Parking

User Guide

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Version:v2.8.0

Acconeer AB March 29, 2021

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1.1 Source Code

ref_app_parking.c

1.2 Description

The parking reference application is suited for ground-mounted parking detectors. It uses the Envelope service to detect whether a car is parked above the sensor or not.

1.3 Configuration

The Envelope service is used in the parking reference application. See Read-the-Docs for a detailed description and acc_service_envelope.h for the API.

To be able to visualize the data and test different configurations, use the Parking processing in the Python Exploration Tool and see Read-the-Docs for a detailed description.

The table below shows the configuration parameters that the reference application is using.

Service Parameter	Value
start	0.12
length	0.50
end	0.62
asynchronous_measurement	true
downsampling_factor	2
gain	0.5
hw_accelerated_average_samples	20
maximize_signal_attenuation	false
noise_level_normalization	true
power_save_mode	off
profile	2
repetition_mode	On Demand
running_average_factor	0.0
tx_disable	false

1.3.1 Bluetooth

A Bluetooth beacon is enabled for the XM122. It advertises the reference application output data over Bluetooth. The 'nRF Connect' application can be used to read the data. See 'XM122 Software Development Guide' for more information about Bluetooth advertisements.

1.4 Testing

1.4.1 Test setup

The reference application is tested using both a real-life setup mounted on the ground underneath a car and in lab environment setup using a wooden board and office paper to simulate a car. Tests for both true and false detections are performed, i.e. with and without a car.

Real-life setup The testing was done outside and in a garage using two cars. Testing outside was done on three different places under the car and without a car. Testing inside was done under the car and without a car. Hardware used for testing was the XM132 using the LH132 with a flat lid.
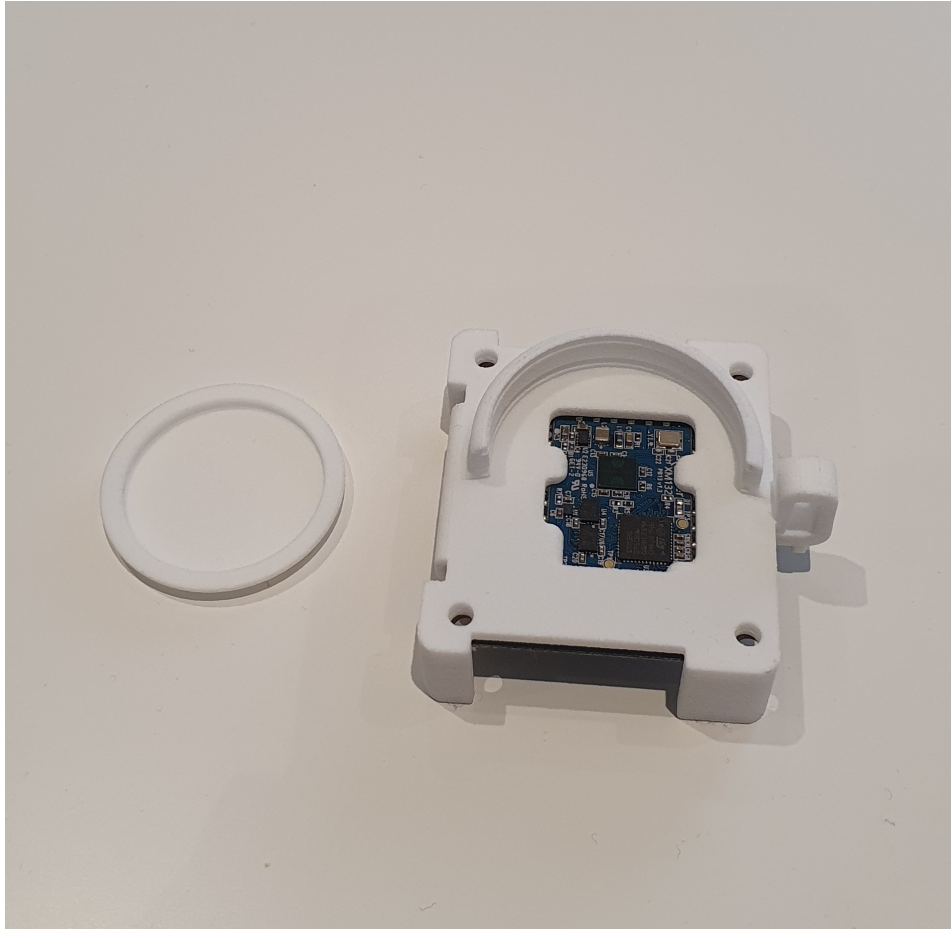
Figure 1: XM132 and LH132 with flat lid

Figure 2: XM132 and LH132 with lid mounted

Figure 3: Sensor under the tank

Figure 4: Sensor under the tank

Figure 5: Sensor under the middle of the car

Figure 6: Sensor under the front of the car

Figure 7: Sensor under the front of the car

Lab environment setup The lab environment was setup to test multiple sensors over temperature using a reference card XR111, a validation board and a temperature chamber. The door of the temperature chamber is replaced with foam which is invisible to the radar sensor. A wooden board with a sheet of office paper in front of it was setup in front of the sensors.

1.4.2 Test execution

All testing was done for both true and false detections.

Outside testing Four test cases was tested on the test setup outside.

1. Under the tank of the car

2. Under the middle of the car

3. Under the front of the car

4. Without a car with a person walking over the sensor

Test case 1 to 3 runs the reference application and looks for false negative detections and test case 4 looks for false positive detections.

Long duration testing The long duration test was performed inside for 24 hours with and without a car. In the first the reference applications runs and looks for false negative detections and the second case looks for false positive detections.

Over temperature Two test cases is tested over temperature, with and without a car. Both cases are run on 8 sensors over three temperature, -40C, 25C and 80C. In the first case the wooden board and paper is placed in front of the sensor and in the second case the object is removed. The test was run for 1 hour per sensor at update rate 10 Hz, instead of default update rate 0.1 Hz.

1.4.3 Test results

Table 2: Memory usage for Reference Application Parking

Hardware	Flash [kB]	Static memory [kB]	Stack [kB]	Heap [kB]
XM132	80	7.0	1.9	6.2
XM122*	127	12.7	1.9	6.2

*Memory and flash used by the SoftDevice and the bootloader is not included in the table

Table 3: Power consumption for Reference Application Parking

Hardware	Update rate [Hz]	Mean current [mA]	Voltage [V]	Power [mW]
XM132	0.1	0.056	1.8	0.102
XM122	0.1	0.037	2.0	0.074

Test results will be presented in percent detections, expecting 100% when a car is present and 0% when no car is present.

Table 4: Outside testing

Test case	Detections
Under the tank of the car	100%
Under the middle of the car	100%
Under the front of the car	100%
No car	0%

Table 5: Long duration testing

Test case	Detections
Car	100%
No car	0%

Table 6: Over temperature.

Temperature	Value	True detection rate	False detection rate
-40C	Mean	100%	0.179%
-40C	Std	0.0	0.280
25C	Mean	99.9%	0.0338%
25C	Std	0.328	0.0650
85C	Mean	99.8%	0.00375%
85C	Std	0.324	0.00992

1.5 Limitations

Near sensor detection for detecting material covering the sensor, e.g. wet leaves and ice, is not included in this reference application.

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