**Rise & Shine**

***A Daylight-Sensing Automatic Coffee Maker***

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**Background**

Many Americans rely on a good cup o’ Joe to help them rise and shine in the morning. Reports by the Huffington Post and the Harvard T.H. Chan School of Public Health concluded that 54% of Americans drink at least one cup of coffee every day, with 65% of Americans drinking it with their Breakfast. In addition, 58% of coffee drinkers brew their coffee the same exact way every single morning.

With a regular coffee maker, an American can brew his or her own cup of coffee at home in about 10 minutes. If the average American made a cup of coffee every single day from age 20 to age 85, he or she would spend 236,600 minutes waiting for coffee in his or her lifetime. That’s equivalent to 3943 hours, or 164 days, of waiting for coffee to be made. Granted, the average American can be busy with other interests while coffee is being made, but almost half a year of his or her life spent waiting of coffee is a long time.

What if there was a way for coffee to be made *as soon as* the average American was awake? What if instead of waiting 10 minutes every morning, he or she waiting 0 minutes?

**Purpose**

The purpose of this project is to design an embedded system to automate the coffee making process. We will design circuitry around the PIC18F4321, as well as complementary software, to accomplish this task.

**Project Description**

This project will operate in two separate parts: circuitry to control the coffee maker (the *Hardware*) and a program to automate the process (the *Software*). The project will utilize several design features to accomplish this task.

*Alarm Clock*

The project will feature an alarm clock. This clock will be a standard 12-hour digital clock, with the time format HH:MM:SS. The alarm clock will function per standard clock regulations, with one hour passing every sixty minutes, and one minute passing every sixty seconds. In addition, the clock will be able to determine AM vs. PM, and roll over accordingly when the clock changes from 11:59 to 12:00. The clock will be able to be set by the user.

*Human Interface*

The project will have a human interface in the form of a Liquid Crystal Display (LCD) and analog switches (buttons). The LCD will display the current time in the format HH:MM:SS. The time can be set by using the attached buttons. One button will be used as a debugging tool to pause program execution, and three other buttons will be used to set the clock’s time (one to increment the hours, one to increment the minutes, and one to increment the seconds).

*Coffee Maker*

The project will automate a Mr. Coffee Model CG13 Coffee Maker. The microcontroller will essentially bypass the analog switch on the coffee maker’s housing, and turn it on with a control signal.

*Daylight Sensor*

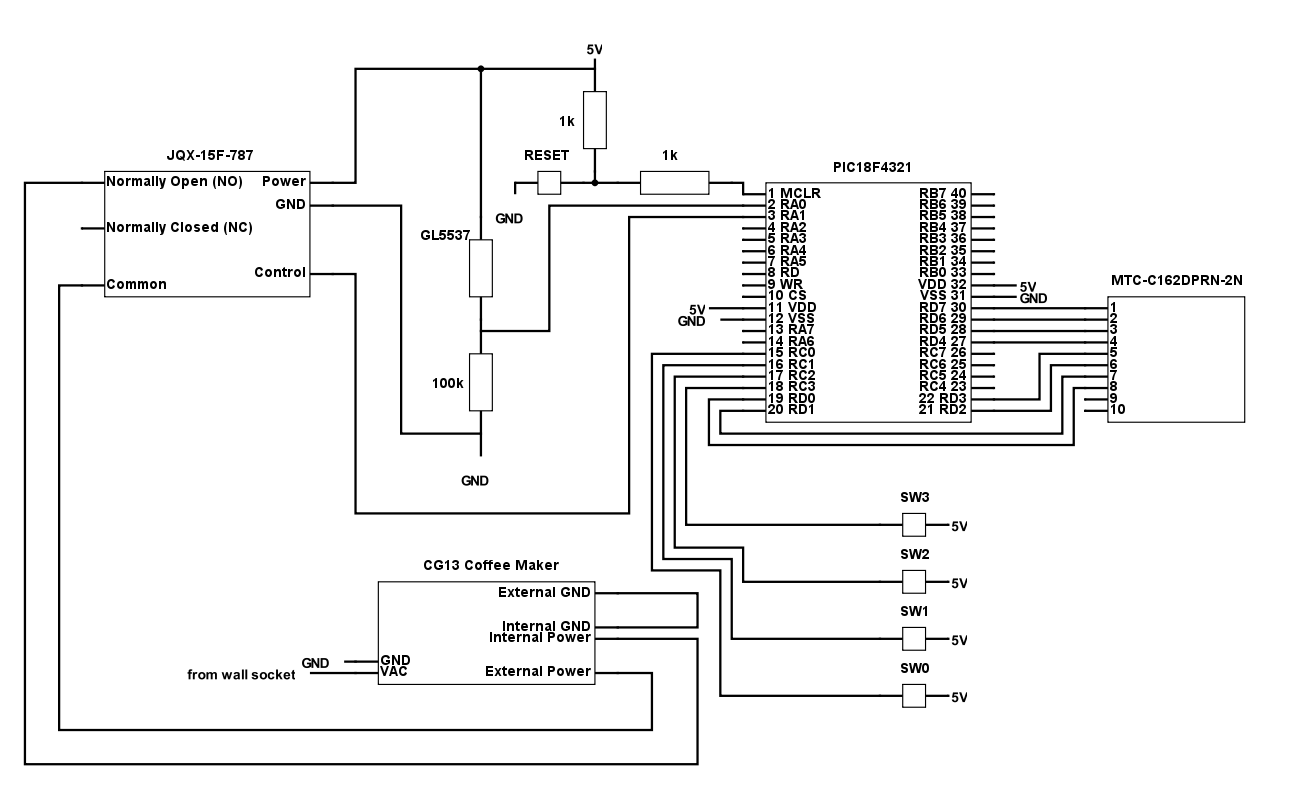
The project will use a daylight sensor to sense the brightness of the room. The daylight sensor will be left near a window or on a bedside table, and when it senses the light it bright enough, the project will turn on the coffee maker. The hope is that the daylight sensor will sense when the day begins and start making coffee before the user wakes up, so that coffee is ready and prepared prior to the user entering the kitchen.

**Hardware Design**

**Hardware**

1. (1x) *Mr. Coffee* Model CG13 Coffee Maker
2. (1x) Shaanxi Qunli Electric Company Miniature Heavy Duty DC Electromagnetic Relay (JQX-15F-787)
3. (1x) GL5537 Photoresistor
4. (1x) Microchip PIC18F4321 Microcontroller
5. (1x) Microchip PICkit 3 In-Circuit Debugger (PG164130)
6. (1x) Kanda Kit – Main Board
7. (1x) Kanda Kit – Training Board
8. (1x) Kanda Kit - LCD Board
9. (1x) Truly LCD Module (MTC-C162DPRN-2N)
10. (2x) resistor
11. (1x) resistor

**Schematic**

*Figure 1: Rise & Shine schematic*

**Design**

We started by embedding our PIC18F4321 with a Kanda Kit, which included a main board and a training board. The main board has headers for Ports A-D, as well as a switch for Reset. The training board houses the switches and LEDs, as well as the hardware interface for the LCD Module.

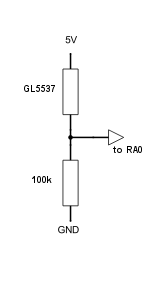
*Sensing*

The daylight sensor circuitry consists of the GL5537 photoresistor in series with a resistor. The GL5537 varies its impedance based on its environment’s brightness. The impedance value of the GL5537 are shown in Table 1.

*Table 1: GL5537 Illuminance and Resistance Values*

|  |  |  |
| --- | --- | --- |
| **Setting** | **Illuminance ()** | **Impedance ()** |
| Day | 10 | 5 |
| Night | 1 | 500 |

The brighter the light, the smaller the impedance of the GL5537. The daylight senor circuitry is shown in Fig. 2.

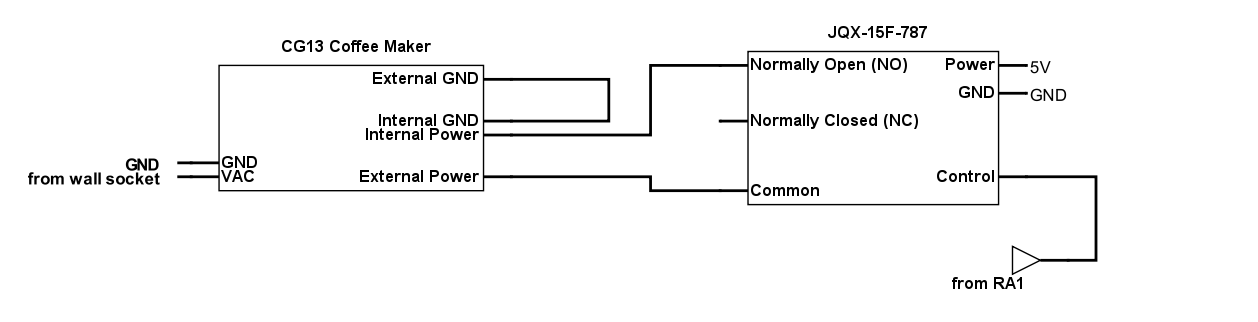


*Figure 2: Daylight sensor circuitry*

When the light is on (representing daytime), *RA0* would read a value of at least , as the impedance of the GL5537 would drop to , or 5% of the sensor’s total impedance. When the light is off (representing nighttime), *RA0* would read a value of almost (depending on the brightness of the room), as the impedance of the GL5537 would raise to at least , or 83.3% of the sensor’s total impedance.

*Controlling*

The CG13 Coffee Maker is controlled by JQX-15F-787 Electromagnetic Relay. The CG13 is natively controlled by an analog Single Pole Single Throw (SPST) switch. Within the internal circuitry of the CG13, the SPST connects the *External Power* to *Internal Power* when thrown. The *Internal GND* and *External GND* pins are always shorted together. The controlling circuitry is shown in Fig. 3.



*Figure 3: JQX-15F-787 & CG13 control circuitry*

When it is time for the CG13 to turn on, the PIC18F4321 puts a *logic high* () on *RA1*, which causes the relay to connect the *Normally Open (NO)* and *Common* leads. This shorts the *External Power* and *Internal Power* pins on the CG13, causing it to turn on.

*Human Interface*

The “human-friendly” part of the hardware consists of the LCD Module and four analog push-button momentary switches. The LCD Module displays the current time in the format HH:MM:SS AM/PM. The user can change or set the time by using the momentary switches. The function of each switch is listed in Table 2.

*Table 2: Switch Functions & PIC Locations*

|  |  |  |
| --- | --- | --- |
| **Switch** | **PIC18F4321 Pin** | **Function** |
| *SW0* | *RC0* | Pause program execution |
| *SW1* | *RC1* | Increment hours |
| *SW2* | *RC2* | Increment minutes |
| *SW3* | *RC3* | Increment seconds |

**Software Design**

**Implementation Details**

The software for the project had two primary functions:

1. Control alarm clock and timing
2. Sense input from daylight sensor circuitry and send corresponding output to electromagnetic relay

**Function Descriptions**

void main (void)

char\* char2ASCII(unsigned char s)

void sendNibble(char nibble)

void sendByte(char data)

void lcdAdd(char text[])

void lcdWrite(char text[])

void interrupt timerReset(void)

**Design Considerations**

**Hardware Considerations**

**Software Considerations**

**Gallery**

**Appendix**

**Source Code**

**Data Sheets**