



UPPSALA  
UNIVERSITET

**Project in Embedded Systems (15 hp)**

# **Electron gun vacuum system control**

**Microcontroller based control system interfaced**

**with industrial grade electronics**

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## **Report - Phase 1**

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### **Summary**

During this phase most of the work has been focused on getting the screen part of the LCD-touch-display to receive instructions from the microcontroller. Also, work has been done to receive the touch-panel outputs from the display on the microcontroller. A small library providing basic functionality for drawing objects on the screen has been written. A simple GUI with a basic menu system to be used for the control system has been programmed.

### **Work done**

#### **Pre lab access**

Due to some delay in getting access to the lab and the prototyping equipment the first part of this phase, a couple of days or so, was spent looking for information regarding the involved components, specifically the LCD & touch-display to be used in the project, henceforth referred to as the display. Various programs required for programming the microcontroller was installed and a git repository was set up for the project. Code examples for similar screens were also found.

The display used is an MI0283QT-9A, which has a resolution of 320 by 240 pixels, driven by an ILI9341 controller chip. The particular display used in the project comes mounted on a break out board that allows easy access to the display pins. The microcontroller used to control the screen is an ATmega328, run with a crystal oscillator of 12 MHz.

#### **Post lab access**

When access was granted to the laboratory and the prototyping equipment, some decoding of cryptic data sheets had to be done in order to try to connect the display correctly. It was decided to communicate with the display using the hardware SPI interface provided on the microcontroller.

While connecting the screen, simultaneously code for the microcontroller to test the screen functionality was written drawing inspiration from the code examples found. Almost all code found was written in C++, however as I am not familiar with writing C++ I translated the functionality of the code into C.

To communicate with the screen the Serial Peripheral Interface (SPI) was chosen. The ATmega328 is equipped with a hardware SPI-module which can be run at up to half the main oscillator frequency. Using a 12 MHz crystal therefore enables an SPI clock of up to 6 MHz.

When the screen was made to display some basic demo functionality work was started to write a small library with functions to draw different primitives onto the screen. This small library was then used when writing a small GUI for the screen.

To be able to interact with the GUI, the touch functionality of the screen had to be made working. The screen comes with a 4-wire resistive touch interface layered on top of the screen. This touch interface can be used to read the X and Y coordinates as well as the pressure of something pressing on the screen. To read information from the 4 wires, the correct wires are grounded and pulled up while others remain floating. The voltage on the floating wires can then be read using the ATmega328's onboard analog to digital converters (ADCs). The resulting voltage levels can be transformed to correspond to a coordinate on the screen.

To transform the resulting voltage levels from the ADC conversion of the touch interface wires the screen was made to print the read voltage level as well as a pointer at the current voltage level locations. I then pressed the screen at the edges and searched the screen to find what levels it put the pointer at the edges. This resulted in a pair of linear mappings to map the position pointed to by the user to the actual pixel position on the screen.

When the transformation was calibrated in this way, design of the GUI could proceed with a simple menu system.

Also during this phase, some basic ground work for the PCB design was done, such as writing down pin mappings of the screen to the microcontroller.

## **Conclusion and plan for the next phase**

Summarizing, the LCD and touch display for the system has been made to work and libraries for drawing objects on the screen as well as receiving touch inputs have been written. A simple GUI with a simple menu system has been implemented.

For the next phase, additional work on the PCB design should be carried out. In addition, the software logic for the actual control system as well as the interface between microcontroller and high voltage circuitry should be looked at. Also, PID control should be looked at. Some minor work with the GUI where necessary.