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Smartphone app for the control of a radar Exposimeter

Group work

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# Introduction

Radar signals consists of short and very powerful pulses. In some cases, the peak power of a transmitted burst can reach very high values compared to the ones from telecommunication base stations. Meanwhile, the use of very short duty cycles and the rotation of a radar Antenna lead to comparatively low average power values. Due to the huge differences between the average and the peak field near radar stations, a commercially available exposure meter is not suitable to correctly differentiate these two field values. Hence, there is a need for a device, which is capable of measuring both fields precisely. The Institute of Electromagnetic Fields (IEF) at the ETH Zurich developed therefore a display-less, portable tool, called “Exposimeter”. In order to control this device and to plot the measured data, there is a demand for a smartphone app. In an early stage, a first application provided the plotting of single frequencies without the ability to control the Exposimeter. The lack of the capacity to regulate the device and the fact that a newer version of the Exposimeter did no longer provide the connection over Bluetooth but over Wi-Fi lead to a development of a new app.

# Requirements

The requirements for the app are:

* Connect to the device over Wi-Fi
* Processing and plotting data
* Controlling the Exposimeter
* Run on Android based smartphones

The app consists of three different plotting types:

* Overview: A measurement over a big range of frequencies, to show the outstanding values of either peak or RMS fields.
* Detail view: One to six frequencies can be chosen separately for further investigation. The corresponding values, both peak and RMS, are plotted in a new window.
* Timeline: To display one of these selected frequencies in real time.

The Exposimeter has four different attenuation levels which can be set by the application:

* Normal mode
* -42dB
* -21 dB
* LNA

Further information provided by the app:

* Battery level of the Exposimeter
* Device number

# Functional blocks

The second chapter typically introduces the theory subsequently needed. It will allow a reader in the field to read the next chapters without looking up books. Key results and derivations are given. The theory may be derived from literature – but proper citing is expected. The material however has to be made up in a consistent way and a common nomenclature has to be used throughout the thesis.

The chapter should give both an overview on the theory and its context but also an in-depth idea of the formulas used in the next chapters.

The programming environment is Android Studio. The work was divided in three mayor task, each of which can be programmed separately ??? The merging of these parts is described in section 3.4 Data Flow.

## Data Transmission

## Data Process

## Data Plot

## Data Flow

## Matlab & Debug

### Heading 3

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# Results

## User manual

### General

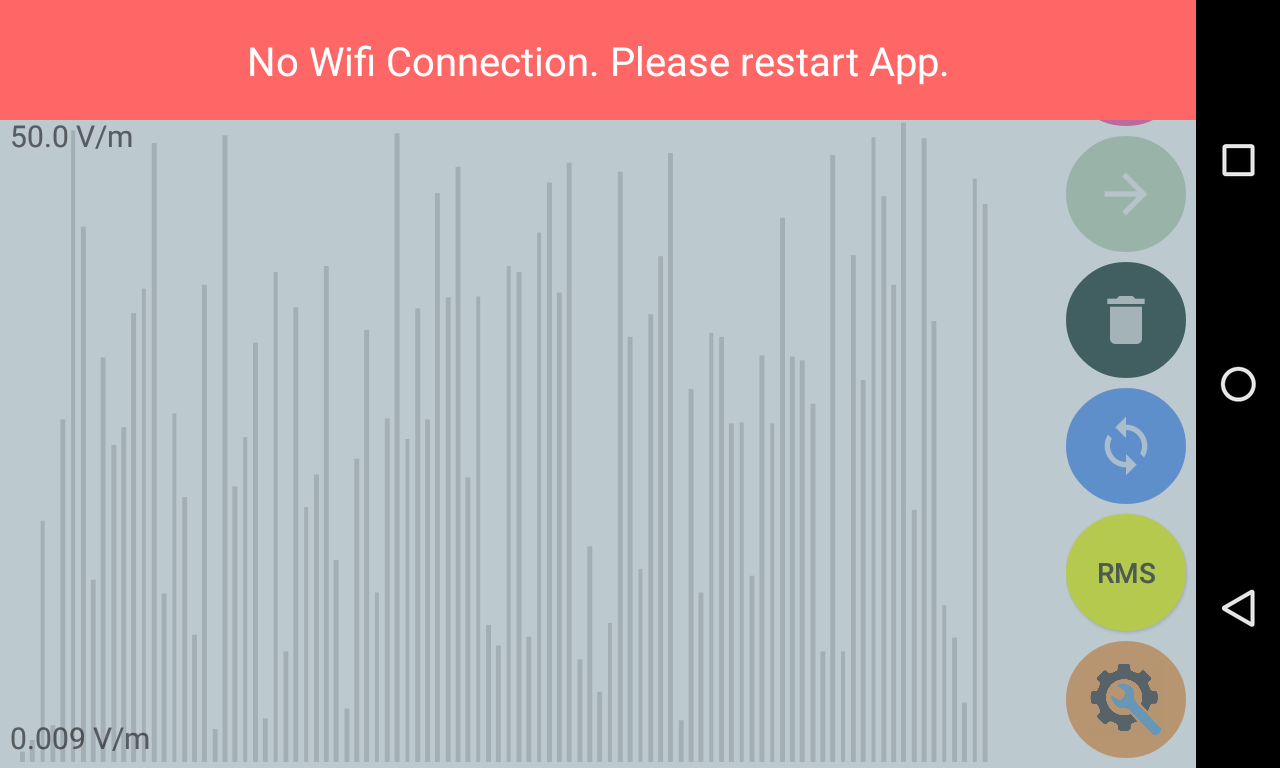
#### Hotspot configuration

The data is passed between the Exposimeter and the smartphone over Wi-Fi. The smartphone plays the role of a master, the Exposimeter the one of a slave. Therefore, the smartphone must offer a hotspot for the connecting device. The configuration must be adjusted before opening the app. To configure the hotspot, follow these steps: Settings -> Wireless & networks -> Tethering & portable hotspot -> set up Wi-Fi hotspot. Set up the network name and password the same as in the Exposimeter. Then enable Portable Wi-Fi hotspot. Note that this is only working, if the airplane mode is not enabled. If the hotspot isn’t enabled, the app will store the current network state and enable the Wi-Fi hotspot on starting and reset the network state on closing.

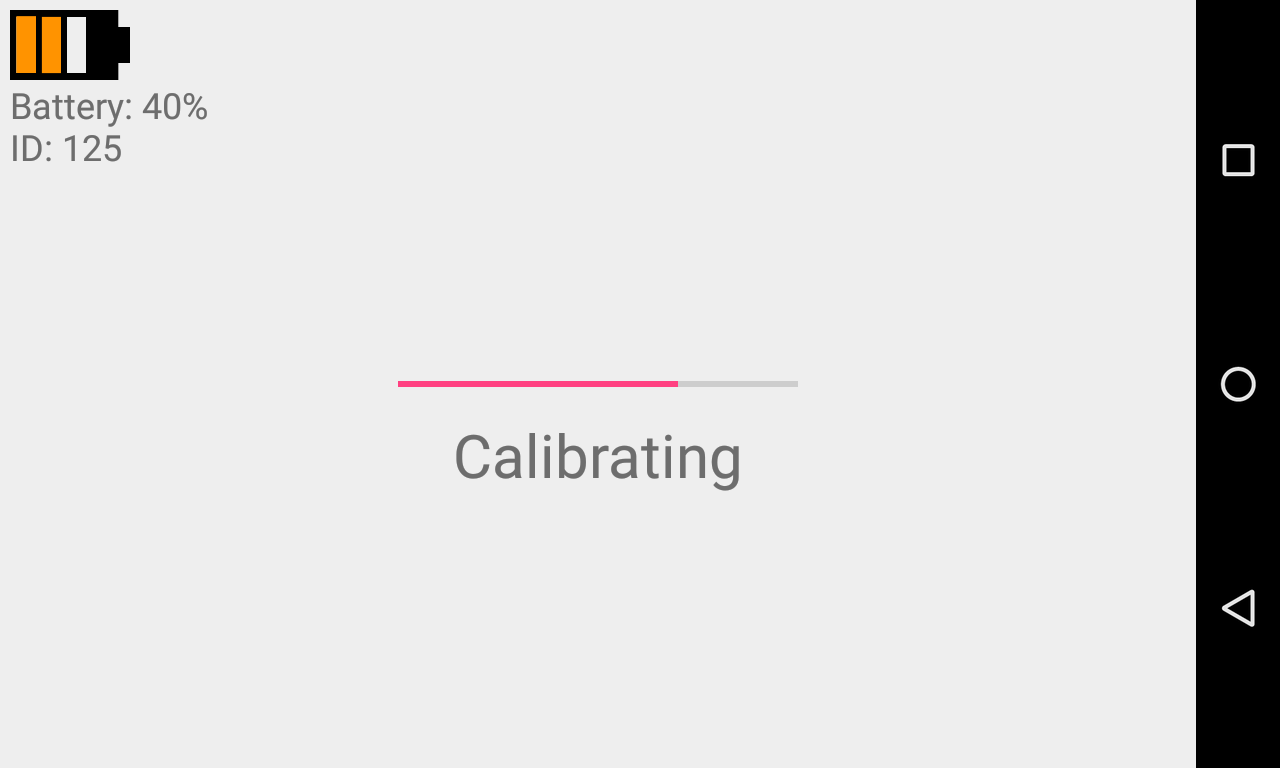
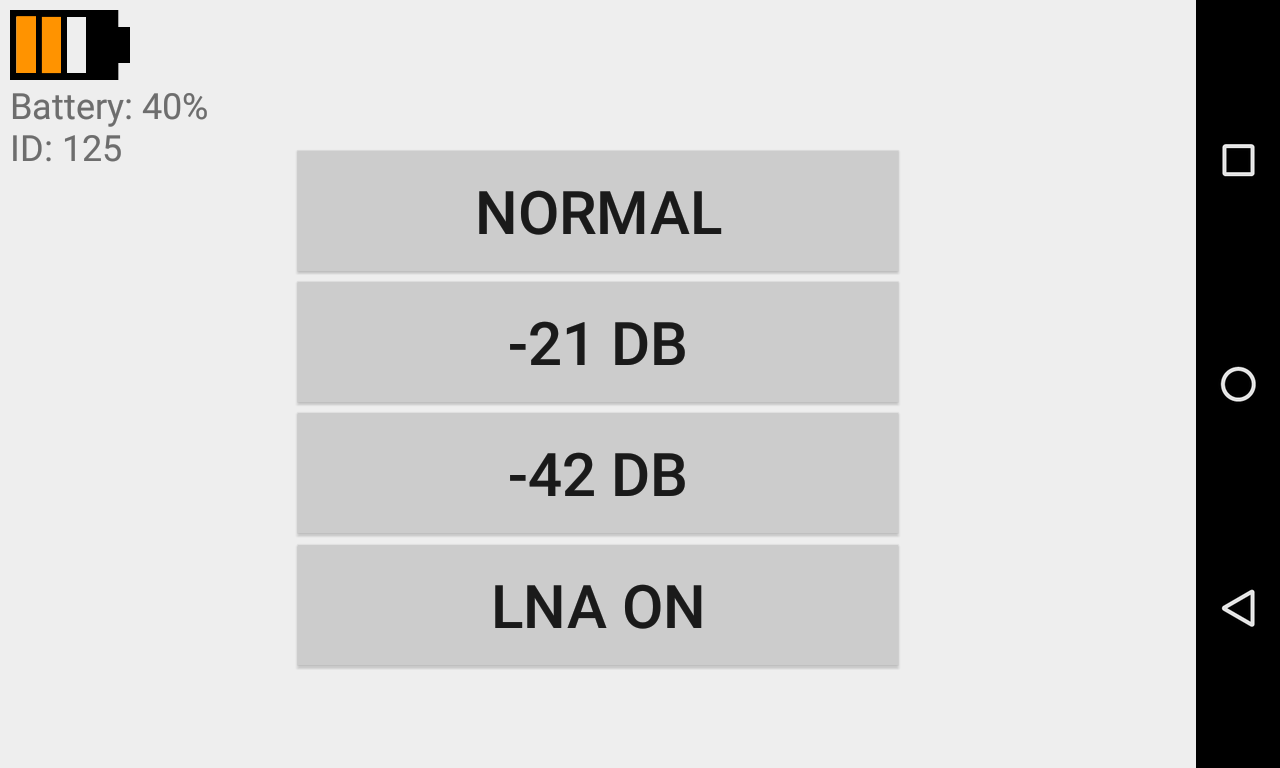
#### Connection lost

If the connection between the smartphone and the Exposimeter is lost, a red bar will show on the top. To fix this error, close the app, check the connection and restart the app.

### Home Screen



On first starting the app, the hotspot configuration will be enabled and a trigger packet will be sent automatically to the Exposimeter, which then returns all calibration tables for each of the four different attenuation modes. A progress bar is indicating the progress of the transmission. After receiving all calibration spreadsheets, one can choose between the four attenuation modes. On the top left, the battery level of the Exposimeter and its device ID is displayed, see Fig 3.2.



### Overview

On clicking on one of the attenuation modes, a new window will open and show a plot of all frequencies, ranging from 500 to 10000. On the right hand side, there are six buttons for further interaction:

* After selecting an interesting frequency by pressing on the corresponding frequency-bar, this selected frequency is added in a pool for further investigation. A maximum of six different frequencies can be chosen and added each separately to this pool. The bars shown in green are already selected, while the bar shown in red can be added to the pool by pressing the plus button.
* For the selected green bars, a new window opens in the Detail view.
* Each selected frequency can be deleted from the pool one by one.
* To refresh the whole overview plot, one can use the refreshing button.
* The overview plot is either showing the peak or the RMS measurement. The yellow button is for switching between these two states. The current configuration can be seen in the top left corner.
* On pressing on the configuration button, one can see and change the current attenuation mode.

### Detail view

After selecting some frequencies and pressing the green arrow button, a new window opens in the Detail view. The Peak and RMS value of all chosen frequencies are shown. On pressing on one single frequency, the timeline window will open for this selected frequency. On the right side, there are two buttons for interaction:

* The Peak and RMS values are updated from time to time. To stop this refreshing, one can press the yellow stop button. Another press on the same button will restart the updating.

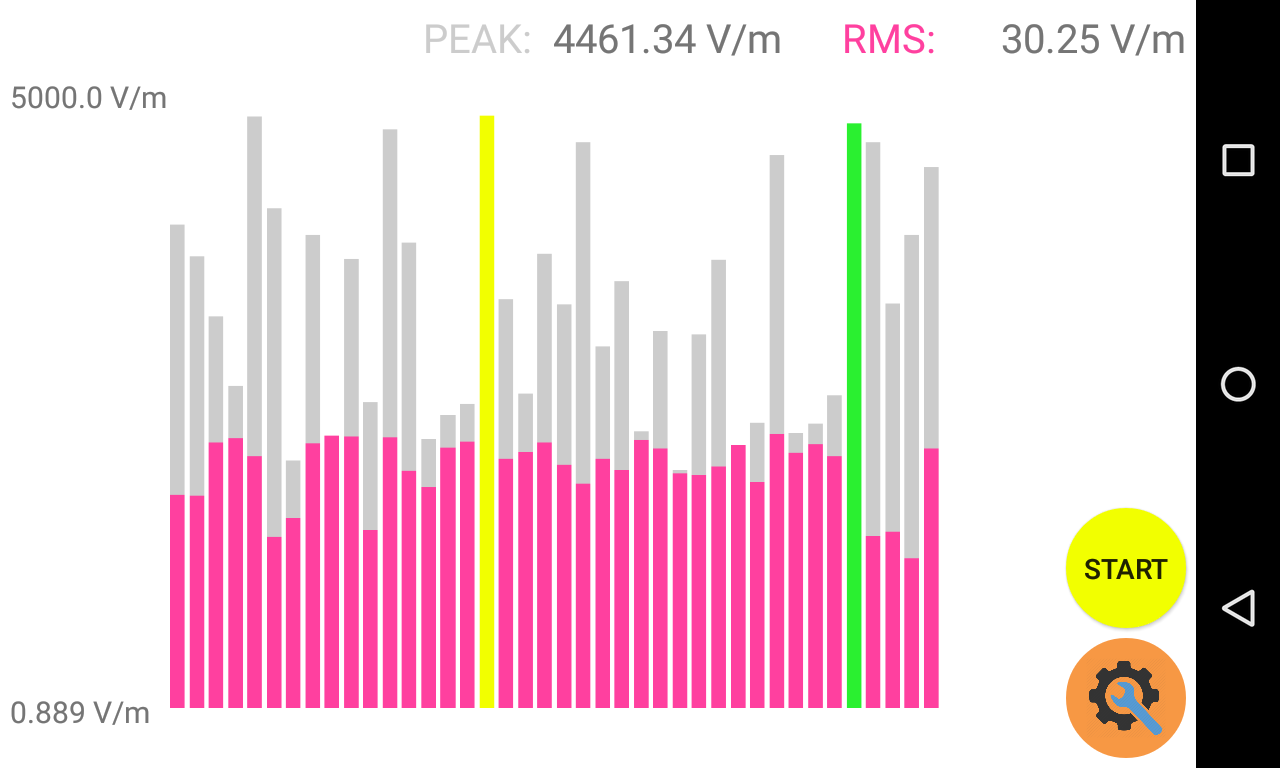
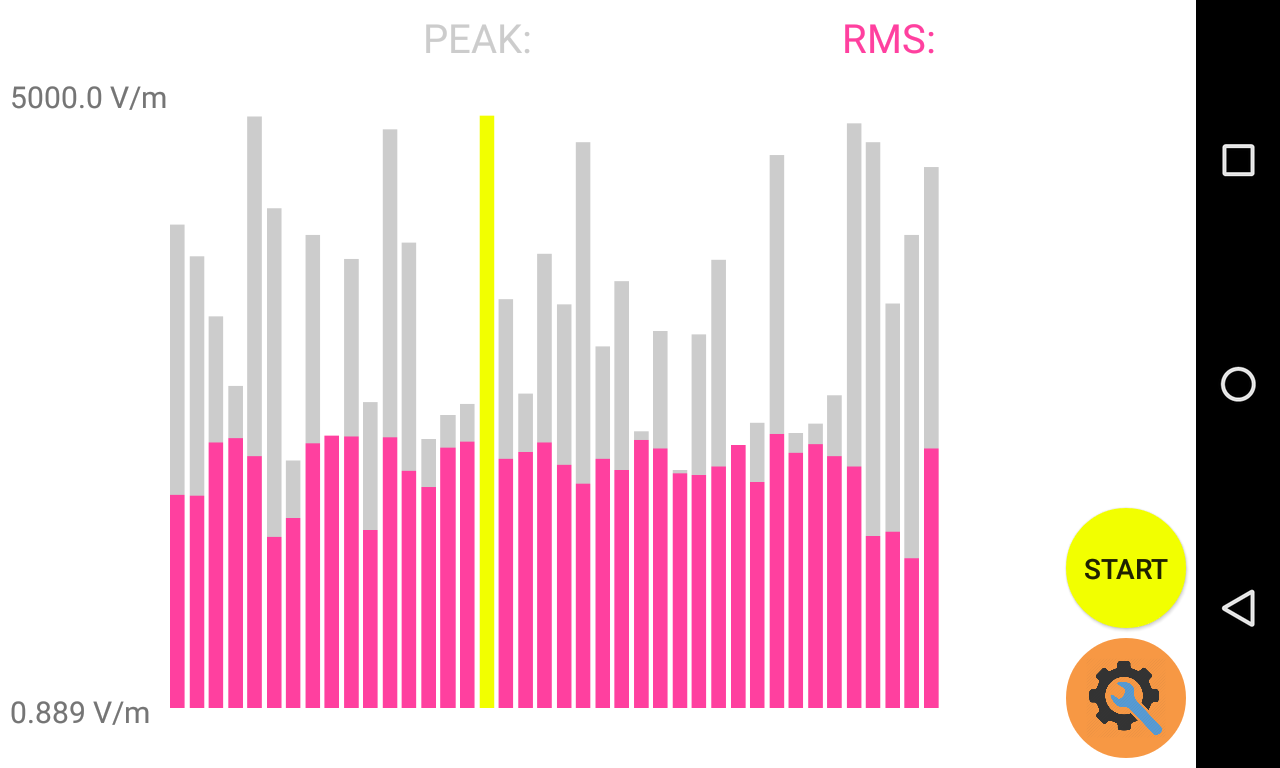
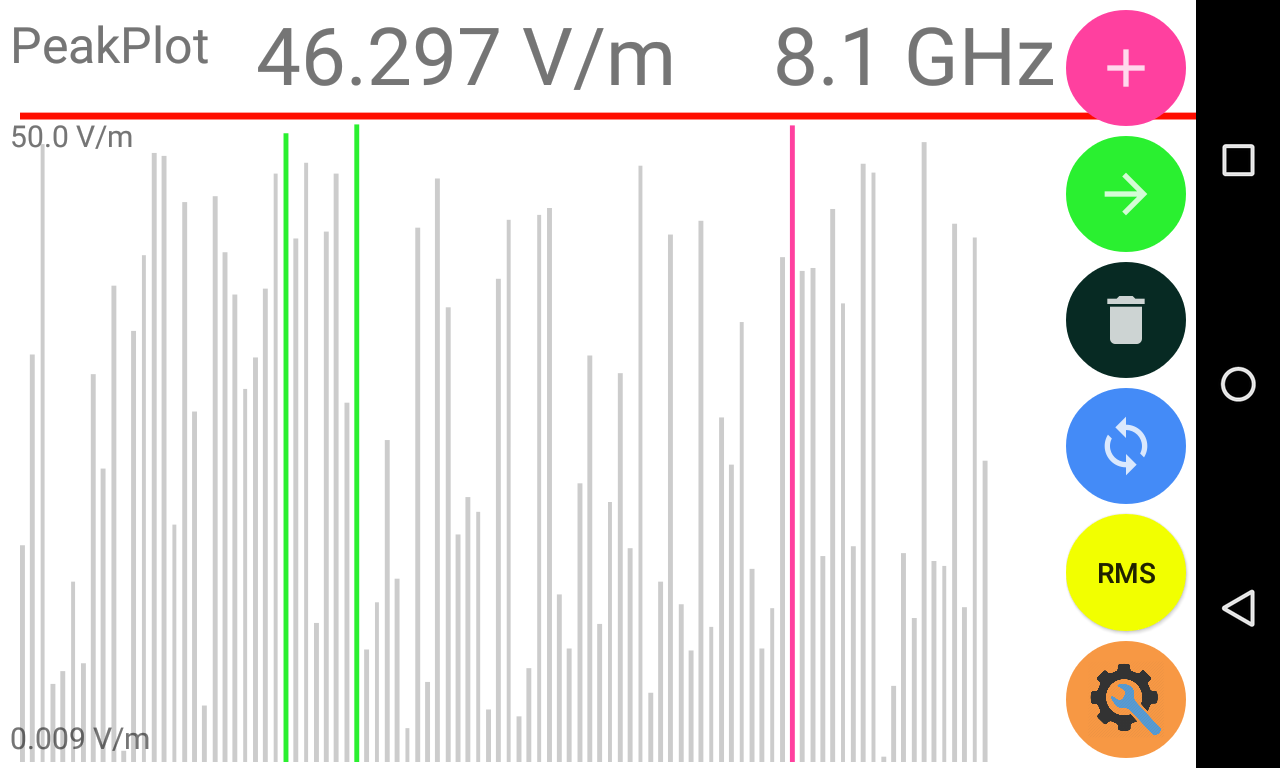
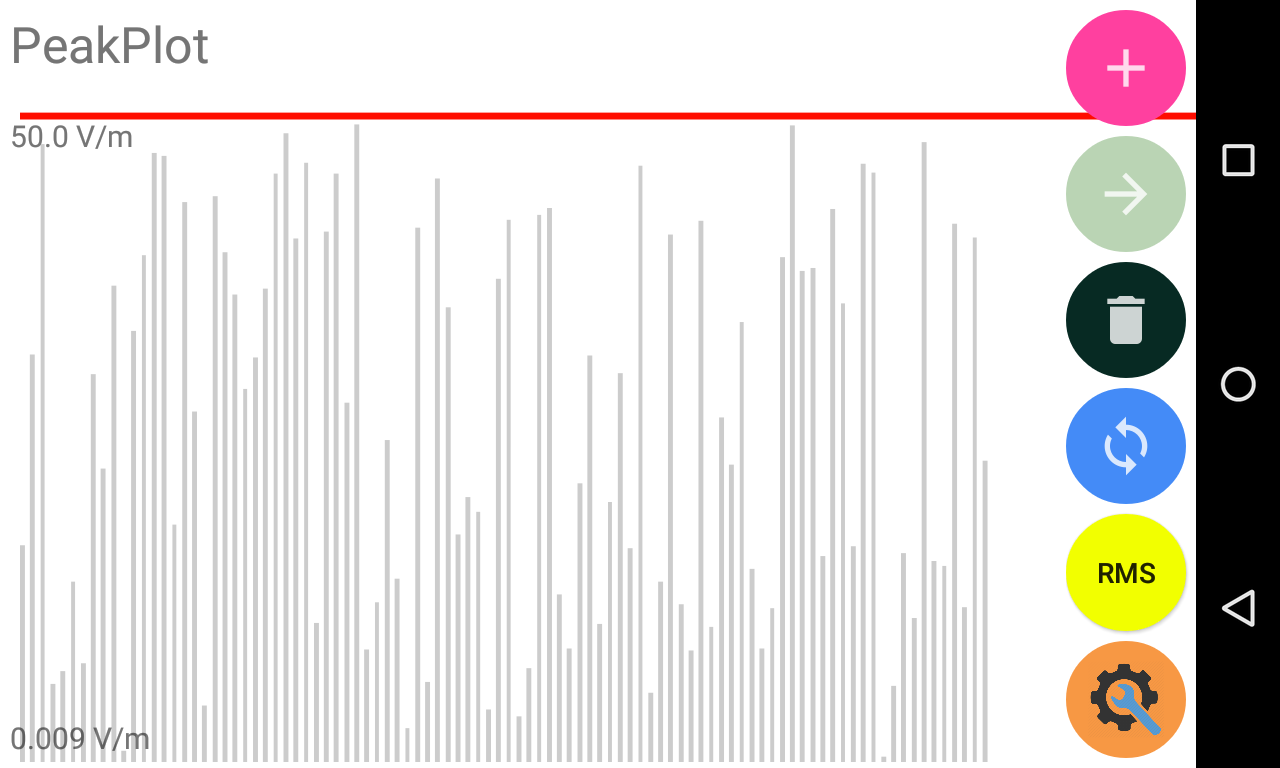


* On pressing on the configuration button, one can see and change the current attenuation mode.

### Timeline

The timeline view plots one single frequency over time. The frequency can be selected in the Detail view. A yellow bar is swiping through the chart, indicating the current measured value. To inspect the RMS and Peak value at a specific time, one can select a bar, which will then appear in green. On the right side, there are the same two buttons as in the Detail view for interaction:

* The Peak and RMS values are updated from time to time. To stop this refreshing, one can press the yellow stop button. Another press on the same button will restart the updating.
* On pressing on the configuration button, one can see and change the current attenuation mode.



## Test App

Since the Exposimeter has not been completely build yet, there was no real data to work with. In order to debug the app and to plot some values, a test function is implemented. This class simulates an Exposimeter by reacting to commands, sent by the application. The normally outgoing packets are parsed in the class and, dependent on the respectively instruction, some more or less realistic data is sent back to the application. To switch between the test class and the class for real connection, only one line in the code must be altered, see Appendix ??.



Fig. 3.1: Caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption caption.

# Summary

The outcome of the project is a well-functioning, simple to handle and purposeful app. The application is capable to connect easily with the Exposimeter, getting data, process and parse the data and plot it in a clear way as well as giving some basic information about the Exposimeter. Furthermore, the attenuation modes can be controlled by the smartphone. The key features are three different plotting types, which provides suitable information about the peak and average field. Additionally, it is possible to test the app even without an Exposimeter.

In future, the app could be used to set even more configurations than the attenuation modes. Another idea would be to store the received data on a server to handle them later on a stationary computer.

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1. Code

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