Introduction and Theory of Operation

The CAN (Controller Area Network) Device OBD-II (On Board Diagnostic) reader is a handheld touch screen computer that interfaces with an automobiles OBD-II port and reads the basic SAE (Society of Automotive Engineers) codes from the ECU (Engine Control Unit) through the CAN-bus as shown in Figure 1. The CAN Device uses a PIC32 microprocessor to communicate with touch screen LCD. A PCB was designed and fabricated to have all parts mounted in one small package. Modern vehicles have many computers to control the advanced systems such as brakes, power steering, transmission, etc. The CAN-bus was created as a communication system to allow all of the vehicle’s subsystems to communicate simultaneously. All modules communicate simultaneously with the main ECU therefore a priority system is necessary to give priority to important messages. It is one of five communication protocols used on the OBD-II standard and has become mandatory to use on all vehicles 2008 or newer in the U.S.

Design Process

The first step was selecting the Kyocera display; chosen for its price, functionality (display and touchpad all in one), and its ease of programmability. Next the Microchip PIC32 microprocessor was chosen for its processing power and its compatibility with CAN. It has a dedicated module specifically for sending, receiving, and storing CAN messages with only a CAN transceiver needed to complete the communication. Once the main components were chosen, the next step was configuring power distribution. Three different voltages are necessary to power all the components: 3.3V to power the processor, display and touchpad, 5V to power the CAN transceiver, and 19V to power the LCD backlight of the display. Because the CAN device interfaces with the ECU it was decided that the power will be drawn from the car battery (12V-15V). A 9-36V to 5V switching converter was chosen to step the voltage down to 5V to maximize efficiency. From there a linear regulator is used to step 5V down to 3.3V, and a boost converter is used to step it up to 20V.

Implementing the Design

A schematic was created using ORCAD Capture as shown in Figure 2. Next the PCB layout was implemented on PCB editor as shown in Figure 3. Figure 5 shows the milled PCB. There were many critical elements that went into the PCB design, the most critical aspect of the layout being the placement of the display ribbon connectors with respect to the screen mounting holes. Incorrect measurements would prevent the ribbons from aligning, which would prevent the screen from being able to be connected.

Communication protocols

There were several different modes of communication used within the CAN Device including parallel data transfer, synchronous serial data transfer, and asynchronous serial data transfer. The LCD part of the display uses a 16bit data bus with read (RD), write (WR), register select (RS), and chip select (CS) lines. [2] The touchpad part of the display uses a serial peripheral interface (SPI) to communicate data in and out. The SPI interface only has one line to carry the data in (SDI) and one line to carry the data out (SDO). The PIC32’s CAN module acts as a controller on the CAN-bus allowing it to send and receive messages to and from the bus. The CAN transceiver converts the serial data from the microprocessor to the differential (CAN high and CAN Low) signals. Each message has a unique 29 bit identifier to identify what type of data it is and between 8 to 64 bits of data in the message. Figure 4 shows what a typical CAN network looks like.

Results/ Challenges

Overall the project ended as a success. Figure 6 shows what communication between the processor and the touch pad looks like. Getting the touch screen to communicate with the processor was one of many challenges presented. Other challenges include PCB design errors, power issues and CAN message transfer. Designing the PCB layout was by far the most time consuming challenge. Routing lines efficiently and minimizing data line lengths for optimal performance caused extreme attention to detail in the design process. The PCB sizing is not optimal due to not possessing the LCD touch screen until after designing the PCB therefore it is larger than desired but about average in size when compared to market competitors.

References

4. Microchip, “PIC32MX datasheet”.

Environmental and Economic Aspects

The CAN device gives an extended window into the statuses of critical systems of a vehicle that are not known or accessible to a standard driver. Because it is not critical to the average customer, the CAN device would be a great item for hobbyists who like to tune engine parameters or repair technicians who want a pocket reader. The CAN device has some advantages and disadvantages compared to similar products. One advantage is the touch screen capability in small design. Many of the full graphics display CAN readers are 2-3x larger than the CAN device. Even though it is smaller than most, the design could be further refined to make it smaller and more pocket friendly. [5]