for the nRF52 DK select "NRF52832_xxAA" device, for the nRF52840 DK select "NRF52840_xxAA" device, for nRF52833 DK and DWM3001CDK select "NRF52833_xxAA" by clicking on the "three dots" button as shown below in *SEGGER J-Flash Lite, first screen*
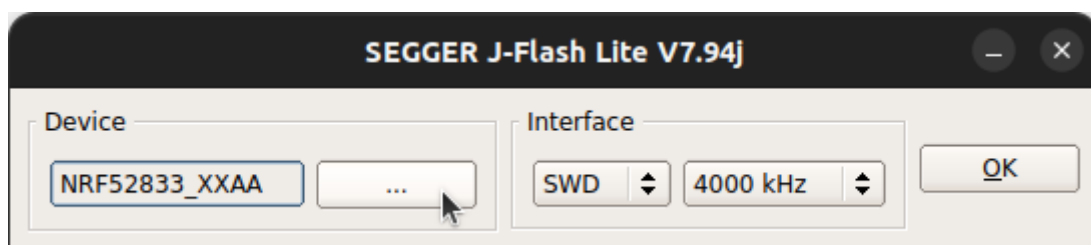

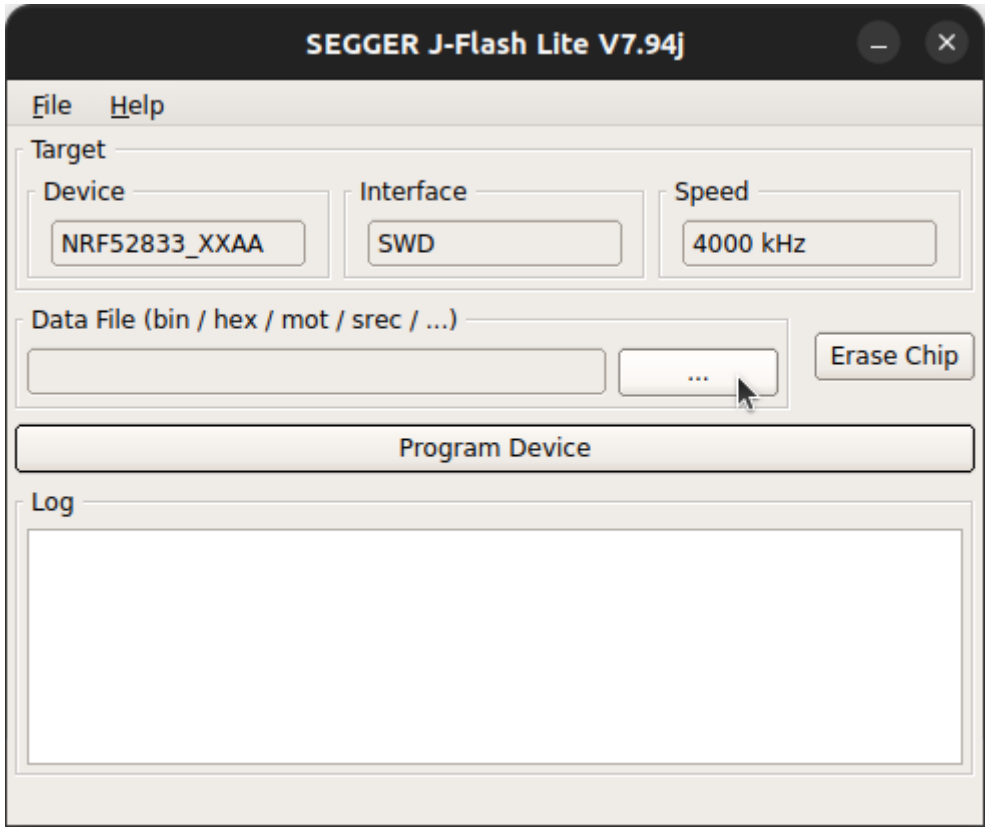Figure 1.10: SEGGER J-Flash Lite, first screen

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Figure 1.11: Three dots button to select the Nearby Interaction example binary

On the new screen click on the three dots button to load the binary file to be programmed to the board. Select the binary file for the correct target pre-built by Qorvo and then click on the "Program Device" button.
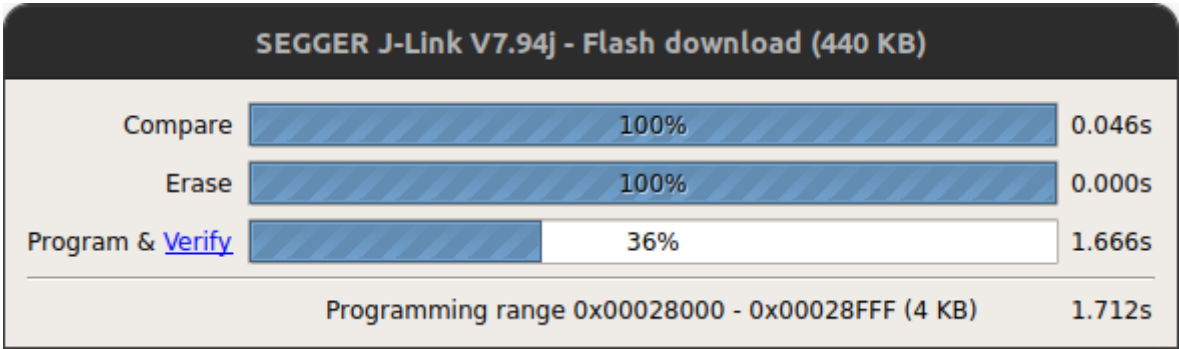

Figure 1.12: Programming progress window

The programming process takes a few seconds to finish.

Note: If a 'programming' error occurs, try to 'erase' the chip first ("Erase Chip" button) and then try again to program the board as described in the previous section.

Qorvo NI Background Application

Nearby Interaction featuring background mode with Third Party Accessories was introduced starting from iOS 16. It is required to update an iPhone to the iOS 16 version or later. The "Qorvo NI Background" iOS App is available for download on the Apple App Store:

Figure 1.13: QR Code to the Apple App Store and direct download link

Also, you can obtain the "Qorvo NI Background" sample code from Qorvo, instructions are provided on how to compile and run the app in a compatible iPhone device. After install, open the *"Qorvo Nearby Interaction" iOS App* by tapping the icon on your iOS device.

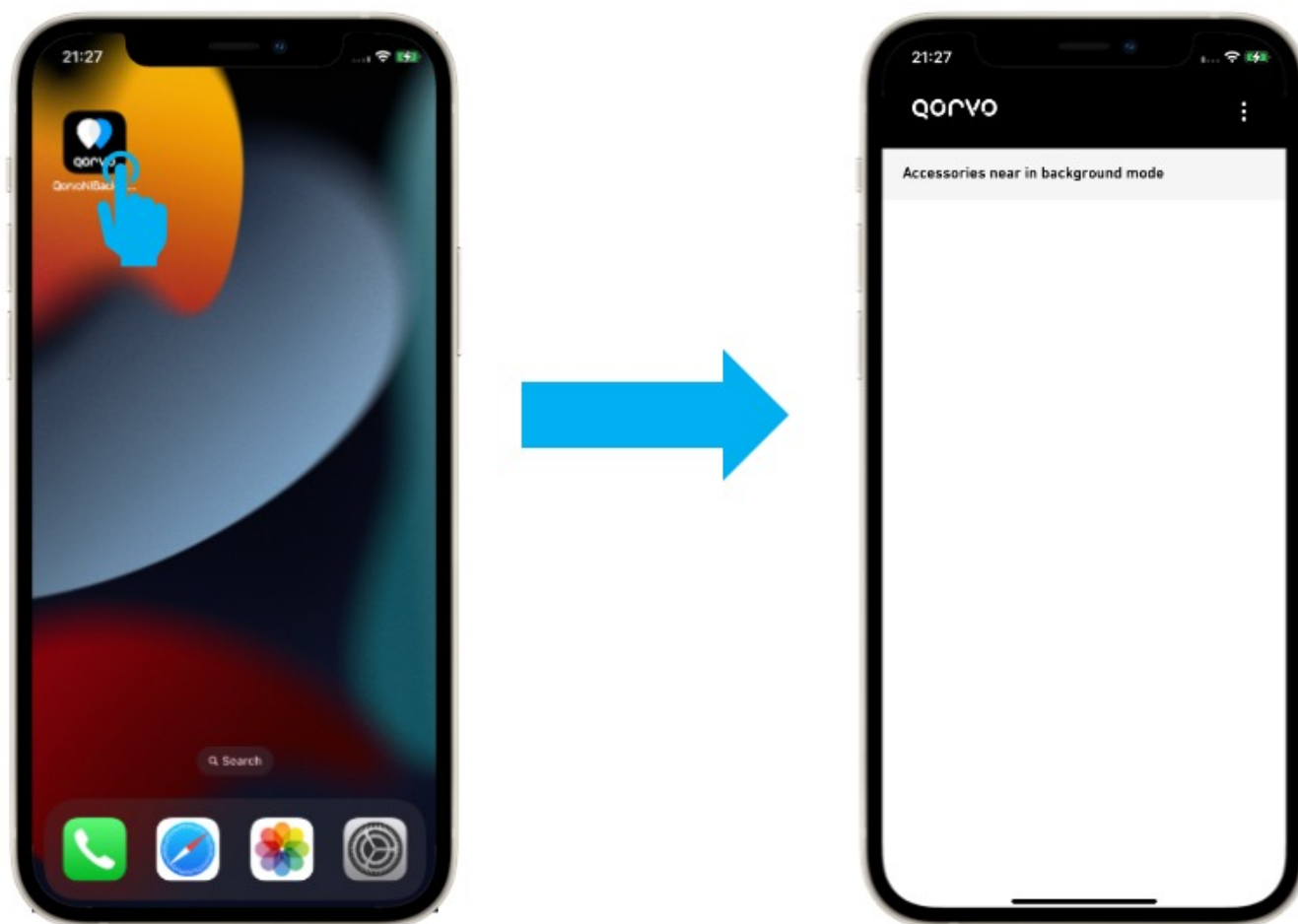[1] https://apps.apple.com/us/app/qorvo-ni-background/id6444859929

Figure 1.14: "Qorvo NI Background" iOS App

When opening "Qorvo NI Background" for the first time it will request user's approval to use BLE and allow the app to send notifications (*"Qorvo NI Background" requesting user permissions*).
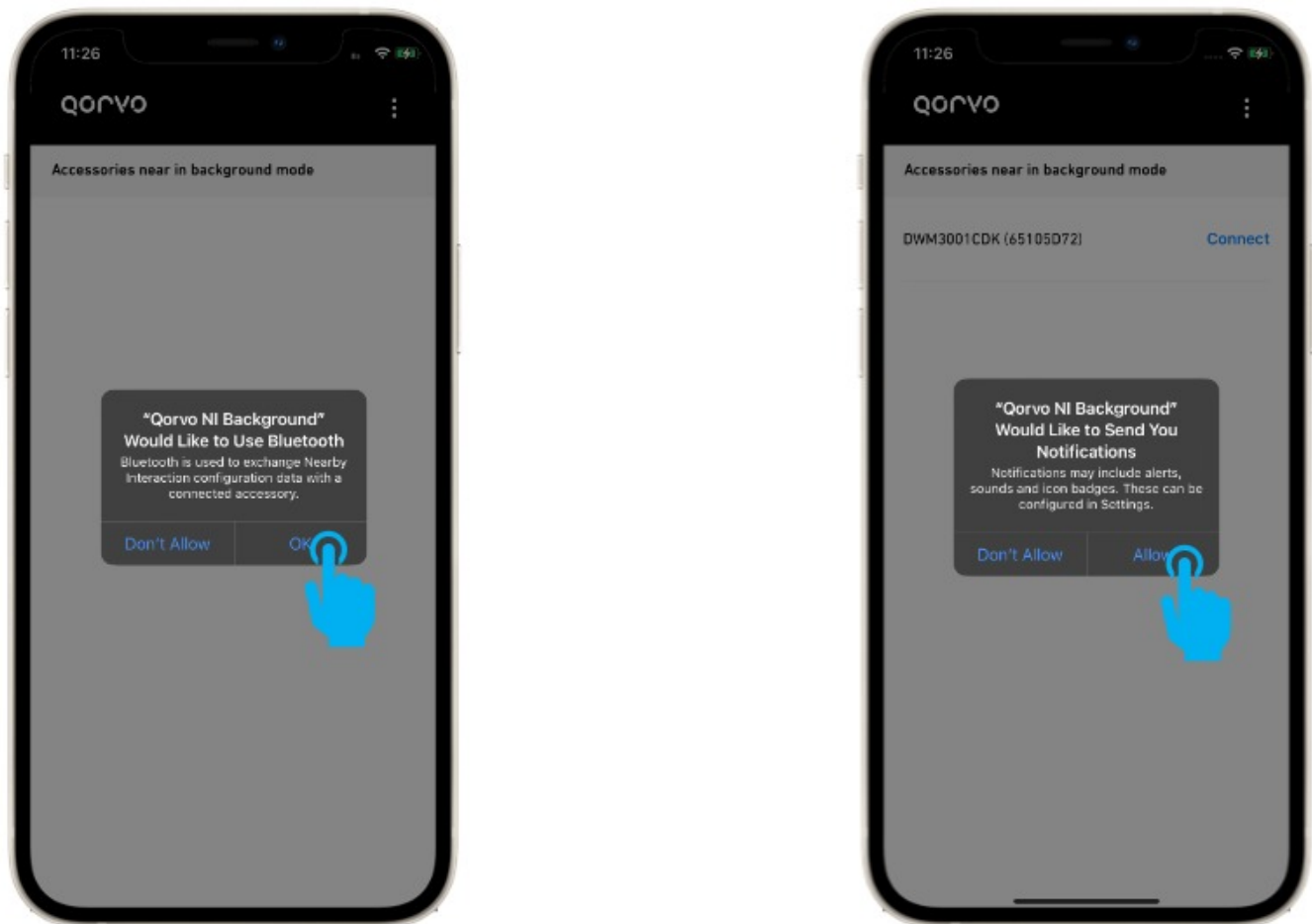
Figure 1.15: "Qorvo NI Background" requesting user permissions

When "Qorvo NI Background" opens it starts scanning for nearby accessories using the QNIS BLE service. When a Qorvo device is found, it is added to a list "Devices near you", *click on the button "Connect"* (on the right of the Qorvo device name) to command the Qorvo device to start ranging.
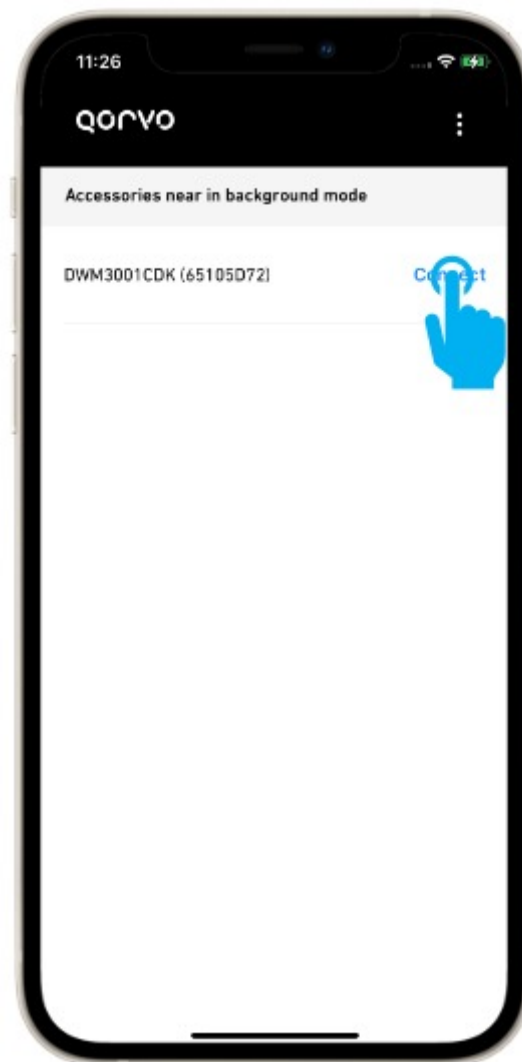
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Figure 1.16: Click on "Connect" to command the Qorvo device to start ranging

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Note: Qorvo devices running firmware v2.0.5 or previous will not be shown in the list. Update the device firmware to v3.0.0 or later to evaluate background mode.

Nearby Interaction for background mode requires that the Qorvo device is paired with the iOS device, when connecting with a device for the first time it will be requested to "Pair". When the app starts a NI Session for the first time it will request user's approval to use Nearby Interaction.
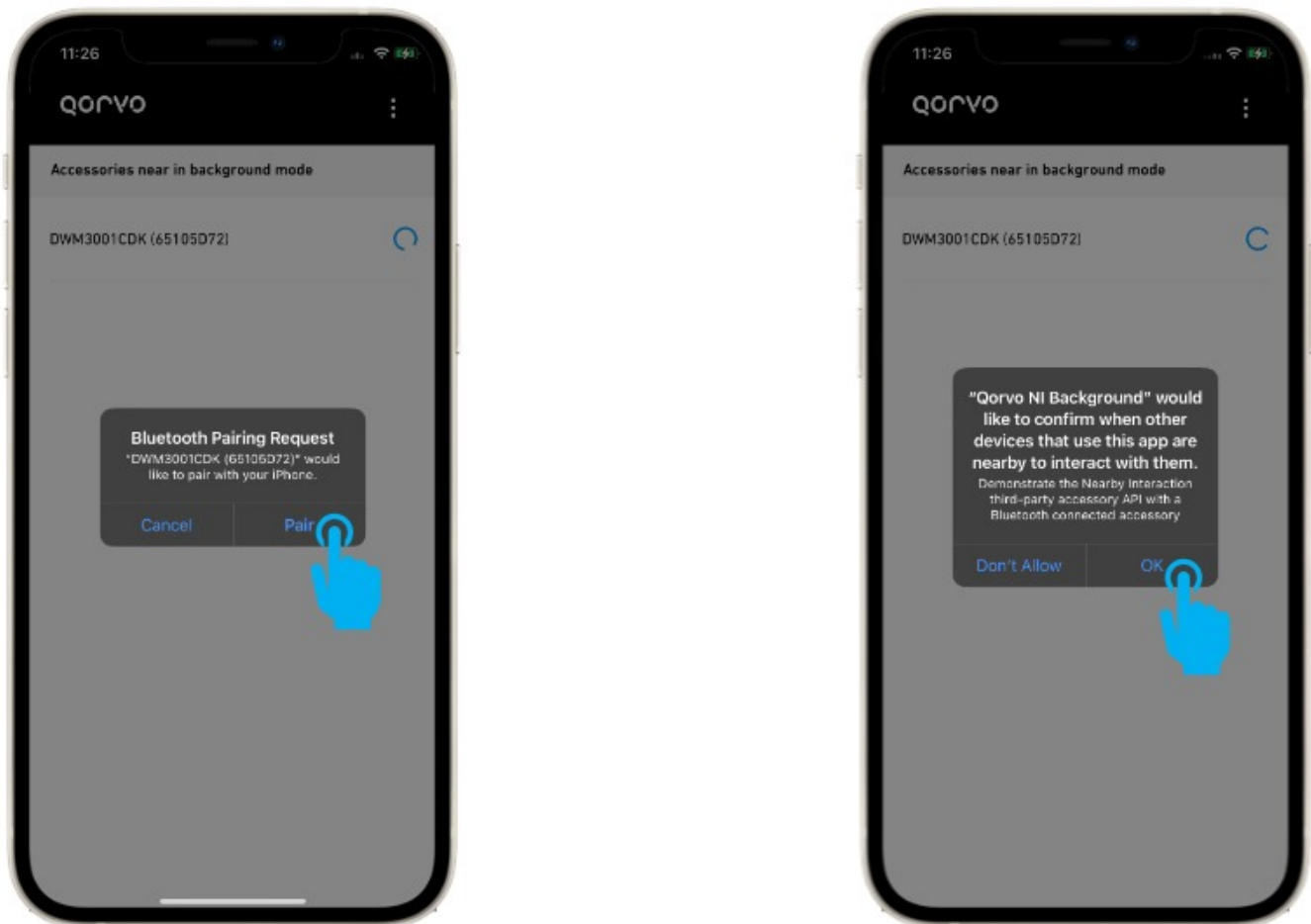
Figure 1.17: Pair request and permission to use Nearby Interaction

After that, no more permissions will be requested, only Pairing requests if connecting to a Qorvo device for the first time.

Note: Paired devices are included in the iOS Settings→Bluetooth list. If a device is removed from there it is required to erase the Qorvo device's flash memory too (*Programming/Upgrading firmware*).

After every ranging round, new distance information will be available on the screen. Different from foreground mode, NI enabling background mode has a lower update rate (a third of when not using background), and it enables distance only. This way, the Nearby Interaction experience is foccused on the device side.

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Figure 1.18: Real Time distance information

Moving the Qorvo device towards or away from the iPhone will change the information displayed on the app as shown in *Real Time distance information*.

When the app is sent to background (or the iPhone screen is turned off), the U1 chip in the iPhone will keep all ongoing NI Sessions. In iOS 15 the behaviour was invalidate all NI Sessions. The device can keep Two-Way Ranging and get distance to the iPhone to trigger actions.

The Qorvo device has set two distance thresholds to trigger actions, and interact with the iPhone when the app is in background. First is 1.2 m, when the *Device is outside the Secure Bubble*. When distance is higher than 1.2 m the device will send a BLE message to the iPhone, If the "Qorvo NI Background" is in background (or screen is locked) it will turn into a notification, informing the user that the device is outside the Secure Bubble.

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Figure 1.19: Device is outside the Secure Bubble

The second is 0.2 m, when the *Device is inside the Secure Bubble*. The device will send another BLE message to trigger the notification informing the user that the device is inside the Secure Bubble.

Figure 1.20: Device is inside the Secure Bubble

If the Qorvo device has LEDs it will additionally show the distance status using them. As an example, the DWM3001CDK will turn the Green LED On, when outside the Security Bubble, and the Red LED when inside.

Once a Qorvo device is connected it will be added to a "Known Devices" list, and the app will automatically starts Two-Way Ranging with that device next discovery, even if the app is in background.
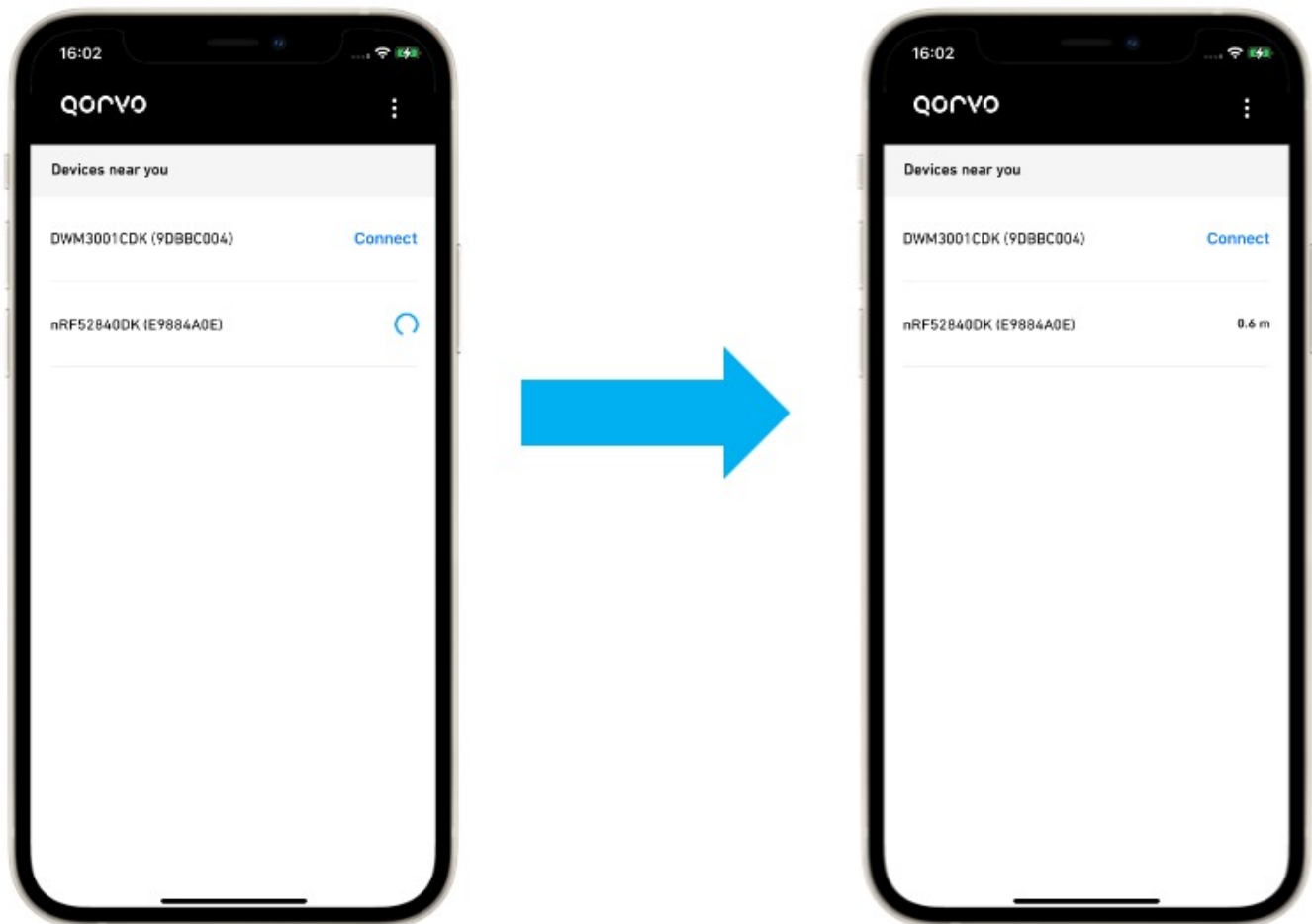
Figure 1.21: Known Qorvo device is discovered and automatically starts TWR

Click on the "three dots" button (on the top right) to open the Settings screen. All nearby devices are shown with their status, "Push Notifications" can be enabled/disabled and the "Known Devices" list can be cleared.
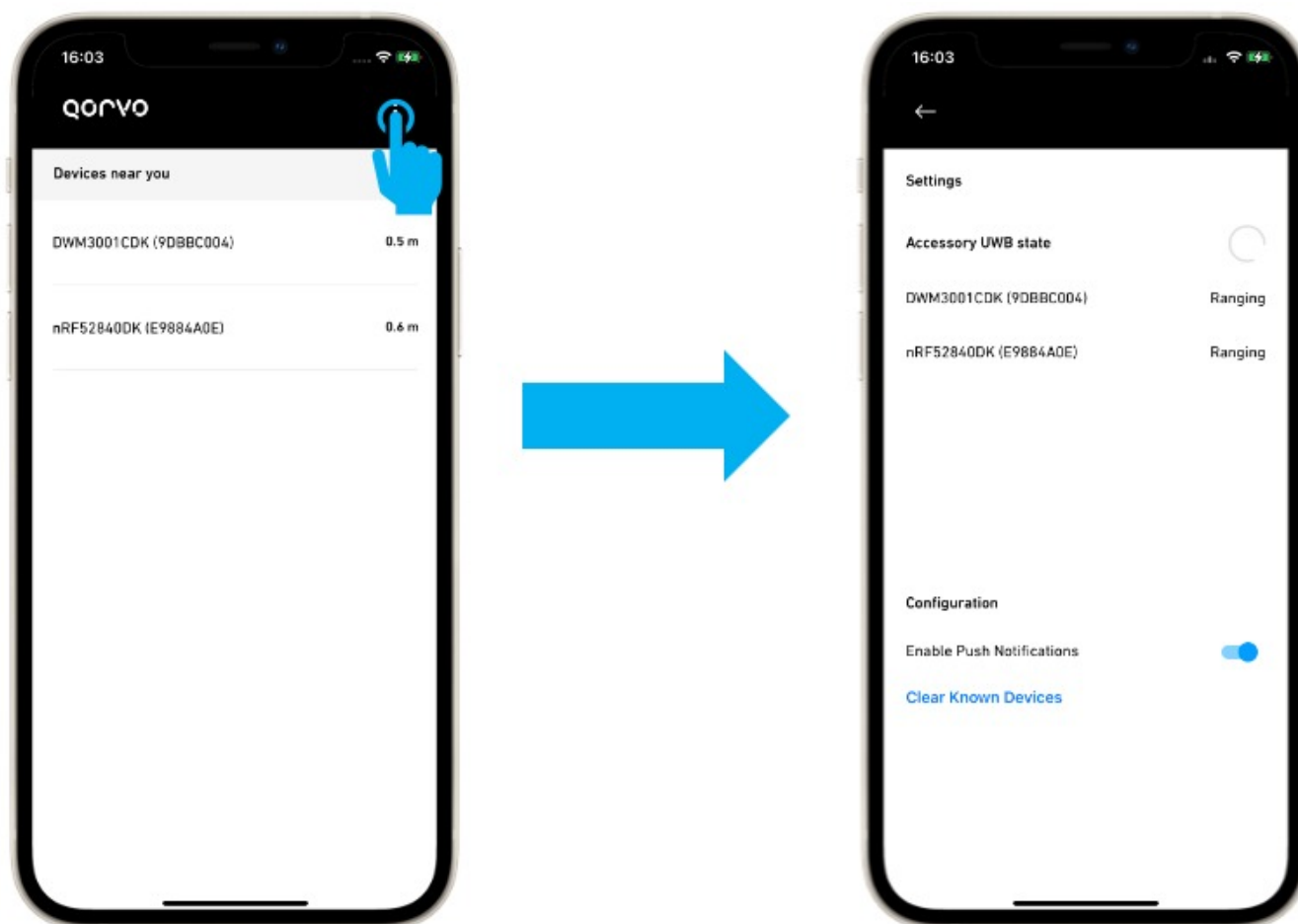
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Figure 1.22: Click on the "three dots" button to open the Settings screen