Feasibility of Temperature Sensors in Railway Coaches

Vishal Sharma

***Abstract*— This project is useful in case of fire in railway coaches, where on line monitoring of current temperature conditions is performed and at the same instance effective possible remedies can be taken. It introduces the user to the simplest possible software solution for basic 1-WireTM communication between a microcontroller and any number of DS18x20 or DS1822 temperature sensors and provides a simple and low cost solution to automatically monitor temperature inside railway coaches and thus provide an alarm in case the temperature exceeds the acceptable values which can set by the user.**

***Index Terms*— 1-Wire digital temperature sensor, Thermostatic controls, Convert T, EEPROM, Memory Commands**

I. Introduction

Now a days fire in railway coaches is a major problem for railway department. Till now there is no effective and low cost software based solution to overcome this problem. Previously there are some techniques to measure humidity, light and temperature in some mechanical devices like rotor, motor and in automobiles. Using Embedded Technology some effective and online safety solution is possible and this paper is one of them.

This work provides a simple and low cost solution to automatically monitor temperature inside railway coaches and thus provide an alarm in case the temperature exceeds the acceptable values which can set by the user. Different temperature sensors can be deployed at various critical places and can be monitored by a single microcontroller.

II. Hardware Design:

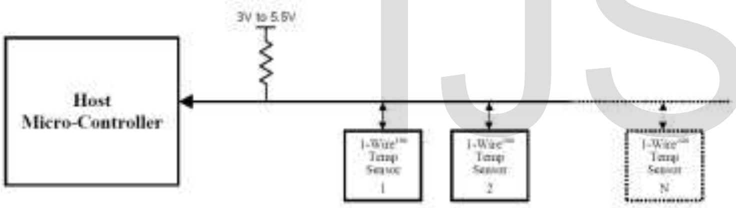

Fig 1: Host Microcontroller interface

In hardware design Host Microcontroller used is 8051 and Digital temperature sensor is DS1820 powered by USB. As from Fig 1 using 1-Wire communication we can use more than one temperature sensor but for testing purpose only 1 temperature sensor is used here.

A. 1-Wire Digital Temperature Sensor Characteristics

- 1-wire interface requires only one port pin for communication.
- Each device has a unique 64-bit serial code stored in ROM
- Distributed temperature sensing applications
- Requires no external components
- Can be powered from data line. Power supply range is 3.0V to 5.5V
- Measures temperatures from –55°C to +125°C (–67°F to +257°F)
- ± 0.5°C accuracy from –10°C to +85°C
- 9-bit resolution
- Converts temperature in 750 ms (max.)
- User-definable non-volatile alarm settings
- Alarm search command (temperature alarm condition)
- Applications include thermostatic controls, industrial systems, consumer products, thermometers, or any thermally sensitive system.

B. Microcontroller 8051

- 8-bit ALU, Accumulator and 8-bit Registers; hence it is an 8- bit microcontroller
- 8-bit data bus – It can access 8 bits of data in one operation
- 16-bit address bus – It can access 216 memory locations – 64 KB (65536 locations) each of RAM and ROM
- On-chip RAM – 128 bytes (data memory)
- On-chip ROM – 4 kByte (program memory)
- Four byte bi-directional input/output port
- UART (serial port)
- Two 16-bit Counter/timers
- Two-level interrupt priority
- Power saving mode (on some derivatives)

III.Software Design

For compilation, 8051 C compiler is used. The supporting algorithm used is described below.

Algorithm:
The algorithms used for 1-Wire communication between the Host microcontroller and number of sensors are shown in Figure 2.

Communication between host microcontroller and number of sensors is shown in Fig 1. The temperature sensor output has 9 bit resolution, which corresponds to 0.5° C. The temperature data is stored as a 16 bit sign extended 2's compliment number in the temperature register, for positive numbers S=0 and for negative numbers S=1 Important commands used are as follows

A. CONVERT T [44h]: To initiate the temperature measurement and A-to-D conversion the master must issue a convert T [44h]

- Vishal Sharma is currently pursuing PhD in Quantum Cryptography and Coding from IIT Jodhpur, India, Mob. +919462101242
  Email: bits.vishal12@gmail.com

command. Following the conversion, the resulting thermal data is stored in the 2 byte temperature register in the scratchpad memory and the DS18S20 returns to its ideal state.

B. *READ SCRATCHPAD [BEh]:* This command allows the master to read the contents of the scratchpad. The data transfer starts with the least significant bit of byte 0 and continues through the

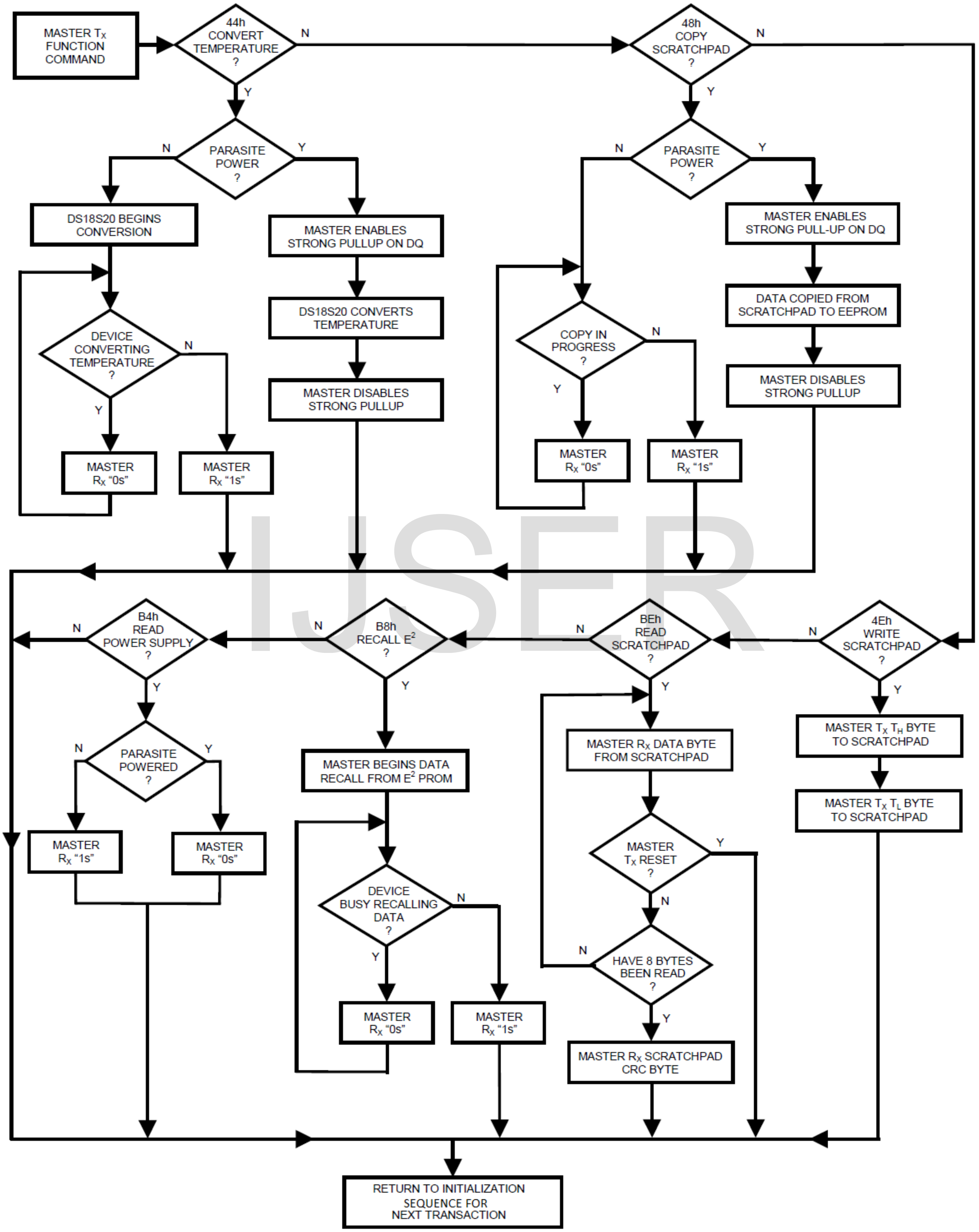

Fig 2: DS18S20 Function commands flow chart

scratchpad until the 9th byte (byte 8 – CRC) is read. The master may issue a reset to terminate reading at any time if only part of the scratchpad data is needed.

C. SKIP ROM [CCh]: The master can use this command to address all devices on the bus simultaneously without sending out any ROM code information. For example, the master can make all DS18S20s on the bus perform simultaneous temperature conversions by issuing a Skip ROM command followed by a Convert T [44h] command. Note, however, that the Skip ROM command can only be followed by the Read Scratchpad [BEh] command when there is one slave on the bus. This sequence saves time by allowing the master to read from the device without sending its 64–bit ROM code. This sequence will cause a data collision on the bus if there is more than one slave since multiple devices will attempt to transmit data simultaneously.

V. Simulation and Results

For simulation purpose Proteus simulator is used and also Successful implementation of 1-Wire Digital temperature sensor and 8051 Microcontroller Development board is achieved.

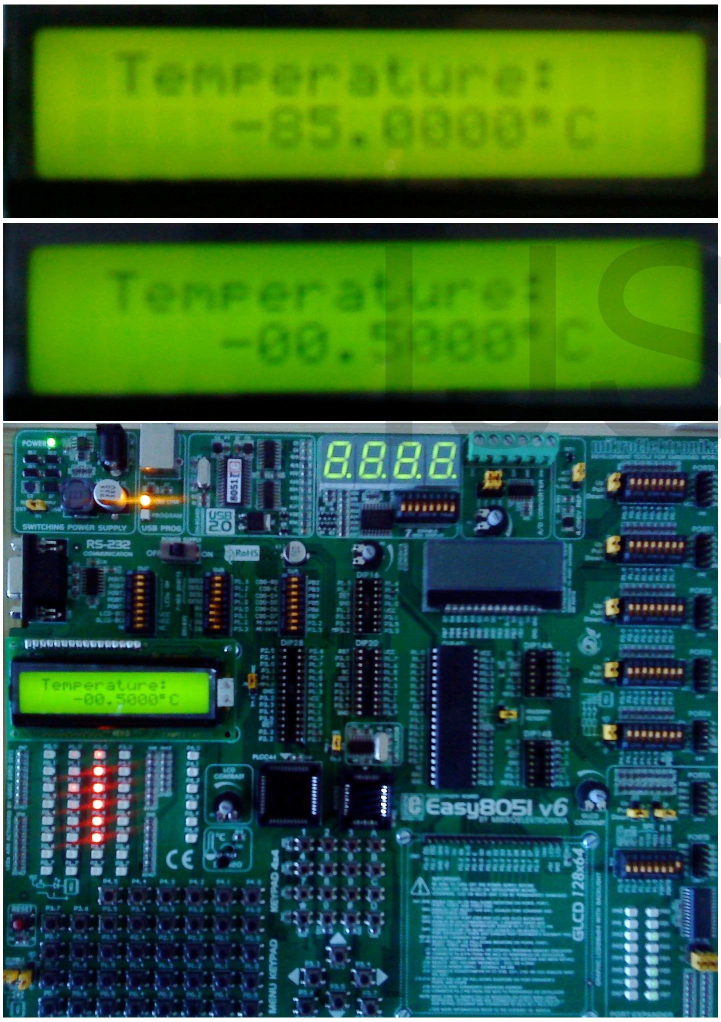

Fig 3: 8051 Microcontroller Developement Board and Temperature outputs

Temperature readings are in 9 bit resolution with ±0.5° C accuracy from -10° to +85° C. The resultant temperature readings are from -55° C to +125° C (-67° F to +257° F) (Fig 3 shows the 8051 Microcontroller Developement Board and Temperature outputs and Fig 4 shows Proteus Simulation results including Alarm condition)

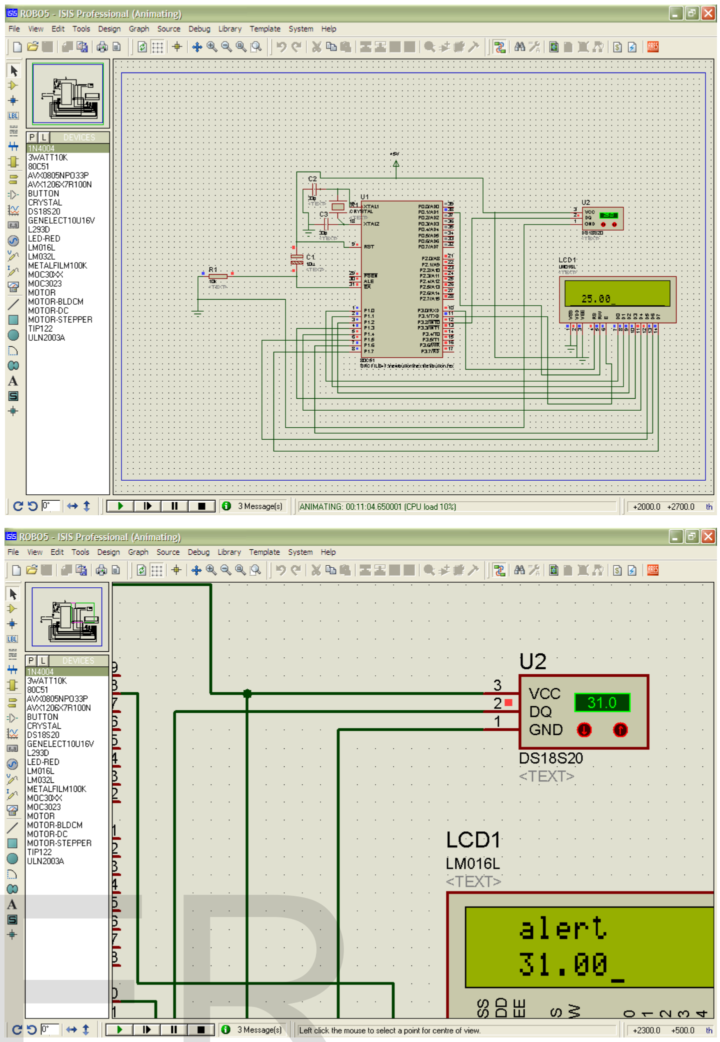

Fig 4: Proteus Simulation results including Alarm condition

VI. Conclusion

The temperature sensor DS18S20 has the ability to operate without an external power using parasitic power supply and alarm signaling is one of the simple and effective approaches without much cost. Data in EEPROM registers is retained when the device is powered down, at power-up the EEPROM data is reloaded into the corresponding scratchpad locations and reverse action is also possible.

Applications that can also benefit from this project are HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

Above 100°C, use of parasite power is not effective, because DS18S20 may not be able to sustain communications due to the higher leakage currents that can exist at these temperatures, so in these conditions this temperature sensor must be powered by an external power supply.

Actual practical implementation can be achieved by placing these temperature sensors (covered by proper insulating materials of high temperature withstand capability) at various nodes of grids of a particular railway coach (Dimension of a Coach is divided into number of grids).

V. References

(1) http://www.maxim-ic.com/

(2) "Interfacing the DS18x20/DS1822 1-Wire Temperature Sensor in a Micro- Controller Environment", Application Note 162, Dallas Semiconductor MAXIM.

(3) "DS18S20, High-Precision 1-Wire Digital Temperature sensor", Dallas Semiconductor, MAXIM.

(4) "The 8051 Microcontroller and Embedded Systems", Second Edition, by Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay.

(5) WAYNE WOLF, "Computers as components : Principles of Embedded computer system design "

(6) Raj Kamal, "Embedded Systems : Architecture, Programming and Design".