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ATCZ203 AMOR PROJECT

EMC Reference EUT

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1 Introduction

The task outlined in the following is about building a reference EUT (equipment under test) for the evaluation of EMI (electromagnetic interference) receiver capabilities in terms of battery-powered IoT devices. The measurements will be performed in a GTEM cell corresponding to *IEC 61000*. In order to prove the validity of the measurements on a real world example the device shall implement commonly seen features that are known to be prone for failing the EMC certification rather than just sending signals with an antenna.

Furthermore, best practices regarding EMC design shall be actively ignored to make sure that the device would fail a compliance measurement and there should be some versatility regarding the configuration of the device in order to examine the impact of the different features and its properties (e.g. clock speed) on the measurements.

2 EUT Sturcture

The EUT will be a battery powered device to dismiss any electromagnetic influences that would result from feeding power lines into the measurement cell and shall be around 100mm x 100mm in size. The heart of it will be a microcontroller (*TI TM4C129X*) which interfaces additional periphery. An optical link for remote in situ configuration of the is planned to be implemented based on TOSLINK transceivers.

The EUT will incorporate the following features / EMC problem sources:

- A brushed DC motor that induces broadband fields due to brush sparking. The motor will be driven with a pulse width modulated supply with both frequency and duty cycle being variable.
- A class D amplifier which is by design switching very fast. Normally EM disturbances are reduced by filtering the output before feeding it to the speaker but filters will be omitted for the sake of high noise. From an audio perspective this is offcourse no problem as the mechanical system of the speaker has a comparatively low cutoff frequency.
- A parallel interfaced display will be connected to the microcontroller. Since many data lines are usually guided in parallel and their signals might be correlated (for instance when drawing periodic patterns) an effect of constructive interference might occur. Therefore it is favourable to not only have a variable bus speed but also variable patterns / images to be displayed. Furthermore the display shall have no graphical memory and therefore the parallel bus needs to be written permanently.
- A high speed (multiple 10 MHz) SPI bus will be implemented which can be a source of problems. It will be possible to write data to it in different modes like permanent or bursted to test if and how the measurement equipment performs differently based on the dynamics.
- A parametrizable buck converter will also be on board. The control loop will be implemented in the microcontroller which gives felxibility regarding different control schemes and frequencies. Its load will be steerable by the microcontroller too in order to vary

the currents and therefore magnetic fields and to enforce continuous or discontinuous operation of the converter.

All of the above features will be enabled and disabled independently by the microcontroller to allow highest possible flexibility and to distinguish the different factors regarding EMC performance. As pointed out before the routing will be suboptimal by design (e.g. large current loops, busses longer than necessary etc.) and the layer count will be reduced to a minimum. Hence some fast switching signal traces will not be guided over solid copper planes which should account to even more EMC problems whilst the microcontroller section itself will be implemented in a proper and way to guarantee its reliability in operation.

3 Progress

Most of the key components have been selected according to operational requirements and availability. A first version of the layout regarding the mechanically large components is depicted in figure 1. It shows that there is still enough space for implementing the microcontroller together with its periphery and the buck converter.

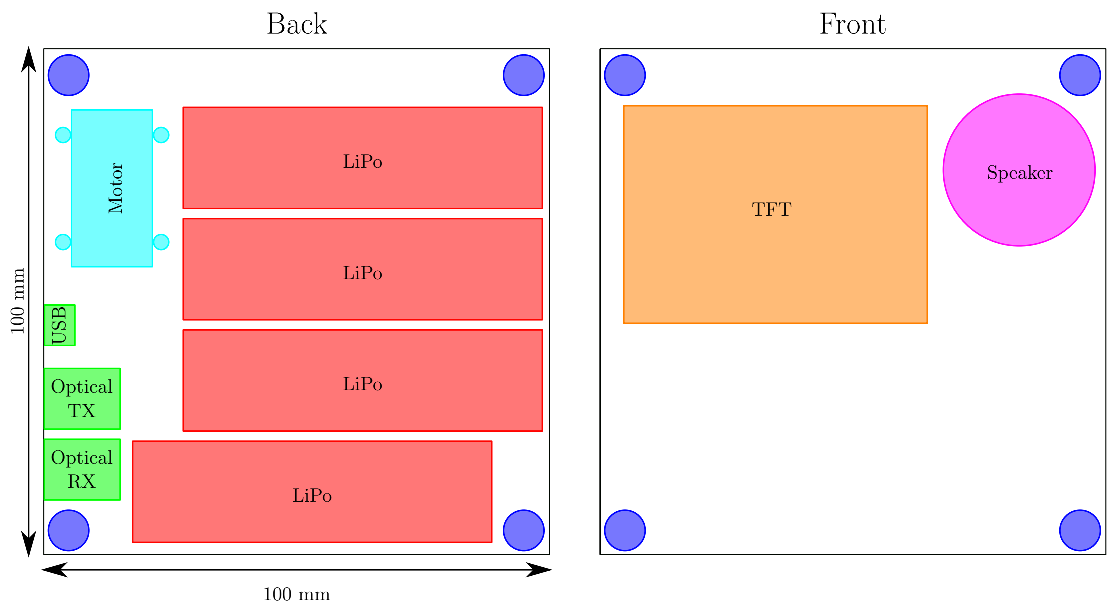

Figure 1: Layout of the mechanical components on the PCB

Additionally an evaluation kit for the microprocessor has been purchased and first steps towards writing the firmware were performed.

4 Planned Measurements

Firstly, the EUT will be characterized in a certified semi-anaechoic test site in order to have comparable reference data for the measurements with a TEM cell. When an appropriate setup with the waveguide has been found, keeping the error compared to the reference in a justifiable range, broadband time-domain measurement will be performed.

The goal of the signal analysis in time-domain is to characterize which dynamic range the analog front-end has to deal with. Furthermore, periodicities will be analyzed to estimate the required additional dynamic for the quasi-peak detector. Another important aspect is the bandwidth of the interfering signals. Therefore, the measurement data will be investigated in frequency-domain as well.

Based on this gained knowledge, the signal will be analyzed in the IF range which is specified in *CISPR 16-1-1* for the desired frequency band. With these results the requirements for the ADC should be elaborated.

Lastly, the reference EUT will be utilized as an example for analyzing the performance of software-defined-radios out of the box.