Remote RF sensor readings without µController

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Introduction

For data logging systems the sensor cannot always have a wired connection with the data logger. So transferring sensor data, which is often a voltage, via RF is the main goal of this project. The described system has a transmitter (Tx) side, which is able to measure sensor voltages between 0..3V and transfers this information via an 433 MHz RF-link to the receiver (Rx) side. At the Tx side the sensor voltage is represented as an 8 bit parallel output, which is converted in a hardware encoder and send serially to the receiver side. And at the receiver converted to 8 bits parallel again. The complete set-up is depicted in Fig. 1. The main goal of the project is; use only hardware at the sensor side, thus no software and no µController.

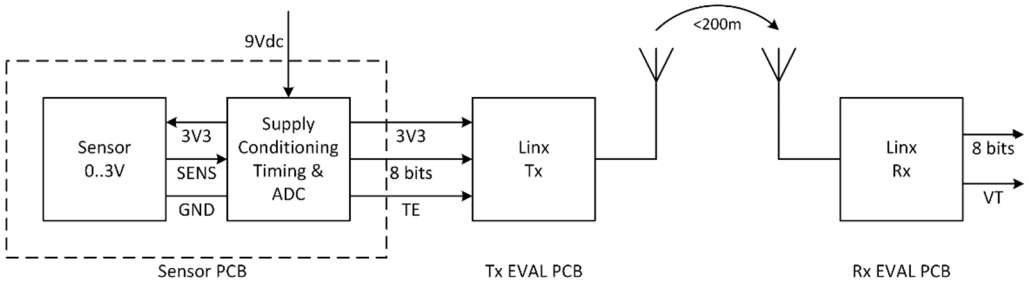

Fig. 1: Set-up of the RF-system

Implementation

Use initially an RF-evaluation kit (see next paragraph) and an 8 bits ADC converter, which is timed with simple LMC555 RC timers. By choosing different reference voltages (V-ref) the ADC resolution can be optimised in combination with the used sensor.

Hardware

Fig. 2 shows the RF Tx/Rx Linx EVAL-xxx-DS kit [1], which is based on three IC's; an Encoder (LICAL-EDC-DS001), a Tx-chip (TXM-xxx-LR) and Rx (RXM-xxx-LR) chip, where xxx equals the frequency 315, 418 or 433 MHz. For both boards together roughly 25 euro. For in house (i.e. short distance) applications the on-board antenna is more than sufficient. With the EVAL kit, set at 1mW output power and in combination with the short 5cm antenna [2] one is able to cover a distance of 200m. The Tx chip has an adjustable output power level and the encoder/decoder chip has 1022 unique addresses to avoid interference with possible other Linx modules used in the near surrounding. A serial protocol, which reduces transmit errors is implemented too. So, if you are out of reach there is just no data. Till now I didn't see wrong data. If the flag Valid Transmission (VT) is set the data is correct.

Fig. 2: Tx and Rx board from the EVAL-xxx-DS kit

Both Linx PCB's has a prototyping area. For the Tx-board I have developed an ADC-board, which is shown in Fig. 3. This board has the following functions/specifications:

- Build up with hardware only
- Single 9Vdc supply
- 5V, 3V3 and V-ref on board power supplies for the input op-amp, sensor supply, Linx board and ADC+logic
- 8 bits resolution; AD7819 [3]
- RC adjustable sample time up to 60s.
- Adjustable ADC V-ref voltage (1.0V…3.0V) resulting in a sensitivity of 3.9mV.. 11.7mV/bit
- Sensor mimicking jumper header for 0x, 0.25x, 0.5x, 0.75x and 1x V-ref (for field commissioning purposes)

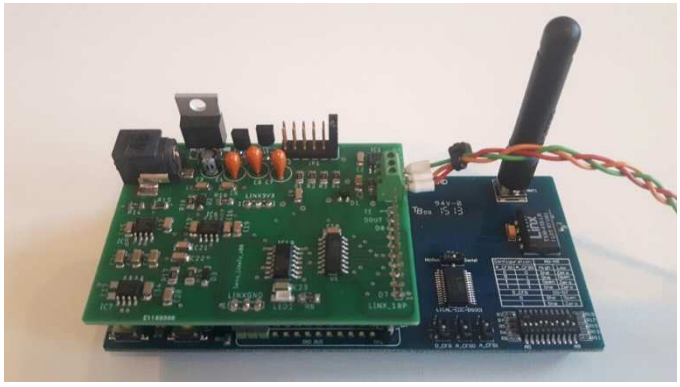

Fig. 3: ADC-board mounted on top of the Linx EVAL Tx-board, here connected with a low budget TMP37 sensor [4] (not shown in picture)

Fig. 4: Linx Rx-board with ribbon cable data connection towards a µController

Results

Fig. 5 shows the typical timing at a sample rate of 5s. The sensor input voltage is here 0.56V, which results in D0..D7=0010.1111. This results, with a V-ref of 3V in 47/256 *3V = 0.55V. The AD conversion is started with a small ~20ms pulse (signal 9). After roughly 100ms the data from the ADC is available (signal D0..7) and a 100ms Transmit Enable (TE) pulse is generated for the Linx board.

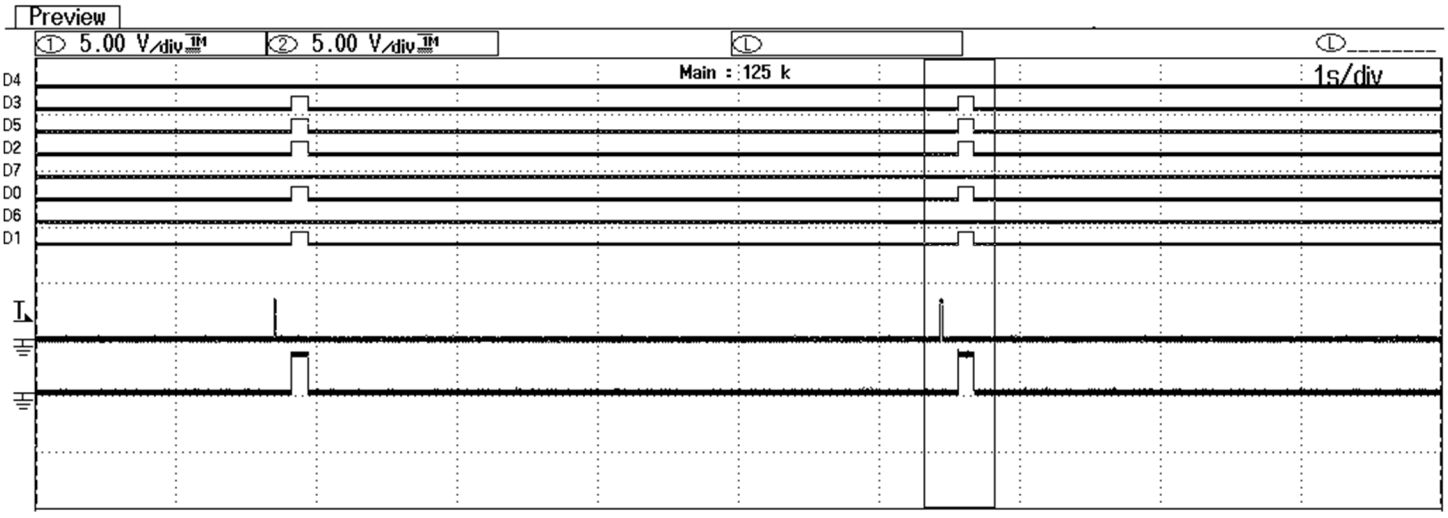

Fig. 5: Typical data output (D0..D7) and ADC timing signals EXT CONVST (ADC start) and TE (Transmit Enable for LInx module)

On the Rx side the valid transmission (VT) signal can be used to read the output data lines (D0..D7). Typical observed delay between the TE and VT pulse is roughly 35ms.

Remarks

The following steps are under consideration for the second version of the RF sensor board:

- To increase the resolution, use a 12 or 16 bits ADC and send the data in two 8 bit packages [5]
- Couple more Tx sensors to one Rx board (use time sharing, e.g. based on a time base from DCF77)
- Addition of a unique hardware header (e.g. 4 bits + 12 data bits) to distinguish these different sensor readings
- To reduce costs place the Encoder and Tx chip directly on the ADC-board
- Equip the design with an on-board track antenna [6]

Questions?

If you are interested in the hardware, schematics, scripts, measurement data over a longer period, or something else, please contact me at mail@bartroodenburg.nl

References

[1]: Linx RF evaluation kit; EVAL-xxx-DS https://linxtechnologies.com/wp/wp-content/uploads/eval-fff-ds.pdf, last visited March 1st, 2020

[2]: ANT-433-CW-RH datasheet ; https://www.linxtechnologies.com/wp/wp-content/uploads/ant-433-cw-rh.pdf, last visited March 1st, 2020

[3]: AD7819 datasheet; https://www.analog.com/media/en/technical-documentation/data-sheets/AD7819.pdf, last visited March 1st, 2020

[4]: TMP37 sensor datasheet; https://www.analog.com/media/en/technical-documentation/data-sheets/TMP35_36_37.pdf, last visited March 1st, 2020

[5]: LTC1282; 12 bits ADC; https://www.analog.com/media/en/technical-documentation/data-sheets/LTC1282.pdf; with multi byte read timing functionality.

[6]: Proper PCB Design for Embedded Antennas; https://linxtechnologies.com/wp/wp-content/uploads/an-00502.pdf, last visited March 1st, 2020