

## Exercise 7: Digital Sensors

### Overview

In the last exercise, you have decoded the DCF77 time signal. For reasons of simplicity, we used sampling to decode the signal. In this lab course exercise, we will analyze a different type of signal with a different digital communication protocol. The protocol we are interested in is called ZACwire™ and our “communication partner” is a TSic™306 temperature sensor. Figure 1 shows an example oscilloscope plot of the signal in question.

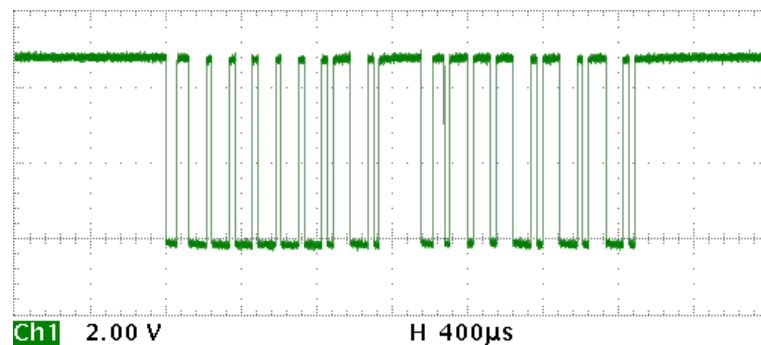


Figure 1: ZACwire™ signal plot

### ZACwire™ Signal Structure

The following files on the lab course file server and on the website are needed for this lab course:

- ZACWire.pdf specifies the ZACwire™ protocol.
- TSic-Datasheet.pdf is the technical documentation of the TSic™ sensor family.

#### Exercise 7.1

Scan through the documents mentioned above and answer the following questions.

- a) What is the ZACwire™ signal being used for?
- b) What is the advantage of sensors with digital communication in contrast to analog value acquisition? Think of the following aspects:
  - Sensor calibration.
  - Sensor networks with a large amount of sensors.
  - Long cables between sensor and microcontroller.

Can you imagine what the downside of this approach is?

- c) How often does the TSic 306 sensor transmit its temperature value? What is the resolution in °C of the sensor? What is the resolution of the value transferred in a ZACwire™ packet (in bits)? What is the possible range of values (in digital values) and their interpretation in °C?
- d) Derive a concrete formula to calculate the temperature value  $T$  in °C from the digital value  $d$  transmitted by TSic 306. Your formula should not include any variables besides  $T$  and  $d$ .

- e) What recommendations does the ZACwire™ specification give on attaching the sensor to a microcontroller? Explain both possible scenarios and their advantages and disadvantages:
- “Always on” scenario as explained in section 1.4.
  - “Power up on request” scenario as presented in section 1.4.2.

## Microcontroller-based Analysis of the ZACwire™ Signal

### Exercise 7.2

- a) Attach the TSic 306 sensor to the microcontroller according to figure 5-2 on page 9 of the TSic data sheet. Please note that our sensors use the e-line package, which means that footnote 1) gives you the correct polarity! In the image on the top, the sensor is seen from the top! Document your pin assignment.
- b) Write a program that analyzes the ZACwire™ signal and displays the current temperature value in the debug console. Follow the guidelines given in the specification, namely first sampling  $T_{\text{strobe}}$  and then sampling the signal at the correct points in time. Do not forget to verify that the parity is correct.
- c) Now change your program to use the “power up on request” configuration as suggested in section 4.1.2 of the ZACwire™ specification. We neglect the RC filter circuit that is suggested in the specification. It is up to you to decide what trigger to use for requesting a new temperature value (e.g., when a button is pressed, every 5s). Document your changes in pin assignment.

**That’s it!**  
**A Merry Christmas and a Happy New Year!**