ELSEVIER

Low-cost Radiation Sensor Network

Sawaiz Syed and Xiaochun He

Department of Physics and Astronomy, Georgia State University, Atlanta, GA 30303

Abstract

A novel radiation sensor network has been developed for monitoring radioactive events in real-time. The sensor nodes consists of low-cost Geiger tubes which are read out using AVR microcontroller with a 2.4 GHz wireless interface. The receiver node is implemented with a Raspberry PI which provides the database interface and the network with other servers.

Keywords: Keyword1, Keyword2, Keyword3

1. Introduction

2. Sensor Node Design and Implementation

A sensor node consists of a radiation sensor (i.e. Geiger tube), a power supply unit and readout circuit, a microcontroller and a wireless transceiver as shown in Figure 1. The microcontroller is a 8-bit RISC-based AVR (ATtiny2313) made by Atmel and is programed in C for controlling Geiger tube high voltage, signal readout and wireless communication.

In the current design, we pick a Geiger tube (SBM-20) made by VNIITFA company in Russia. The stainless steel Geiger tube is filled with a mixture of $Ne + Br_2 + Ar$ gases and has a dimension of 108 mm in length and 11 mm in diameter. Its operating high voltage is 350 - 475 volts (the recommended voltage is 400 volts). The tube life is about at least 2×10^{10} pulses and has a dead time of 190 μs. The Geiger tube high voltage power supply is deigned as a DC-to-DC boost converter as shown in Figure 2 for reducing both the cost and physical dimensions. The high voltage output can be program with the onboard microcontroller (ATtiny2313).

3. Receiver Node Design and Implementation

The receiver node consists of the same wireless transceiver and a host computer (i.e., Raspberry PI).

4. Sensor Network Integration
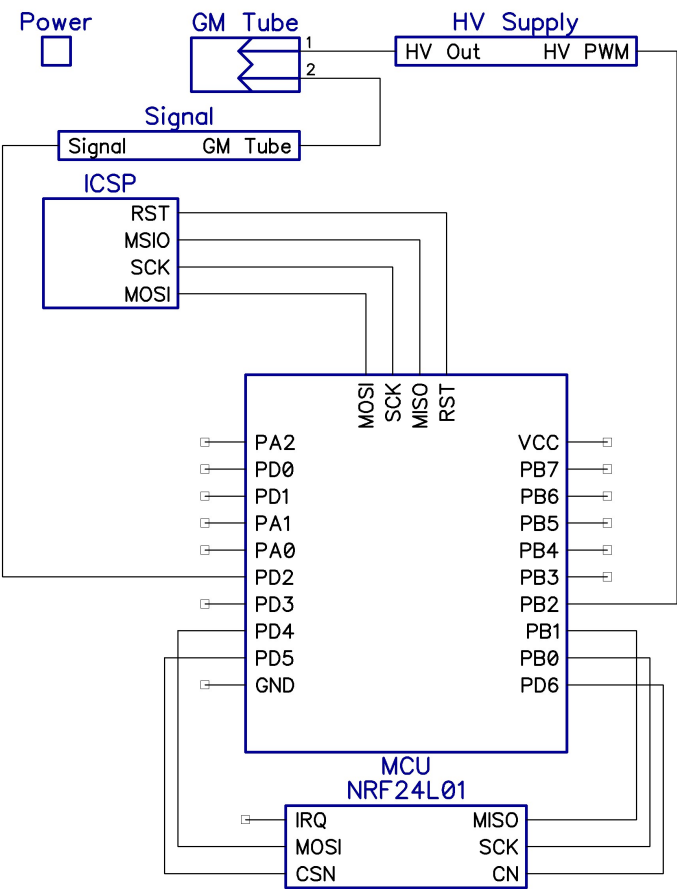
5. Results and Summary

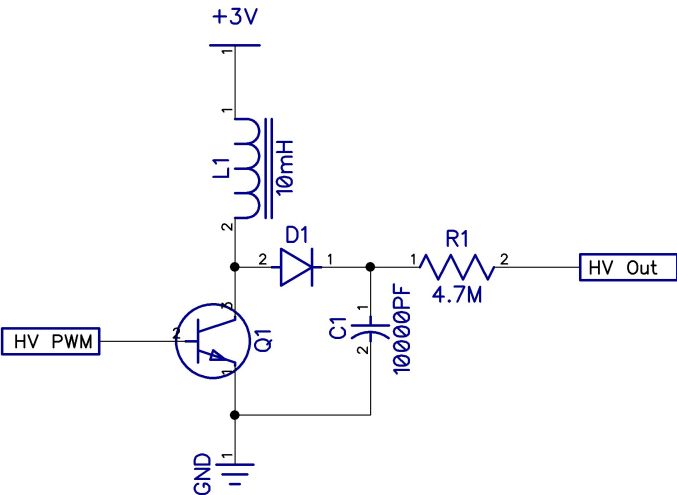Figure 1. Sensor node assembly

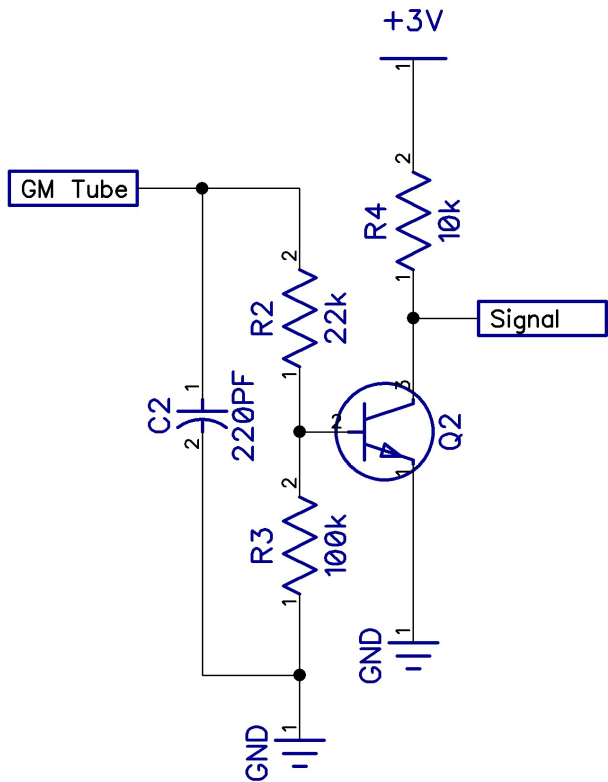Figure 2. High voltage power supply circuit design for the Geiger tube.

Figure 3. Digital signal output

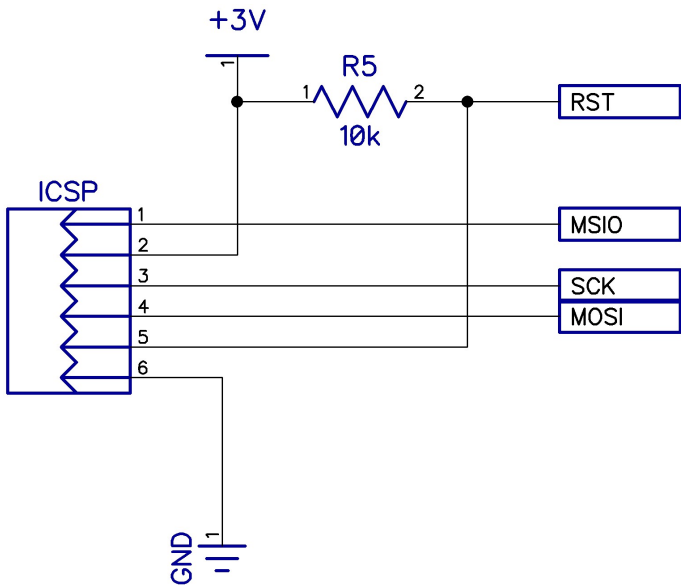Figure 4. Header

+3V

IRQ ———— 8
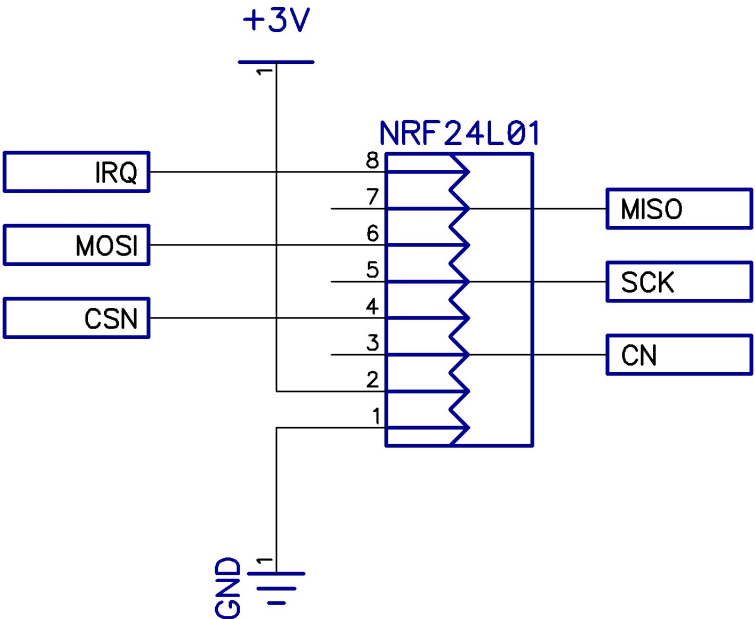   7 ———— MISO
MOSI ———— 6
          5 ———— SCK
CSN ———— 4
          3 ———— CN
          2
          1

NRF24L01

GND

Figure 5. Wireless module interface circuit.

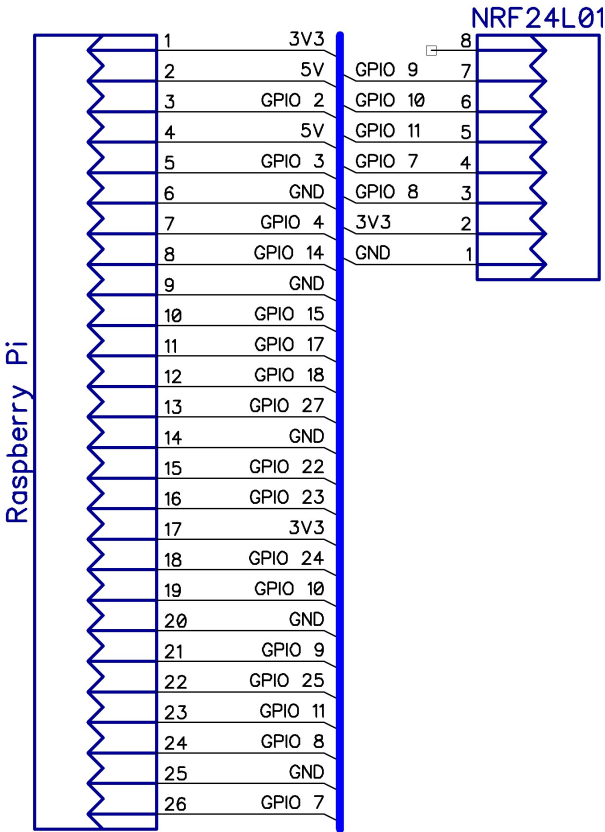|		NRF24L01	
1	3V3	8	
2	5V	GPIO 9	7
3	GPIO 2	GPIO 10	6
4	5V	GPIO 11	5
5	GPIO 3	GPIO 7	4
6	GND	GPIO 8	3
7	GPIO 4	3V3	2
8	GPIO 14	GND	1
9	GND		
10	GPIO 15		
11	GPIO 17		
12	GPIO 18		
13	GPIO 27		
14	GND		
15	GPIO 22		
16	GPIO 23		
17	3V3		
18	GPIO 24		
19	GPIO 10		
20	GND		
21	GPIO 9		
22	GPIO 25		
23	GPIO 11		
24	GPIO 8		
25	GND		
26	GPIO 7		

Raspberry Pi

Figure 6. Wireless module interface with Raspberry PI.

4

References

[1] J. van der Geer, J.A.J. Hanraads, R.A. Lupton, J. Sci. Commun. 163 (2000) 5159.
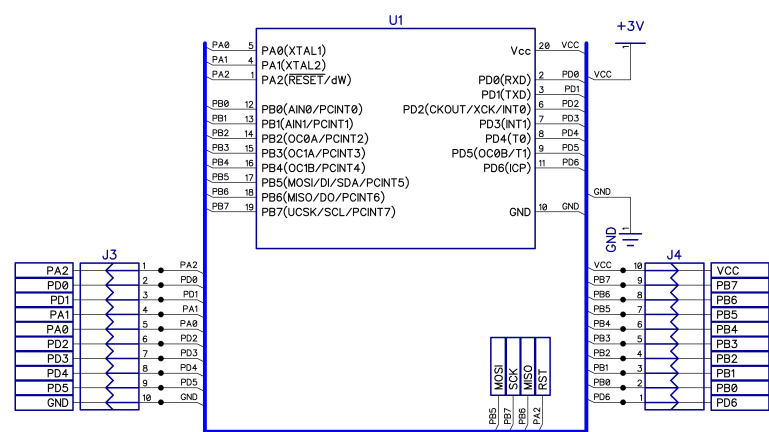[2] W. Strunk Jr., E.B. White, The Elements of Style, third ed., Macmillan, New York, 1979.

Figure .7. Atmel Microcontroller of the sensor node.

Schematic Diagrams