

Applicaton of USB Serial Communication to Radon Measuring System

Chung-Hyuk Yim¹

¹Dept. of Mechanical System Design Eng.,
Seoul National Univ. of Science & Technology,
Seoul, Korea

¹*chyim@seoultech.ac.kr*

Tae-Gue Oh², Gyu-Sik Kim^{3*}

^{2,3}Dept. of Electrical and Computer Eng.,
University of Seoul
Seoul, Korea

²*otg0831@gmail.com*, ³*gskim318@uos.ac.kr*

* Corresponding author : Gyu-Sik Kim

Abstract— The USB serial communication such as USB-Serial-for PC and USB-Serial-for-Android is studied in order to monitor the measure radon data using a PC screen or a smart phone screen. Through some experimental studies, we believe that the USB serial communication module is useful for checking the data transmitted to a PC from a microcontroller.

Keywords-USB; serial communication; Android;PC;radon measuring

I. INTRODUCTION

Radon is a natural, inert, invisible, odorless, chemically inactive, and radioactive gas emitted by the earth. It is produced by the decay of uranium ore, such as radium, actinium, or thorium. There are many commercial instruments and techniques available for measuring radon indoors. In [1], the system is developed which monitors the radon level, using a PIN diode for detecting the radon particles and a data processing module with Wi-Fi communication capabilities for the transmission and management of measurement results. In [2], a radon counter using PIN photodiode radon sensor module was implemented. Through experimental studies, they found that the PIN photodiode sensor module could be used for a radon counter implementation. There is also much research regarding the measurement of radon concentration in soil gas, water, and indoor air. In [3], results are presented of a preliminary study of radon concentration in soil gas. For the study, AlphaGuard equipment was used to obtain samples from 64 locations within 13 urban areas in Bulgaria from 2008 to 2012.

For our experiments, we used a radon measuring system with USB serial communication. This radon measuring system was used to measure the radon concentration of indoor air in houses and workplaces.

II. RADON MEASURING SYSTEM

A radon measuring system was implemented using Arduino MCU, LCD display, PIN photodiode, plastic chamber, and low-cost ICs (Figure 1). There are a LCD module, Arduino MCU and PIN photodiode, a plastic chamber attached to PCB.

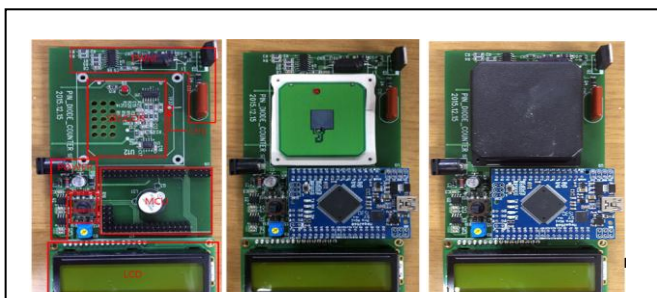


Figure 1. Implemented radon measuring system.

III. USB SERIAL COMMUNICATION

A bidirectional wire communication module was developed in order to download the measure radon data from the radon measuring system to PC. In this paper, a USB-UART serial communication method was chosen.

A. USB-Serial-for-PC

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started [4, 5, 6, 7].

The schematic diagram of the USB communication between a PC-USB converter and a MCU board is shown in Figure 2. The spec. of the microcontroller Atmega16U2 which is used for PC-USB conversion module is shown in Figure 3. For connecting to PC using USB cable, it is connected to COM port of PC through “USB to UART bridge” as Figure 4. The USB to UART Schematic diagram is shown in Figure 5.

B. USB- Serial-for -Andriod

This is the case when a smart phone is used instead of a PC. The advantage of this approach is that the PC to USB module can be developed using OTG cable and Android App. Figure 6 and Figure 7 show an Android App program and a test for Android connection, respectively.

IV. DATA TRANSMISSION TEST

Figure 8 shows that the data of main system are transmitted to a PC via USB cable and they are output on the serial monitor window. When the serial monitor window is executed on a PC and the data transmission menu of a system is run, all of the data of a system memory such as measuring time, measured radon concentration value are checked to be output on the serial monitor screen of a PC.

V. CONCLUSION

A radon measuring system was implemented using a PIN photodiode. The USB serial communication such as USB-Serial-for PC and USB-Serial-for-Android were studied in order to monitor the measure radon data using a PC screen or a

smart phone screen. Through some experimental studies, we believe that the USB serial communication module is useful for checking the data transmitted to a PC from a microcontroller.

ACKNOWLEDGMENT

This work was supported by the Korea Ministry of Environment (MOE) as “the Environmental Health Action Program.” This work was also supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2016011249).

REFERENCES

- [1] S. Folea, M. Hulea, G.Mois, V. Cosma, “Wi-Fi portable solution for distributed radon measurements,” Rom. Journ. Phys., vol.58, pp.S126-s139, 2013.
- [2] Gyu-Sik Kim, Tae-Gue Oh and Jae-Hak Kim, “Implementation of a PIN photodiode radon counter,” Global Journal of Engineering Science and Researches, vol.3, no.1, pp.58-63, Jan., 2016.
- [3] Bistra Kunovska, Kremena Ivanova, Zdenka Stojanovska, Daniel Vuchkov, and Nadia Zaneva, “Measurements of radon concentration in soil gas of urban areas, Bulgaria,” Rom. Journ. Phys., vol.58, Supplement, pp.s172-s179, 2013.
- [4] <https://www.arduino.cc/en/main/arduinoBoardUno>.
- [5] <https://www.arduino.cc/en/reference/serial>
- [6] <https://startingelectronics.org/beginners/start-electronics-now/tut9-using-the-arduino-serial-port/>
- [7] <https://rheingoldheavy.com/arduino-from-scratch-part-8-atmega16u2-subsystem/>

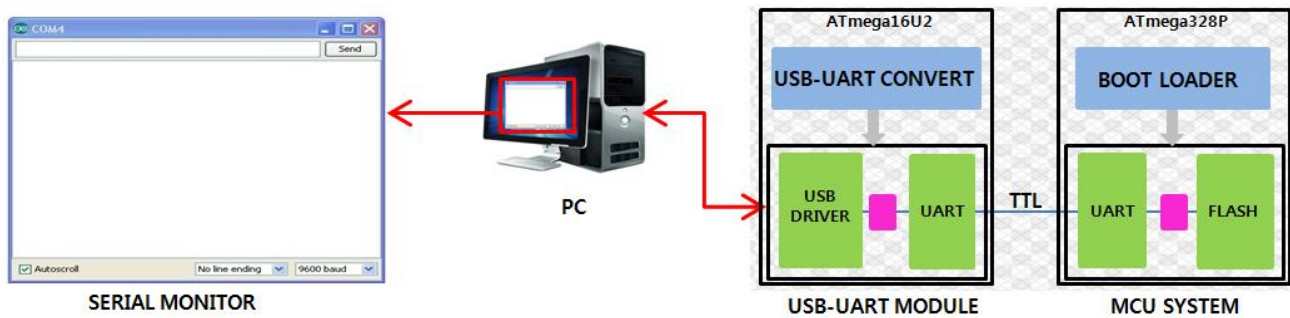


Figure 2. USB-Serial-for PC Communication

ATmega16U2 Features

- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
 - 125 Powerful Instructions
 - Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers – Fully Static Operation
 - Up to 16 MIPS Throughput at 16 MHz
- Non-volatile Program and Data Memories
 - 8K/16K/32K Bytes of In-System Self-Programmable Flash
 - 512/512/1024 EEPROM – 512/512/1024 Internal SRAM
 - Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM
 - Data retention: 20 years at 85 °C/ 100 years at 25°C
 - Optional Boot Code Section with Independent Lock Bits
 - In-System Programming by on-chip Boot Program hardware-activated after reset True Read-While-Write Operation
 - Programming Lock for Software Security
- USB 2.0 Full-speed Device Module with Interrupt on Transfer Completion
 - Complies fully with Universal Serial Bus Specification REV 2.0
 - 48 MHz PLL for Full-speed Bus Operation : data transfer rates at 12 Mbit/s
 - Fully independant 176 bytes USB DPRAM for endpoint memory allocation
 - Endpoint 0 for Control Transfers: from 8 up to 64-bytes
 - 4 Programmable Endpoints:
 - IN or Out Directions Bulk, Interrupt and IsochronousTransfers Programmable maximum packet size from 8 to 64 bytes Programmable single or double buffer
 - Suspend/Resume Interrupts
 - Microcontroller reset on USB Bus Reset without detach
- Peripheral Features
 - USB Bus Disconnection on Microcontroller Request
 - One 8-bit Timer/Counters with Separate Prescaler and Compare Mode (two 8-bit PWM channels)
 - One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Mode (three 8-bit PWM channels)
 - USART with SPI master only mode and hardware flow control (RTS/CTS)
 - Master/Slave SPI Serial Interface
 - Programmable Watchdog Timer with Separate On-chip Oscillator
 - On-chip Analog Comparator – Interrupt and Wake-up on Pin Change
- On Chip Debug Interface (debugWIRE)
- Special Microcontroller Features – Power-On Reset and Programmable Brown-out Detection
 - Internal Calibrated Oscillator
 - External and Internal Interrupt Sources
 - Five Sleep Modes: Idle, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
 - 22 Programmable I/O Lines – QFN32 (5x5mm) / TQFP32 packages
 - Operating Voltages
 - 2.7 - 5.5V
 - Operating temperature
 - Industrial (-40°C to +85°C)
 - Maximum Frequency
 - 8 MHz at 2.7V - Industrial range
 - 16 MHz at 4.5V - Industrial range

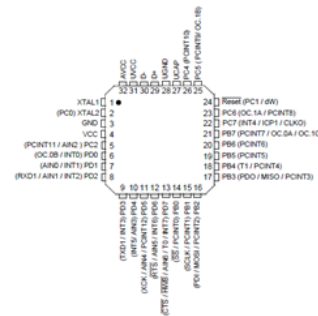


Figure 3. The spec. of the microcontroller Atmega16U2

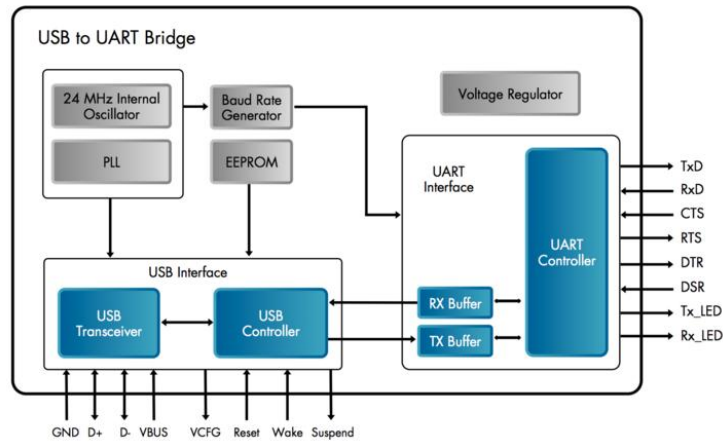
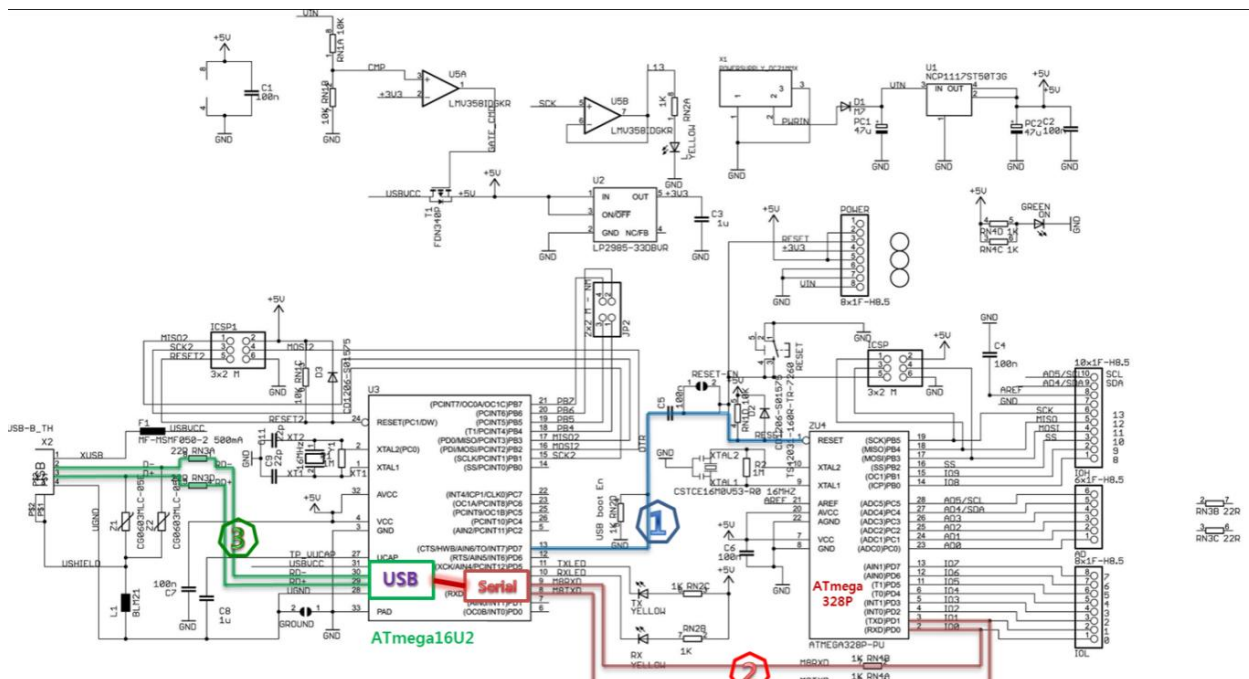


Figure 4. USB to UART bridge diagram



1번:리셋 신호, 2번:UART(TTL레벨) 통신, 3번:USB 호스트 통신.

Figure 5. USB to UART schematic diagram

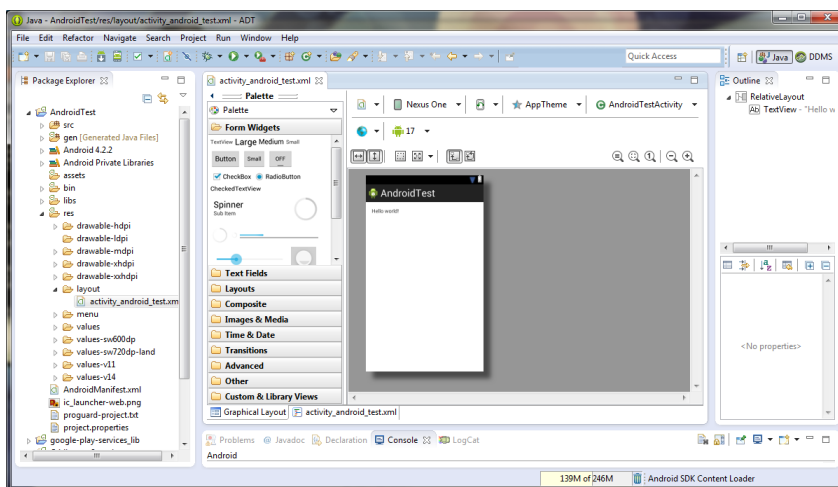


Figure 6. Android App program

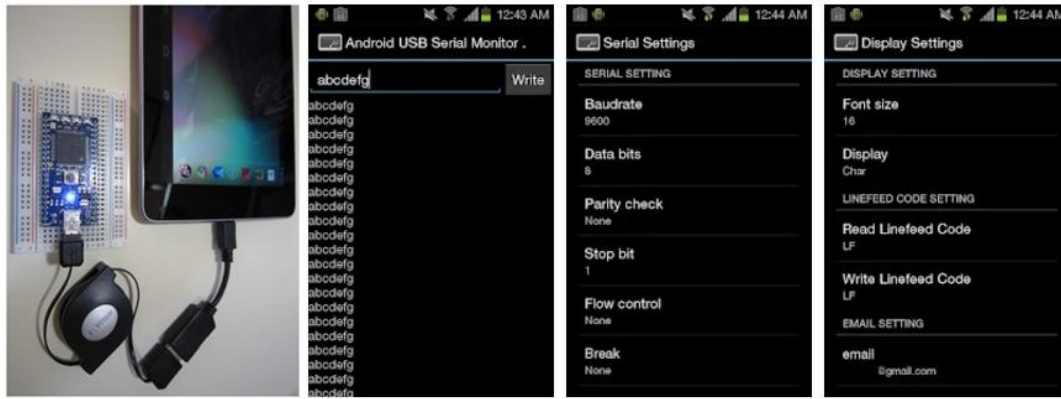


Figure 7. Test for Android connection

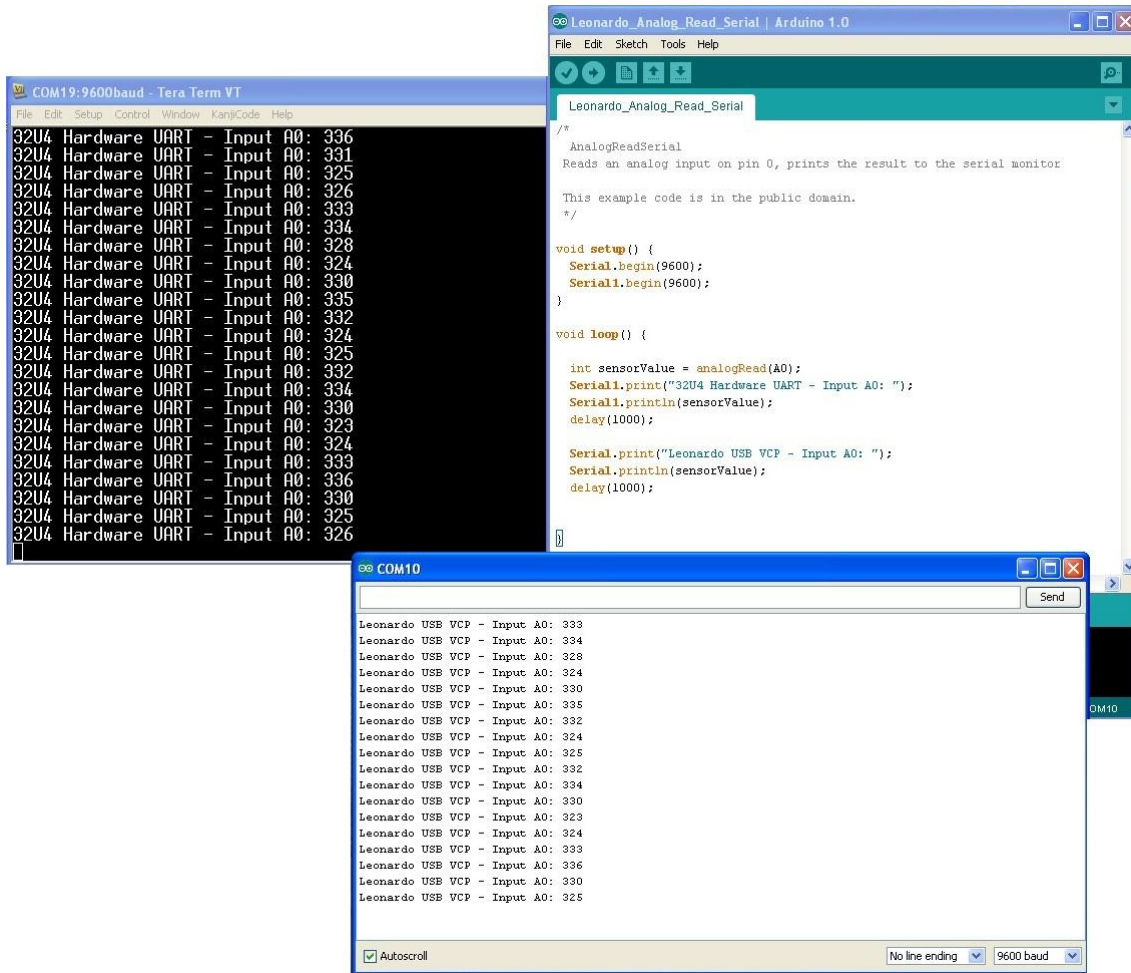


Figure 8. Data transmission test for wire communication