

Prelab:

Read and understand the registers required to manipulate the Atmel 328P GPIO and Timer 1.

Overview, what is this lab about?

In this lab we will begin to use the register set of the Atmel 328P to program the hardware features of the microcontroller. We will no longer rely on functions and libraries written by and for the Arduino system. We will program and use the hardware peripherals of the 328P using only the Atmel's SFRs (Special Function Registers) and standard C. Using only the C language, bitmasking and the 328P register (SFR) set, all programming will be completed. We will continue to use the Arduino IDE and will continue minimal use of the Arduino libraries. Unless otherwise directed the only Arduino functions allowed are `delay()`, `Serial.begin()`, `Serial.println()`, `Serial.print()`, `void setup()` and `void loop()`.

In class we discussed what we mean by Atmel C and Arduino C and their PROs / CONs. To accurately understand both programming styles we now will program and much as possible in Atmel C.

You'll be building your skills in

- 1) Reading a printed circuit board schematic to identify which microcontroller pins need to be configured as inputs or outputs
- 2) Using on-line or pdf references to learn about SFR functionality e.g. TCCR1A
- 3) Dynamically sensing and adapting to I/O configuration.
- 4) Using functions to simplify the logic flow of code.
- 5) Timer setup and uses.

How to Succeed With This Lab:

Read the overview. KNOW how to move through the Spec Sheet (pdf) to determine the hardware programming requirements. Refer back to the code you wrote for Lab 4 as the starting point for Lab 5 code. Continue to utilize the Arduino.cc website for reference information on Arduino pin definitions and language but try to use only Atmel's SFRs and standard C. Read the schematic for the microcontroller and the 202 board.

The number one problem students face doing this lab:

Using the SpecSheet of the Atmel Atmega328P to understand how to use and program SFRs.

SECTION 1 – Converting the jumper configuration from Arduino C to the Atmel 328P's SFRs and standard C.**Procedure:**

- 1) Open a new sketch and copy into it the working code from Lab 4 and save as Lab 5. Verify correct operation of the SPKA / SPKB configuration, the LEDs on the light bar, tones from the speaker and operation of SW1 / 2. (HINT: Keep a copy of the Lab 4 code live and Lab 5 working on your workstation desktop)
- 2) Remove all the programming to measure the elapsed time in microseconds.
- 3) Convert the GPIO setup (ex: in getActiveBeepPin & configureBoardPins) from the Arduino methods of pinMode (), digitalWrite () and digitalWrite () to the SFR use of DDRx, PORTx and PINx. Verify correct operation.
- 4) Demonstrate your working code (jumper identification and configuration setup) to your instructor for a sign off.
- 5) Leave the jumper in the SPK2 position

SECTION 2 – Convert the Shift Register program from Arduino C to the Atmel 328P's SFRs and standard C.**Procedure:**

- 1) Continue revising the Lab 4 code so that all the shift register programming is converted from the Arduino to the SFR style.
- 2) Verify correct serial monitor operation.
- 3) Verify correct shift register operation.
- 4) Verify correct tone operation by programming Timer1.
- 5) Demonstrate your working code to your instructor for a sign off

SECTION 3 – Create a tone using Timer 1**Procedure:**

- 1) Save the revised code for Lab 5.
- 2) Open a new sketch.
- 3) In the setup section write the code necessary to output a 1KHz waveform from Timer 1 in CTC mode.
- 4) In the void loop () blink the Green LED on the 202 board using "delay (50)"
- 5) Verify the waveform using the oscilloscope.
- 6) Obtain a copy of the waveform and staple it to your sign off sheet.

- 7) Modify your code to output different frequencies and verify with the scope
- 8) Demonstrate the 1KHz working code to your instructor for a sign off. Explain what is required in void loop ()

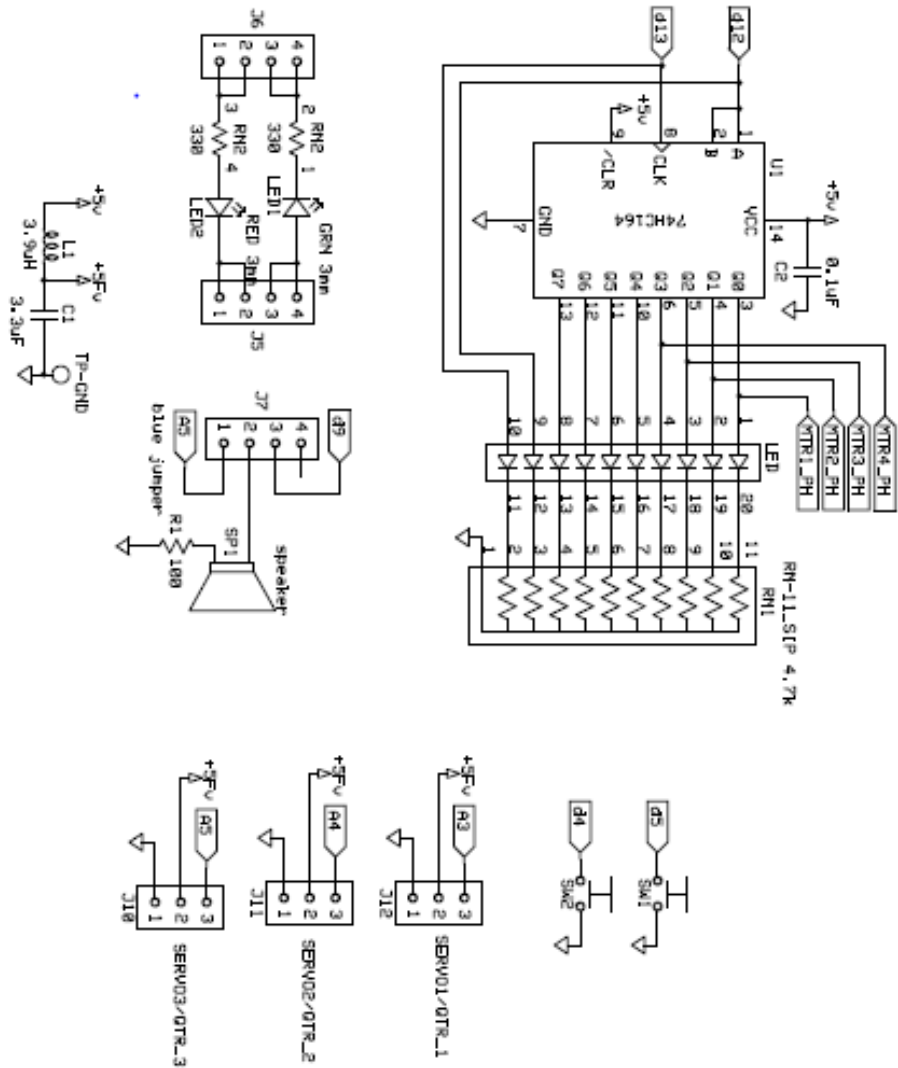
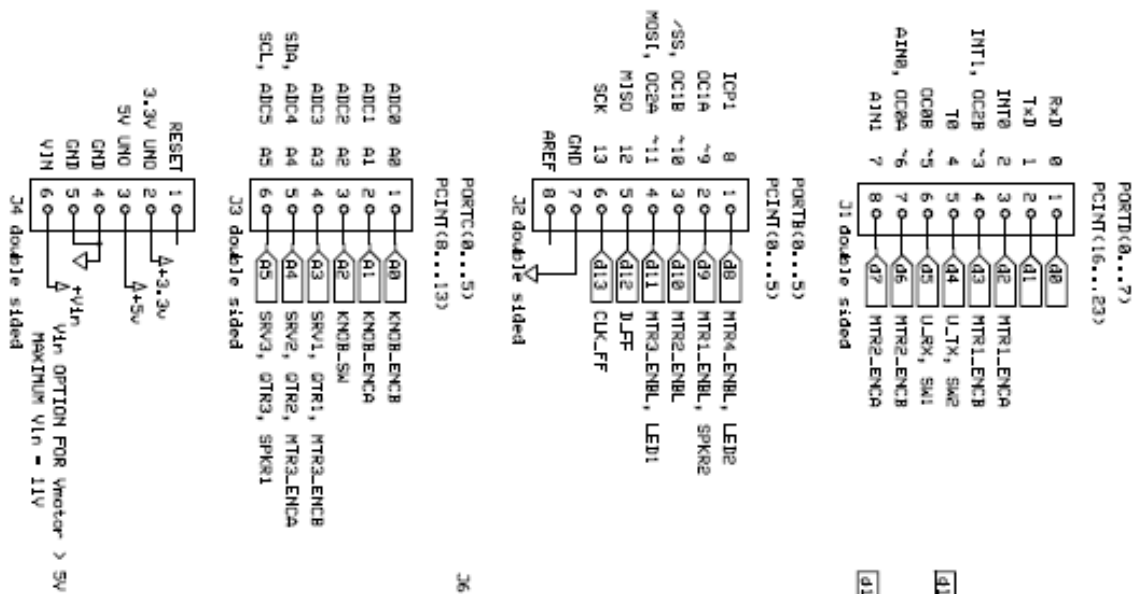
SECTION 4 – Convert from the Arduino tone() and noTone() to using the Timer 1 SFRs

Procedure:

- 1) Convert from tone() / noTone() to controlling the Timer 1 output frequency through its SFRs.
- 2) Verify correct tone operation using Timer 1.
- 3) Demonstrate your working Lab 5 and Lab 4 code to your instructor for a sign off.

Write Up:

There is no write up for this lab, HOWEVER, get the required scope displays and a properly commented printout of the complete Lab 5 Program and attach to the signoff sheet. Hand in the Lab 5 package to the Instructor.



Date: _____

Names: _____

LABORATORY CHECK OFFS	
Section 1 SFR code for Configuration setup.	<input type="checkbox"/>
Section 2 SFR code for shift register use.	<input type="checkbox"/>
Section 3 1KHz and other frequencies from Timer 1 scope and SPKB	<input type="checkbox"/>
Section 4 Demo Converted Lab 5 and Original Lab 4	<input type="checkbox"/>
Points	<input type="checkbox"/>