Ultra-wide-band SAW RFID/sensors

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This *invited* paper describes development of a SAW tag and sensor system operating in the Ultra-Wide-Band (UWB) frequency range. Often SAW tags and sensors operate in 2.45 GHz ISM band using relatively narrow bandwidth = 82.5 MHz. The characteristics of these devices can be improved using UWB technology.

Using UWB signal corresponds to very short signals in time, which means for limited SAW propagation time, a radical increase of number of codes in RFID or decrease of device size. For the sensor applications, the UWB signals are more reliable in the situation with many parasitic reflections in the radio-channel. Reasonably large number of tags can be interrogated by one reader simultaneously ("collision problem").

We have developed prototype devices operating in 200 - 400 MHz and 2000 MHz - 2500 MHz UWB frequency ranges. The devices have either simple wide-band SAW transducers, of different types of spread-spectrum transducers. In the last case the processing gain can be obtained for signals returned back to the interrogator by the sensor/tag compared to the signals reflected by environment. An UWB reader operating in continuous wave radar mode for 2 GHz range was developed by RSSI (Germany) and manufactured. The first remote measurements show compressed RF pulses of about 2 ns duration, which include unique RF filling of a few sinusoids with amplitude modulation. Precise measurement of the pulse position is possible by correlation methods, avoiding the phase ambiguity problem. The temperature is measured with a precisions of about 0.1 °C (Fig.1) . The correlation method works even in a multi-path environment with strong reflections from metal objects For tag application, we measure and identify three different tags at the same time without collision problem, and this number can easily be greatly increased.

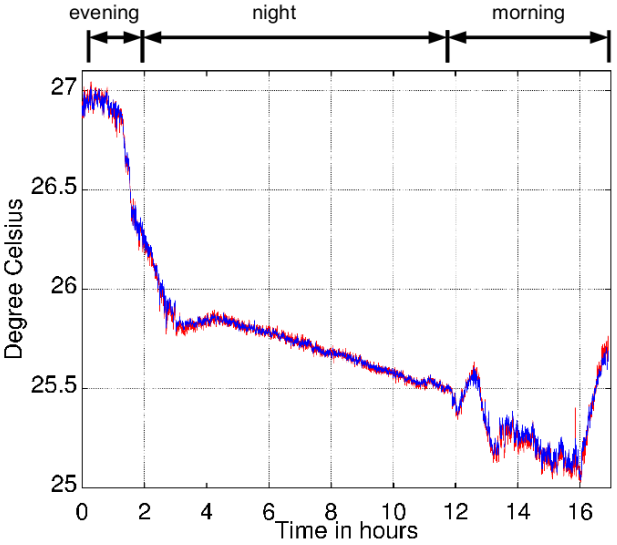

Fig. 1: 16-hour long remote reading, the blue curve plots the measurements made by the reference sensor (Pt100) placed on the SAW sensor package. One of the SAW sensors is represented by the red. The saw sensors resolution is better than 0.1°C .

The feasibility of the UWB (B=750MHz) SAW-tags operating in 6 GHz range was demonstrated experimentally. The devices have small chip size of 0.8 x 2.1 mm^2, small antenna size, and demonstrate loss level only about 10 dB higher than typical values of 2.45GHz analogues.

The use of Hyperbolically Frequency Modulated (HFM) signals instead of traditional Linear Frequency Modulation (LFM) simplifies the compression algorithms, making them invariant to temperature.