

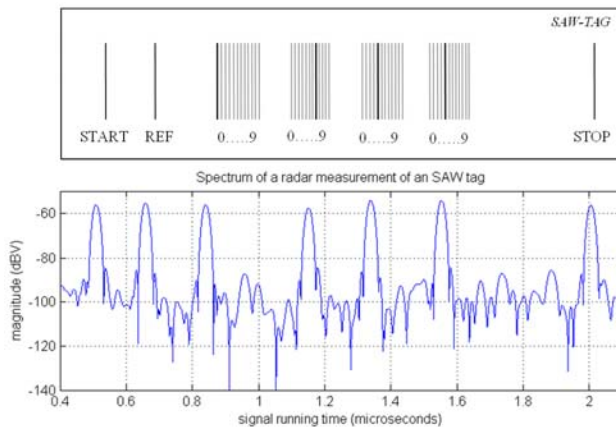
## High-speed DDS controlled radar system for the identification of Surface Acoustic Wave Tags during translational motion

SIMONE WINKLER

### Overview:

- Design of a stand-alone FSCW / FMCW radar system for the wireless identification of Surface Acoustic Wave tags
- Evaluation of a high-speed Direct Digital Synthesizer as frequency generator
- Design of an ultra-low-noise 18 bit Analog-Digital Converter
- Full integration of the entire system into Matlab by a USB2.0 interface
- Implementation of computationally complex and sophisticated parametric frequency estimation algorithms into a DSP

### Identification of SAW Tags by evaluating the spectrum of a radar measurement:

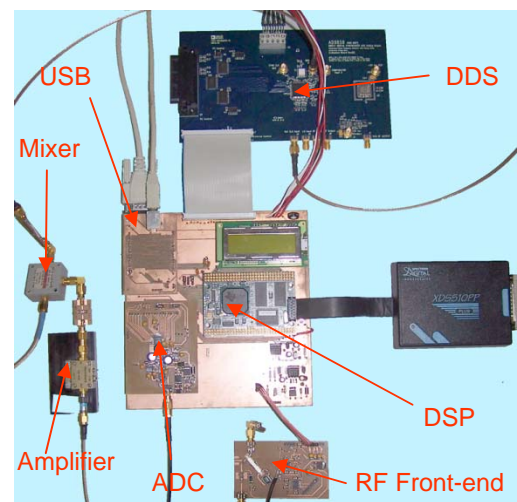
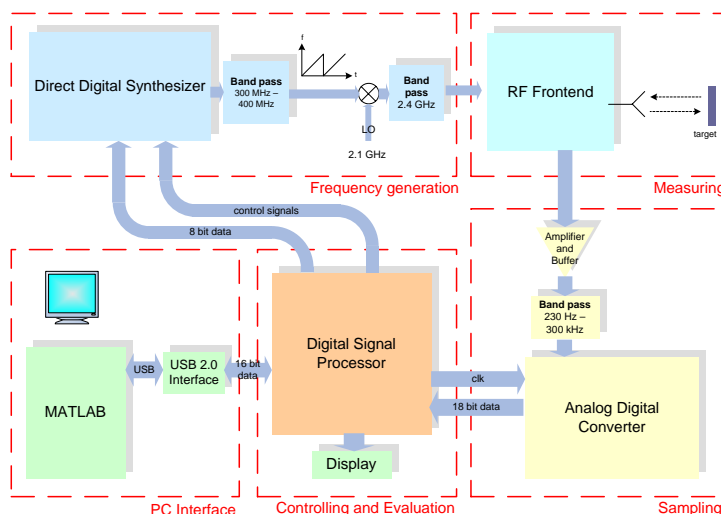


The positions of metal reflectors on a SAW tag are used to impose codes. In the measured spectrum the time-of-flight to each reflector is used to identify the code.

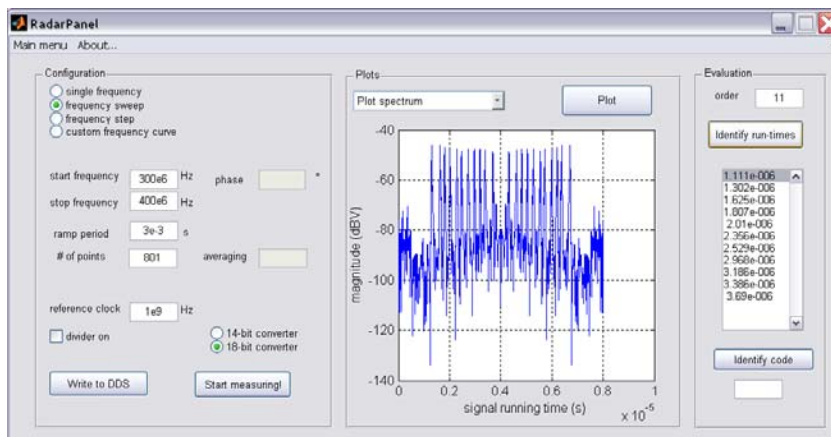
Surface Acoustic waves have a propagation velocity around the acoustic velocity. Thus, a signal's time-of-flight for a reflector at some micrometers is the same as for a target in free space that is at a distance of some 100 meters. Surface Acoustic Wave tags can be used for the following tasks:

- Identification of a code that is imprinted into a surface acoustic material by placing a number of reflectors to certain positions. (shown in the figure)
- Measuring temperatures by determining a change in a signal's run-time due to elongation and change of propagation velocity of the wave.
- Torque measurement due to mechanical force.

### The measurement system:

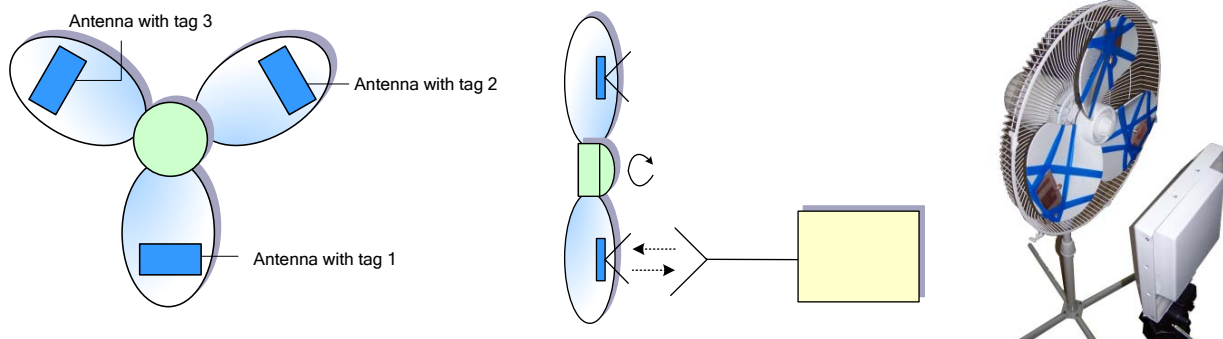


## The RadarPanel, a USB-Matlab-Interface between the radar and the PC:



To offer a user-friendly interface between Matlab and the radar system, the RadarPanel, a Graphical User Interface (GUI), is designed. With the help of this interface, the whole system can be controlled in terms of measurement parameters, as well as it can retrieve the results and the measured data.

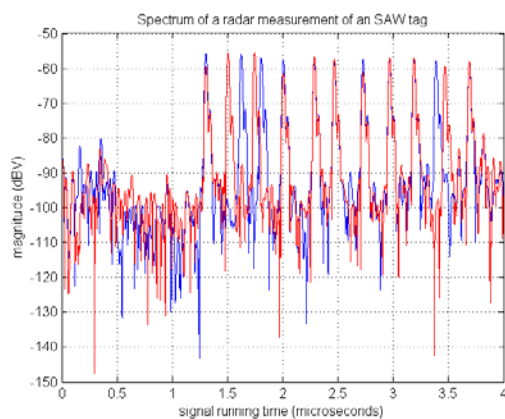
## Measurement of tags during translational motion: Mounting tags onto a ventilator



The aim is to be able to measure the codes of SAW tags that reside under translational motion. The idea is to attach antennas with tags to a ventilator. The antenna at the radar is positioned towards the receiving antennas. The measurement is implemented as an FMCW radar. Very fast ramp periods are necessary to be able to measure much faster than the rotational speed of the ventilator.

## Results

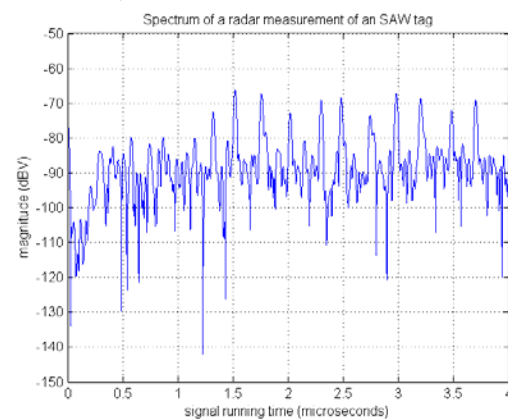
*Static measurement (without ventilator, wired connection)*



*FSCW measurement of two different wired connected tags with an averaging factor of 64:*

11 peaks show the run-times of the signals and therefore mark the positions of the 11 reflectors on the tag. The codes can be identified correctly.

*Dynamic measurement (ventilator)*



*FMCW measurement of tags under translational motion with a measurement duration of 3 ms:*

The code can be identified correctly. In comparison to a measurement of a tag at the same distance without any motion, we obtain the same SNR. This result shows that the ramp period of 3 ms is short enough to represent an instantaneous record of the tag.