Microcomputer controlled thermometer

Functioning sample

UNIVERSITY OF PARDUBICE FACULTY OF TRANSPORT ENGINEERING

Functioning sample identification

Name: Microcomputer controlled thermometer
Identification code: TJ04000301-V4
Project No.: TJ04000301
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Technical specifications

The device was created on the basis of specific needs for measuring the rail temperature within the investigation of the project No. TJ04000301 Non-destructive determination of mechanical stress in continuous welded rail supported by a grant from the ZETA programme of the Technological Agency of the Czech Republic.

The device cosists of three hardware modules. A board with the microprocessor of Atmel ATmega328p named as Arduino Uno R3 328P DIL, whose software content was made and debugged in the Arduino IDE 1.8.13, carries the principal function in the modules. The board itself is not endowed with required peripherals for environmental units measurements, data storing and control of other devices, therefore, additional extension modules were used. The real time module of DS3231 maintains the non-stop operation of the system clock regardless of charging of the module. The LIR 2032 segment of 3 V voltage keeps the data backups. The module contains an EEPROM AT24C32 and a thermally compensated crystal oscillator TCXO, too. Using of these features results in high accuracy of time measurement within a wide scope of temperatures. Data storing is provided by a micro SD card module of the current capacity of 16 GB. A temperature probe with high requirements on endurance and accuracy is the crucial component. The probe of Dallas DS18B20 using a 1-wire bus for the communication with the microprocessor fulfils the required parameters. The particular modules and the probe use the power supply of 5 V, which is kept and further distributed by an installed 5 V stabilizer of the Arduino UNO board. Connecion of modules is performed by Dupont conductors in connection with a ZY-170W breadboard. Charging of the device is realised by two Li-ion Samsung ICR18650-26H batteries with capacity of 2.6 Ah connected in series together with a BMS HX-2S-JH10 battery system. In connection with field deployment of the devices and assumption of long operation periods without service intervention, electrical energy consumption represents an essential topic. Currently, the device shows a consumption level up to 64 mA, which requires a significantly large energy storage in the case of a field installation and non-stop operation. Further development steps shall focus on lowering the device energy consumption to a minimum level.

Economical parameters

The presented device is primarily aimed for rail temperature measurement in exposed locations of railway lines in the Czech Republic, whose count is not known beforehand. It is not feasible to perform such measurements by human workers in the case of larger number of measuring points. This clearly leads to the necessity to automatize the process of data storing. These impetus led to the creation of the functioning sample for the task of an autonomous rail temperature measurement where the data transfer is executed only on a periodical basis. The device makes use of easily available hardware components, total price of which not exceeding 1000 CZK, and all over it forms economically a very attracting solution in relation to the functionality and saved time of potential physical field measurements. The advantage of microprocessor solutions for small-series or series productions resides in an one-time software development that will only be copied to the other products. Production costs of other devices are given by the hardware price and a share of the software price, which is gradually on the decrease.

Description

The thermometer is designed for a long-term rail temperature measurement in selected railway line sections. The measurement is being performed every full hour based on information from the RTC DS3231 module. After each measurement, the value is saved along with the time and date stamp into a text file into the micro SD card using the SD module. Subsequently, the microprocessor waits for the time of the further measurement.

Figures

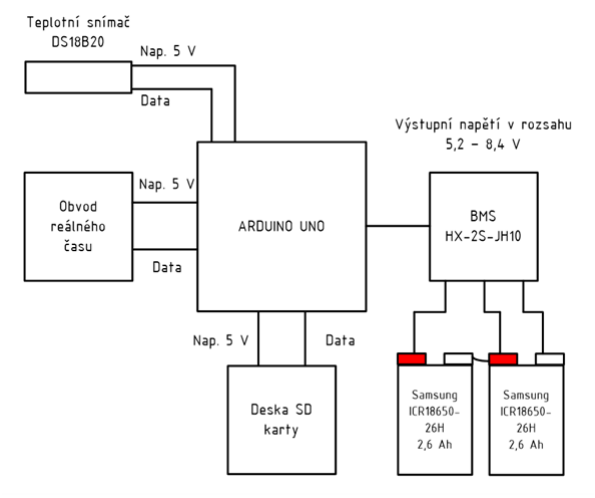

Figure 1: System block diagram.

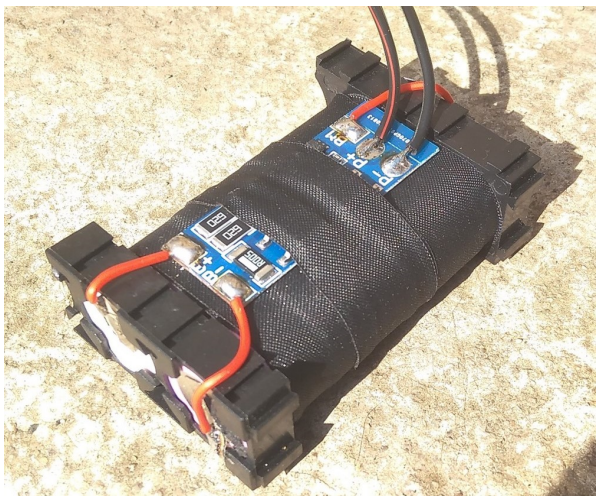

Figure 2: Li-ion battery.

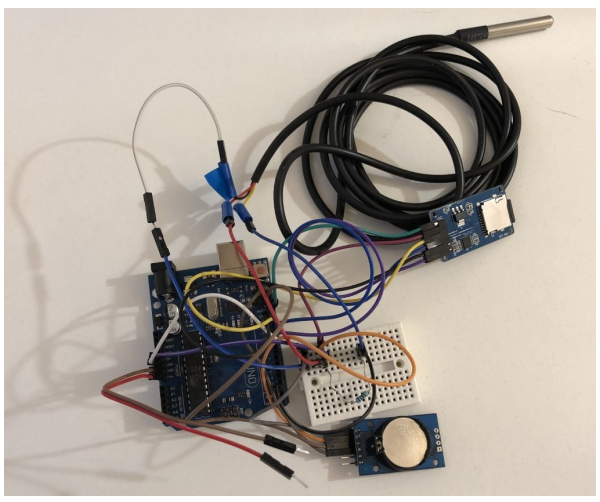

Figure 3: Complete system connection.

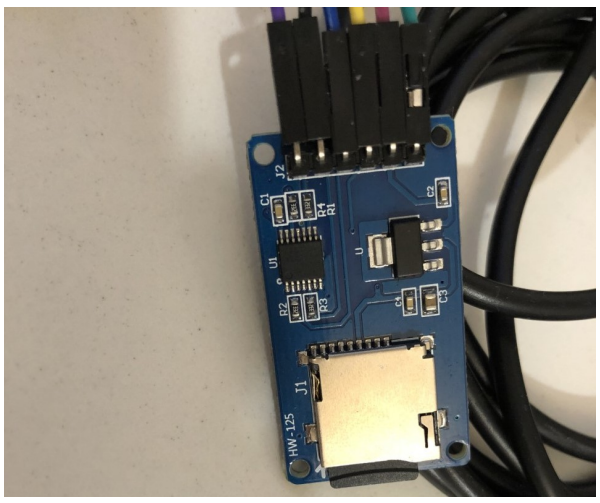

Figure 4: SD card module.