



Sensor Node for Measuring Internal Temperature of Tree Trunk

1 Sensor

For purpose of measuring temperature in different depths inside a tree trunk, we development a depth thermometer using temperature sensors LM35. The figure shows the design of the proposed device.

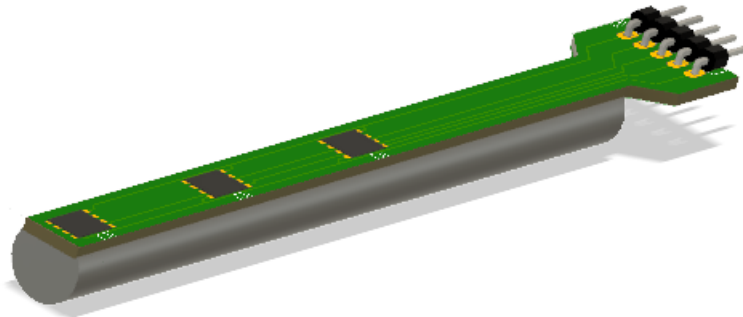


Figure 1: Depth thermometer design

The device consists in a stick shaped printed circuit board of about 120 mm, with 3 temperature sensors welded on the board at 50 mm, 75 mm and 100 mm from the extremity. A support base was designed for a better attachment of the thermometer on the hole in the trunk, this base is made of ABS and it was built on a 3D printer.

The figure below shows the schematic diagram of the circuit.

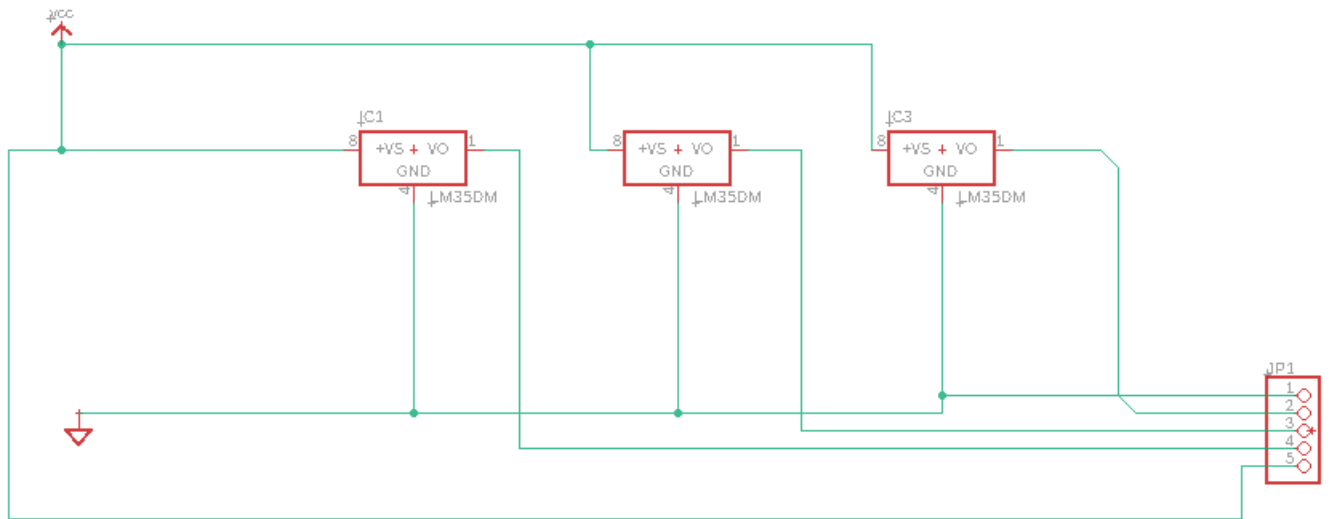


Figure 2: schematic diagram of thermometer circuit

The figure below shows the pinout of the temperature sensor LM35.

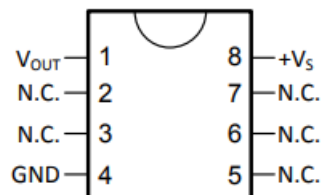


Figure 3: Pinout LM35DM

The figure below shows the pinout of the depth thermometer.



Figure 4: Pinout of depth thermometer

The OUT1, OUT2, OUT3 refer to the voltage output of the LM35 situated at 100 mm, 75 mm and 50 mm from the extremity, respectively.

2 Materials

- Phenolic paper for printed circuit board
- 90 degrees pin header 1x5 pin
- 3 temperature sensors LM35DM
- 2 Xbee Module PRO S2
- 2 Xbee Grove Development Board
- 5 jumper wires female to female

3 Xbee Radio Settings

The Xbee Module is a system for wireless communication based on the Zigbee Protocol. Besides that, the Xbee Module Pro S2 has some peripherals including ADC, PWM and UART. The parameters for transceivers are set in XCTU Software. The figure below shows the XCTU interface.

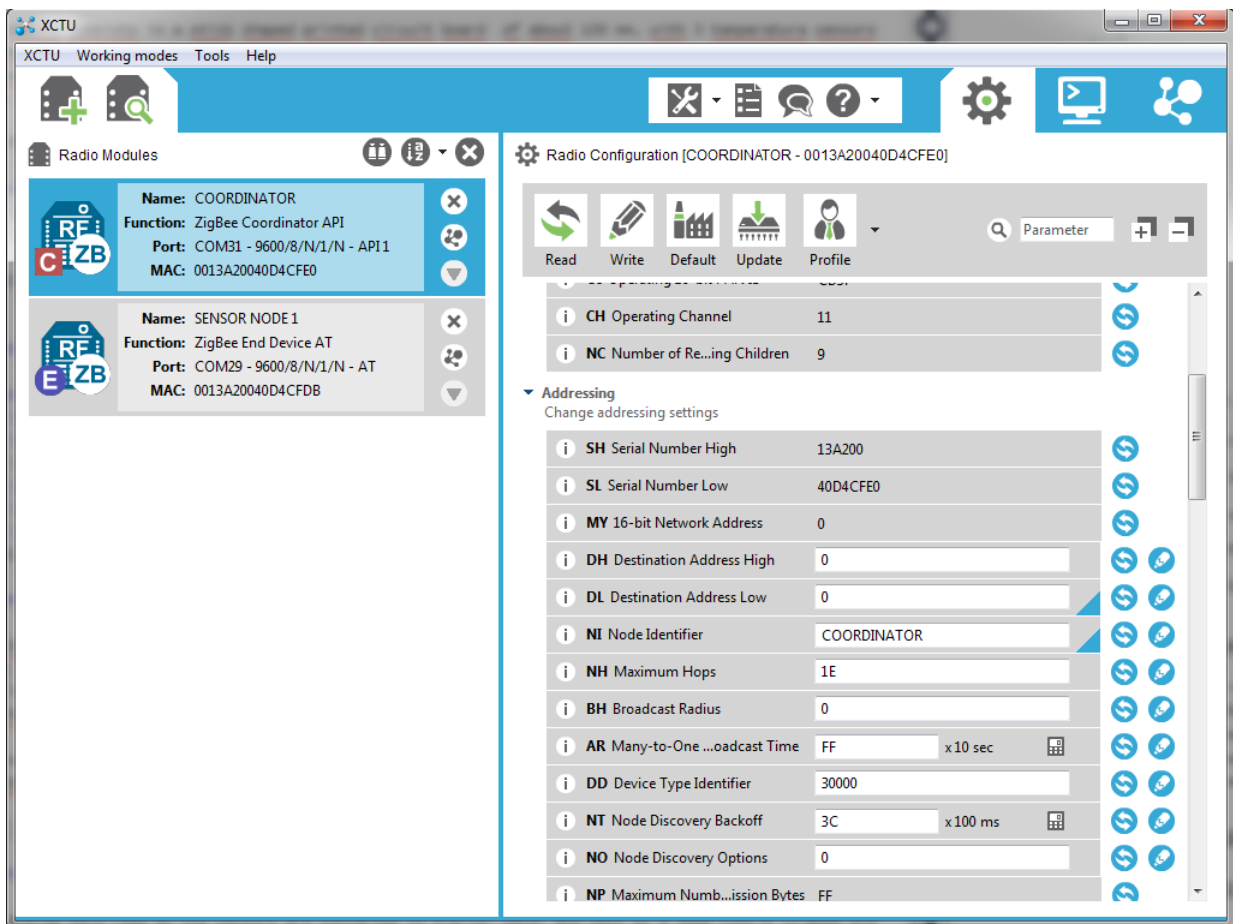


Figure 5: XCTU interface

The Wireless sensor network developed is composed by two nodes, the sensor node and the sink node. The sensor node is configured as Zigbee End Device AT, and the sink node is configured as Zigbee Coordinator API.

4 Data Acquisition System

The analog data read by the sensors are converted to digital data, and sent by a Xbee Module (Zigbee End Device) to other Xbee Module (Zigbee Coordinator) connected to a PC in a laboratory. The received data by the sink node are sent to the computer via serial communication. The digital data are converted to the temperature values using the equation of the sensor, and these values are stored and plotted in real time. All data processing was performed using MATLAB software. The figure shows the flow chart of data processing.

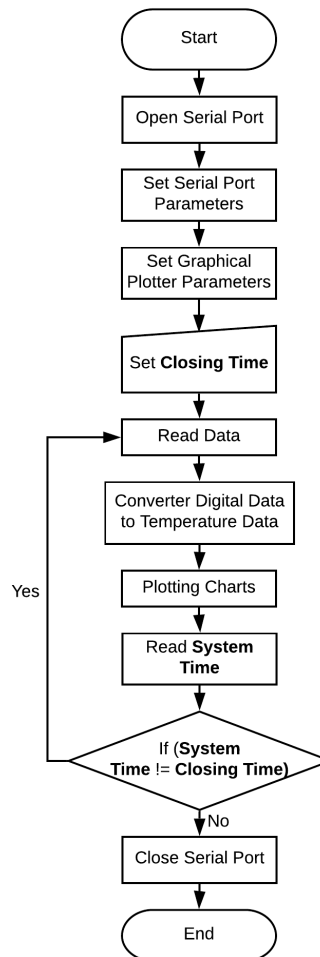


Figure 6: Flow Chart of Data Processing