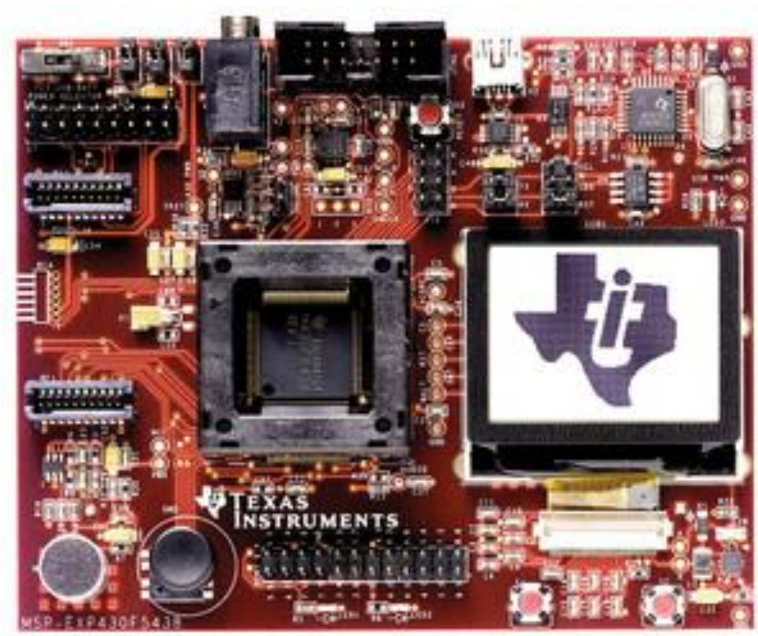
LCD Displays

ECE 480: Design Team 3

Marshall Williams



ABSTRACT

In order for a user to navigate through the operations of a microcontroller, one must be provided with an LCD screen for visual representation. LCD screens are cheap, functional elements that aid in the understanding as well as the efficiency of a microcontroller unit. The following will further breakdown the use and development of such a device.

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LCD DISPLAYS

Introduction

The term LCD is widely known across our culture as we use them quite literally everyday. LCD is an acronym for Liquid Crystal Display. An Austrian Chemist developed the ideology behind LCD screens in 1888 by the name of Friedrich Reinitzer. By taking an immense amount of heat to a very special crystal, he was able to form a new element that isn't really a liquid, nor a solid. It is somewhat in between, although closer to a liquid. These microcystals can be formed into one of many states instantaneously depending on the excitation. When heated, the liquid crystals enter their "nematic" state. While in this state, the liquid crystals act as individual rods with the same orientation and polarity. It is easy to visualize this state as a box of pencils, all pointing in the same direction. However when cooled, these liquid crystals enter their "semectic" phase. During this state, the molecules break up into layers in which they can move freely within their layer but cannot enter other layers. The semetic phase can be visually represented by a hydrophobic element interacting with a hydro element much like that of oil and water. Through the manipulation of both of these states, the crystals twist into a helix-like structure much like that of DNA. Through the twisting and straightening of these structures, light can be polarized. The process of polarizing light is really quite simple. When light is emitted, especially from the sun, it travels in all directions at random, only a few rays being in parallel with each other at a given time. Through the use of filters, only the light that is traveling in parallel will get through. This is how polarized sunglasses work. However when two filters are placed in a 90-degree phase shift from each other, all light will be blocked as it is filtering out all of the light rays. This twisting of filters is exactly how the liquid crystals turn on and off the pixels. In their natural state, the liquid crystals are straight, filtering all light making them dark and in their "off" state. A common light source is used to illuminate all the pixels of a display. These pixels are broken up into three sub-pixels of the colors red, blue and green. Through the use of transistors, the sub-pixels are excited, entering them into their twisted state and allowing the desired color to be shown. This manipulation allows us to view color television and in high definition at that. This is an advanced condition as a majority of LCD screens are simply black and white, not requiring the use of sub-pixel manipulation.

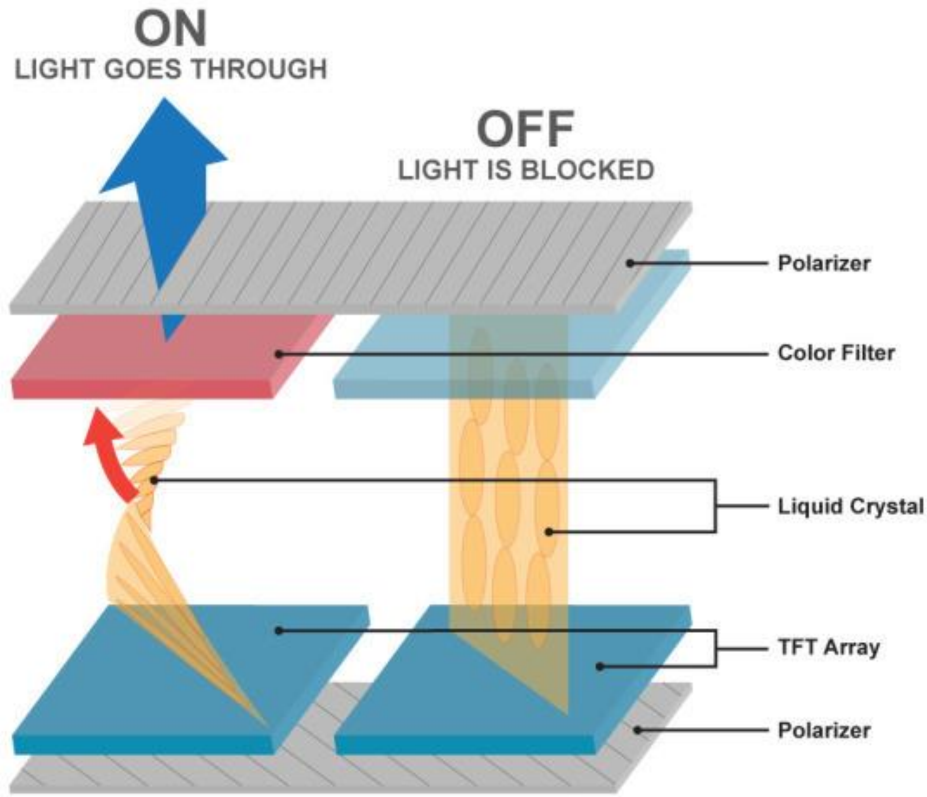

Figure 1- Manipulation of light via Liquid Crystals

Dot-Matrix LCDs

The LCD screen used in our application is a Hitachi HD66753. This LCD utilizes a method of manipulating dots to show an image known as a four monochrome grayscale Dot-Matrix. These applications quantify definition by how many dots there are per square inch, each dot or pixel having four different levels of darkness. The figure below is a visual representation of the actual LCD that is used in our application. The HD66753 features a 138x110-dot graphics display, which is actually much higher than most other displays used on insulin pumps. As it is only going to be used to display text in menus, the resolution doesn't need to be that great. Through the simple manipulation of code, the programmer can easily display the information desired.

Figure 1- Hitachi HD66753 Example

Communication

To connect the LCD to the microcontroller that is ultimately running it, the HD66753 uses a 438 pin serial connection for communication with the microcontroller. The pinout can be seen in the figure on the following page. To supplement the LCD display, the MSP-EXP430F5438 has been equipped with a built-in LCD driver. This is very convenient in our case as we would have had to manually define each and every character that we desired to display. This would have greatly added to our time and would have ultimately ended in the demise of our project. It is not very common that Dot-Matrix LCD's come with LCD drivers, that is why ASCII LCD screens are much more popular in this type of application. ASCII code LCDs typically have a built-in bitmap library. This feature allows the LCD to call upon stored memory corresponding to the character that is input. This makes the coding process very efficient and simple. If one wanted to display the letters "A to Z" they could simply input them as their characters and the ACSII code would then display these. In the case of most Dot-Matrix LCDs, the manual mode is much more difficult. To display even a letter as simple as "A" one would have to go through and construct the bitmap. Calling on each byte of the screen to illuminate the pixel to construct the desired letter would have taken an immense amount of time. Luckily, the MSP-EXP430F5438 came with an example code with a built in header file for bitmap construction so we can go about the programming as if it was an ASCII LCD.

To go about programming the characters that are going to be featured on the LCD screen, one must first call upon the header file. Doing so tells the microcontroller that it must turn the following characters into viewable elements on the LCD screen. The only difficult part arises when the programmer desires different spacing or placement of the words or characters. After calling upon the header file, the programmer must declare how many characters he/she desires to be displayed on that line. By doing so, the LCD driver software will automatically decide the font and spacing. If one desires to alter such a function, they can enter the header file and do so manually.

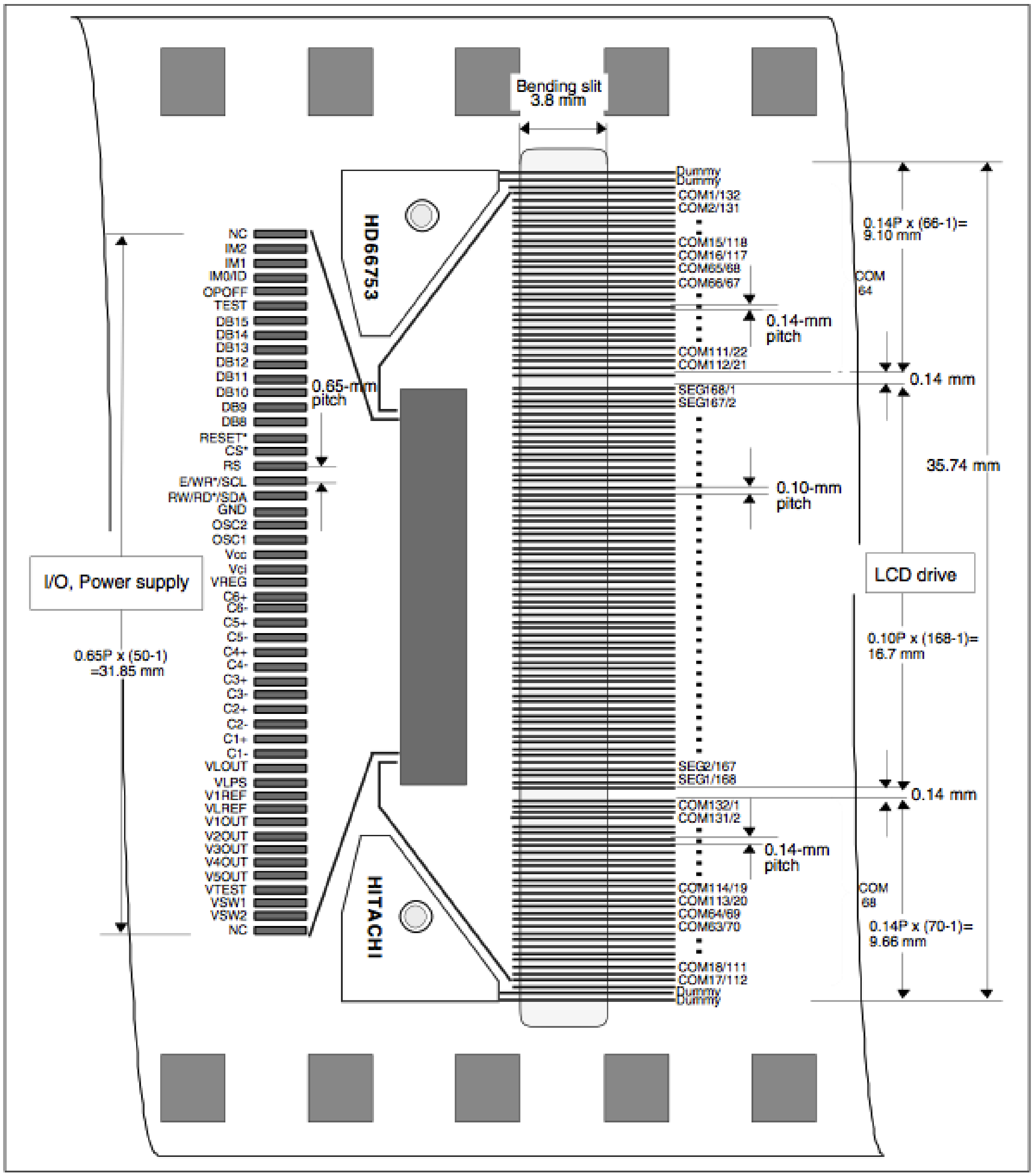

Figure 2- Pinout of HD66753

Conclusion

In conclusion, we believe as a group the microcontroller and LCD combination that we have chosen to drive our product is in fact ample for the data that we plan to use. Through the example code provided by the manufacturer of the MSP-EXP430F5438, Texas Instruments, we were able to easily display the characters that we desired on the LCD screen. The Dot-Matrix display could have been a much larger task to tackle had we not been provided with such resources. As our instrument is geared towards the visually impaired, the quality of the display was not a great concern to us, although it is of higher quality than almost all other insulin pumps on the market today.

Resources

http://www.techhive.com/article/2000075/three-minute-tech-amoled.html
http://janvitek.github.io/vitekj/490s11/Resources_files/HD66753e.pdf
http://electronics.howstuffworks.com/lcd.htm
http://www.explainthatstuff.com/lcdtv.html