A radio frequency based system to detect distance using a transceiver- and transponder module

Subject: Sensor Technology
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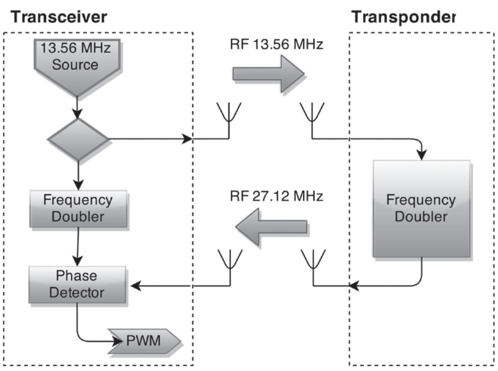
The goal of this task is to implement an electro-magnetic distance detection system that measures distances from zero up to five meters with a resolution of 1 cm. The system uses two modules, a base station and a remote station for transmitting bidirectional electro-magnetic waves in form of radio frequency signals.

Function Principle

The base station transmits a low intensity electromagnetic signal at a radio frequency (RF) of 13.56 MHz. The remote station receives the signal and generates the second harmonics by doubling the received input frequency. This processed signal, now oscillating on a frequency of 27.12 MHz is being time synchronously transmitted back. At the base station, an internal auxiliary oscillator generates locally the second harmonics adapting the same function principle as the remote station. The distance measurement at base station is now realized by comparing the phase shift between the internal generated 27.12 MHz signal and the received signal.

Approach

The design is based on several sub modules. For the bidirectional transmission, 4 antennas were designed most suitable for indoor environments and short ranges. To transmit the base frequency, a RF identification module is used. A resonator couples the signal into the transceiver.



Schematic flow diagram of the distance measuring process

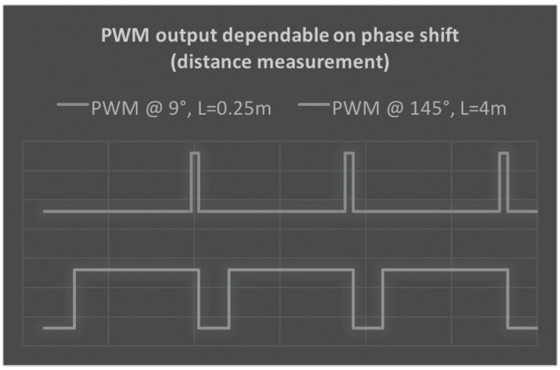
Moreover, a RF amplifier was developed to boost the signal for stronger transmission and reception. Further, a frequency doubling sub circuit is used to produce the harmonics of the base frequency. Finally, a phase detector sub module interprets the phase shift where the actual distance measurement takes place with a maximal range of 1° up to 179°.

Results

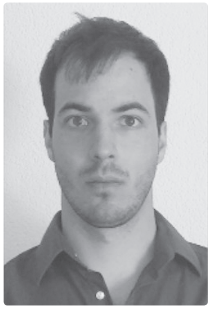
This Bachelor Thesis presents a research paper that suggests a possible system setup for the given task as well as alternatives for several sub modules. The experimental setup gives a first input over well functioning parts and shows deficits where more research is necessary to find more accurate sub modules.

Perspectives

The perspectives of this work are to use the theoretically designed system and work with the inputs of the experimental setup to design the printed circuit boards.
Further, if a higher accuracy is obtained compared to a time-of-flight (ToF) measuring system, the idea is to combine those two systems. The combination shows high accuracy given by the phase detecting system and a range extension given by the ToF input. Additionally, to be able to make direction measurements, a third system could be added to the entire module working with a directional antenna that measures the intensity in a 360° range.



Two sample outputs of the phase detector module, measuring a phase shift of 9° and 145°



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