

Patient Medication Reminder Circuit Using ATMEGA328/P Microcontroller: Design and Implementation

Ibrahim Adabara

Department of Electrical and Computer Engineering, Kampala International University, Uganda. Email: adabara360@gmail.com

Article Received: 30 October 2017	Article Accepted: 31 December 2017	Article Published: 17 March 2018

ABSTRACT

This project patient medication reminder is a system which helps in medication administration and monitoring. This system consists of an ATMEGA328P microcontroller with an inbuilt EEPROM and a real-time circuit. This system is driven by an embedded program that inputs predefined parameters which are processed based on the input variables entered via a user interface device such as the keypad. All the entries made on the keypad are concurrently and simultaneously displayed on the LCD panel of the device. The logic for the processing is built into the embedded program to initiate the alert through an audio alarm. Not only does it have an alarm system, but also an LCD which displays the medicine to be taken at the reminder time.

Keywords: 7085 Voltage regulators, Atmega328/P, Crystal oscillator, Buzzer, Keypad, LCD screen, Power Supply Unit and Resistor.

1. INTRODUCTION

The motivating force behind this design is based on the desire to alleviate the problem faced by the aged and physically challenged people in trying to monitor patients in hospitals or at home. It also takes into consideration the disabled or aged people that may have problems to remind themselves of the time and the medicine to be taken. A substantial number of patients, particularly the handicapped and the elderly do not follow instructions in taking medication. This can result in a patient failing to take medication, taking the wrong medication, taking an incorrect amount of medication, or taking the medication at a wrong time, leading to either a drug overdose or an ineffective application of medication to the patient. The elderly are especially prone to problems since they often take several medications and have failing memories. Caretakers such as nurses also need to be reminded on occasion that a patient needs to take a particular medication at a predetermined time(Rita M. Agans, 1992). There is a recognized need for providing medicines on a regularized basis with timed notice to the person requiring them.

Patient medication reminder is useful to all patients. Nowadays, patient monitoring is a critical task. The physician has to monitor the patient's health continuously, and the prescribed medicine has to be given from time to time. There are instances when patients remember to take medicines at the stipulated time but forget which pill has to be taken. The task is to design, a patient medication reminder circuit system that records the time and the name of the medicine to be taken by patients at a correct time. The time and medicine names are changed according to the patients' need through the keypad connected.

By using the keypad, the prescribed timings can be entered, at which the patients have to take medicine. The list of medicines has to be taken by the patient at the prescribed time which is displayed on Character Liquid Crystal Display. So thus the status of the patients can be easily monitored by the physicians(Park, KeeHyun & Lim, 2012).



2. EXISTING SYSTEMS



Fig 1. Medication Reminder and Healthcare: System Overview

Figure 1 reflects the overview of the app. The input to the system is the information entered by the patient which includes date, time, medicine name, doctor's name, etc. The output of the system focuses on "Medication Adherence." Medication adherence usually refers to whether patients(Rita M. Agans, 1992) take their medications as prescribed (e.g., twice daily), as well as whether they continue to take a prescribed medication. Medication nonadherence is a growing concern to clinicians, healthcare systems, and other stakeholders because of mounting evidence that it is prevalent and associated with adverse outcomes and higher costs of care

3. MATERIALS AND METHODS

Block Diagram of the System



Fig 2. Show block diagram of the system

Components Description

Power Supply Unit (Transformer)

The power will be derived from AC mains and transformer to provide an isolated voltage of 12V AC up to about 100mA. A 12V AC supply was bridge-rectified by a rectifier and smoothed by a capacitor producing a DC supply of about 5V.



ATmega328/P Microcontroller (Arkansas, 2015)

The Atmel Pico Power ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz; this empowers the system designed to optimize the device for power consumption versus processing speed.

PIN CONFIGURATIONS



Fig 3. ATmega328/P Microcontroller

28-Pin PDIP Pin Descriptions

1) VCC

Digital supply voltage.

2) GND

Ground.

3) Port B (PB [7:0]) XTAL1/XTAL2/TOSC1/TOSC2

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating the circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB [7:6] is used as TOSC[2:1] input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.



4) Port C (PC [5:0])

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC [5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

5) PC6/RESET

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

The various special features of Port C are elaborated in the Alternate Functions of Port C section.

6) Port D (PD [7:0])

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

7) AVCC

AVCC is the supply voltage pin for the A/D Converter, PC [3:0], and PE [3:2]. It should be externally connected to VCC even if the ADC is not used. If the ADC is used, it should be connected to VCC Through a low-pass filter. Note that PC [6:4] use digital supply voltage, VCC.

8) AREF

AREF is the analog reference pin for the A/D Converter.

9) ADC [7:6] (TQFP and VFQFN Package Only)

In the TQFP and VFQFN package, ADC [7:6] serve as analog inputs to the A/D converter. The analog supply powers. These pins and serve as 10-bit ADC channels.

I/O Multiplexing

Each pin is by default controlled by the PORT as a general purpose I/O, and alternatively, it can be assigned to one of the peripheral functions.



10) Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or electronic. Typical uses of buzzers and beepers include alarms, timers, and confirmation of user input such as a mouse click or keystroke.

The ON time (T) is the duration of the pulse, and it is determined by the values of resistor and capacitor R. The ON time (T) duration of the pulse is determined by the selected values of resistor R: calculating for a period of 4 seconds

T =
$$1.1 \times R \times C3$$

R= T/1.1×C3
= $3/10 \times 10^{-6} \times 1.1$
= 273 KΩ

The nearest available resistor is chosen as $R=270\ K\Omega$

11) Liquid Crystal Display

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly. They are used in a wide range of applications including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have displaced cathode ray tube (CRT) displays in most applications. They are usually more compact, lightweight, portable, less expensive, more reliable, and easier on the eyes(Books, 2010).



Fig 4. Liquid Crystal Display(LCD)

The voltage supply value must be known. From this value, the characteristic voltage drop of an LCD can then be subtracted, and the value of drop across an LED depending on the desired brightness and colour will range from 1.2 V to 3.0 V.

(3.4.1)

If (max) = 20mA

$$V_{CC} = 5V$$

 $V_F = 2V$
Required current I (req) = 5mA.



 $R_{LCD} = 0.6 \text{ K}\Omega$

But choosing IR (LED) = 10mA

$$R_{LCD} = \frac{5-2}{10 \times 10^{-3}} = 0.3 \text{ K}\Omega (3.5)$$

Where,

 V_F = the maximum forward voltage drop V_{CC} = the supply voltage R_{LCD} = the LCD current limiting Considering equations (3.4.1) and (3.5) R was chosen to be 1K Ω

(3.4.2)

12) 7805 Voltage Regulator

The 7805 (sometimes L7805) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the *xx* is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5-volt output, while the 7812 produces 12 volts)(Stark Tony, 2015). The 78xx line is positive voltage regulators: they produce a voltage that is positive relative to a common ground. 7805 ICs have three terminals and are commonly found in the TO-220 form factor, although they are available in surface-mount, TO-92, and TO-3 packages. These devices support an input voltage anywhere from around 2.5 volts over the intended output voltage up to a maximum of 35 to 40 volts depending on the model and typically provide 1 or 1.5 amperes of current (though smaller or larger packages may have a lower or higher current rating(Platt, 2012).



Fig 5. 7805 Voltage Regulator

Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is commonly used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits(Aduiopedia, 2014).



Keypad



Fig 6. keypad

A keypad is a set of buttons arranged in a block or "pad" which usually bear digits, symbols and usually a complete set of alphabetical letters. If it mostly contains numbers, then it can also be called a numeric keypad. Keypads are found on many alphanumeric keyboards and on other devices such as calculators, push-button telephones, combination locks, and digital door locks(Code Bender, 2015). In order to detect which key is pressed from the matrix, the row lines are to be made low one by one and read the columns. If any of the keys in row1 is pressed then correspondingly the column 1 will give low, that is if the second key is pressed in Row1, then column2 will give low.

Resistor

The resistor to be used in this design are basically used as an amplifier when a resistor is used as an amplifier; it must be either off or fully on. In the fully on state, the resistor is off when V_{IN} is less than 0.7 V because the current will be zero. The power developed in a resistor is very small

In the OFF state Power = $V_D * I_C$ but $I_C = 0$ (3.1) P = 0In the ON state Power = $V_C * IC$ but $V_{CE} \approx O$ (almost) (3.2) $P \approx 0$

So, the power is very small

Using general purpose transistor BC 548

Supply voltage, Vs. = 5V

The load driven by the transistor is the relay R_L

Load resistance $R_L = 150$ ohm

Load current $I_{L} = \frac{\text{Supply Voltage,Vs}}{\text{Load Resistance,R}_{L}} = \frac{5}{150} = 30 \text{mA}$



Since I_C (max) must be greater than I_L and from the datasheet I_C (max) = 100mA

 $I_{C} > I_{L}$

To calculate for Base Resistor, R₁₂

$$R_{11} = \frac{V_{C} \times hFE}{5 \times I_{C}}$$
(3.3.1)

Where

 $V_C = Chip$ supply voltage

But since $V_C = Vs$

Then,

$$R = \frac{Vc \times hFE}{5 \times Ic} = \frac{5 \times 400}{5 \times 100 \times 10^{-3}} = 4k\Omega$$
 (3.3.2)

Where the typical hfe value = 400 from the data sheet, and $I_{C} = 100 \text{ mA}$.

Therefore, R was selected to be 10 K Ω .

Principles of Operation

The working of this system is very simple and user-friendly. When the ac mains is switched on, a 12-volt supply is given to the transformer. This voltage is then stepped down to 5 volts and sent to the power supply board. Here, the AC volt is converted to DC using a series of resistors and a rectifier network. The capacitive network then filters the DC voltage; the regulated output is sent finally to the microcontroller board (Semeer Batra, 2015). In the microcontroller board, the AT89S52 microcontroller is pre-embedded with a software program using a Keil compiler. The input of the microcontroller is given from the oscillating crystal 11.0592 via the pins X1, X2(18,19). The entire system is further interfaced to a PC using a MAX 232 port to connect the RS232 cable. A 6 pin cable is used for the interconnection between the LCD and the microcontroller via the pins (22-27). Apart from this, the microcontroller board is embedded with a reset switch. In the microcontroller board, a series of 4 switches and a memory battery are connected to the EEPROM and the DS1307 RTC. Here, the time, date and year along with the entry data for medicines can be given as input to the EEPROM. Now, the RS232 cable is inserted into the RS232 port of the CPU. When this is done, a HyperTerminal window is opened on the monitor. The reset switch has to be turned on at this instant. The monitor then displays a welcome note. The next step is to switch on the "*" (Enter Medicine) switch. When this is pressed, the monitor displays "ENTER MEDICINE" and "TIME." Then, press the "#" key for processing. At the prescribed timings (as prescribed by the doctor/physician) the buzzer gives an alarm, along with the simultaneous display of the name of the medication on the LCD. The alarm can be turned off by pressing the "*" switch once again.

All component values have been found using some circuit theory techniques as shown in following circuit diagram where all the three major circuit subdivisions (keypad, microcontroller and LCD screen) are all combined as stated in our specific objectives.





Fig. 7 Complete circuit diagram

4. RESULTS AND DISCUSSION

When the device is initially powered on, it must be configured through the setup menu. The device has 12 buttons that allow the user to navigate the setup menus. The device is first put into setup mode; this is done by pressing the "*" button. Once the device is in Setup mode, the user can set the time, and set the time intervals and name of medicine to be taken. This information is then saved to the microcontroller's EEPROM, so configuration only needs to be performed once, even if the device is unplugged temporarily.

The device then uses the configuration defined by the user to set up alarms that remind the user to take the appropriate medicine name at the set times. When an alarm is activated, the medicine name is also shown on the LCD screen to set off the alarm; the device counts the time which is input into minutes when the alarm is switch off the device saves that time value. The device then sums the interval specified for the alarm and saves that value as an alarm. For example, if the time is 8 PM and the interval is 2 hours, the device would set the alarm for that particular slot to 10.



Fig 8. when the circuit is powered.

The above picture (Fig.8) shows what happens before the medicine name and the time are set for the circuit, a 20*4 LCD screen that enables to output at least three types of medicine at the time set for their alarms, the keypad



contains 12 buttons that enabled us to input both medicine name and the time for the alarm that is made by the buzzer. The buzzer is set to be sounded for 4 seconds so that the patients can get the alarm very well. In the LCD screen the word "MEDICAL ATTENTION" is displayed before the input of medicine name and time for the alarm.



Fig 9 Display of medicine one and time



Fig 10. Display of medicine one, two and their times for the alarm





Fig 11. Display of medicine one, two, three and their times for the alarm

5. CONCLUSIONS

Many Medication Reminder Systems have been developed on different platforms. Many of these systems require special hardware devices to remind the patients about the medicine in-take timings. Purchasing new hardware devices becomes costly and more time and money consuming. So in the given work, an attempt has been made to implement a system which will be economical, easily accessible and improves medication adherence. Patient Medication reminder system will reduce the effectiveness of a treatment and imposes a financial burden on healthcare systems. The patients will get the schedule of medicine in-take time with medicine description, starting and ending date of medicine, notification through liquid crystal display (LCD), automatic alarm ringing system. The scheduled reminder will suggest the kind of medicine the patient will take at the exact time of the alarm.

REFERENCES

- Aduiopedia. (2014). Crystal oscillator YouTube. Retrieved December 18, 2017, from https://www.youtube.com/watch?v=XqEQKPGk1vI
- Arkansas. (2015). Atmel atmega328p 8-bit AVR Microcontrollers ATmega328/P DATASHEET COMPLETE Introduction ® ® The Atmel picoPower ATmega328/P is a low-power CMOS. Retrieved December 18, 2017, from https://www.coursehero.com/file/20129050/Atmel-atmega328p/
- Books, L. (2010). Liquid Crystal Displays: Liquid Crystal Display, Lcd Television, Display ... Books, LLC -GoogleBooks.RetrievedDecember18,2017,fromhttps://books.google.co.ug/books/about/Liquid_Crystal_Displays.html?id=0RiISQAACAAJ&redir_esc=y
- Code Bender. (2015). How to Use a Keypad Arduino Tutorial: 4 Steps. Retrieved December 18, 2017, from http://www.instructables.com/id/How-to-use-a-Keypad-Arduino-Tutorial/
- Park, KeeHyun & Lim, S. (2012). Construction of a Medication Reminder Synchronization System based on Data Synchronization. *International Journal of Bio-Science and Bio-Technology*, *4*(4), 1–10.



- Platt, C. (2012). Encyclopedia of electronic components. Volume 1, [Power sources & amp; conversion : resistors, capacitors, inductors, switches, encoders, relays, transistors]. O'Reilly/Make. Retrieved from https://books.google.com/books?id=02wOBifWxyMC&pg=PA163
- Rita M. Agans, A. R. M. (1992). Medicine reminder and dispenser. Retrieved from https://www.google.com/patents/US5159581
- Semeer Batra, S. B. (2015). Portable Health Monitoring and Medicine Reminder for old Age People. International Journal of Science and Research, 6(5), 704–705. Retrieved from https://www.ijsr.net/archive/v6i5/ART20173342.pdf
- Stark Tony. (2015). Voltage Regulators LM78XX ASSAULT. Retrieved December 18, 2017, from https://starkassault.wordpress.com/2015/06/23/voltage-regulators-lm78xx/