GPS Training System

Jason Corbridge
April 29, 2008
ETEC 474
Hardware Description
**Introduction:**

This document describes the hardware construction for the GPS training system being made. It describes in depth the interconnection of parts and the purposes behind the connections made. Using this document along with the schematic and parts list a strong understanding of the GPS’s construction can be developed.

**Microcontroller:**

The microcontroller being used for the GPS training system is the MC9S12DP512. This microcontroller was chosen because it has plenty of memory for the software, and enough I/O ports to operate all of the hardware required for the application. The microcontroller has several different power sources which all operate at five volts. The VDD1, VDD2, and VDDA sources and the VSS1, VSS2, and VSSA ground pins all have a 0.1uF bypass capacitor connected between them for filtering purposes. The microcontroller also has phase locked loop circuitry connected between the VDDPLL and XFC pins, which provide power for the oscillator. The microcontroller also requires the use of a 16 MHz crystal which is connected to the VSSPLL, EXTAL, and XTAL pins. The rest of the connections made to the microcontroller will be discussed in later sections of the hardware description.

**Power Supply and Regulator:**

The power supply used consists of four AA NiMH rechargeable batteries. Each battery has a voltage of 1.2 volts, making the total voltage 4.8 volts. The microcontroller and the rest of the components operate with a supply voltage of five volts, so a step-up DC-DC converter is used to raise the voltage to five volts. The converter used is the LT1173, which will output a five volt supply voltage given an input above two volts. The GND and SW2 pins are both tied to ground. A filtering capacitor is connected between the sense pin and ground in order to filter out noise. A Schottky diode is connected between the output and SW1 in order to reject reverse current flow when SW1 turns off. An inductor is placed between VIN and SW1, and stores current until SW1 turns off. The current then flows to the capacitor and is used to boost the output voltage.

**Buttons:**

The GPS system requires the use of two buttons. The first button that is used is the power button which controls the power to the system. It is a toggle button, which means that it will stay in the current state until it is pressed again. The power button is connected between the output of the voltage regulator and all of the five volt connections within the circuit. The second button is the Start/Stop button, which is a momentary switch. This switch only stays closed while the button is pressed. This button is connected between five volts and PB0 with a pull-down resistor connected to ground.

**LCD:**

The LCD used is the CFAH2004A, which is a 20x4 LCD display. It has sixteen pins which control all of its functions. The LCD receives its power through the VDD, VSS, and VO pins. VDD is the five volt supply voltage for the internal logic, VSS is ground, and VDD-VO is the operating voltage for the LCD and is set to 4.5 volts using a voltage divider. The LCD communicates with the microcontroller using the RS, R/W, E,
and DB0-DB7. RS, R/W, and E are tied to the PK0-PK3, and DB0-DB7 are tied to PA0-PA7. This allows the required data to be transmitted to the LCD from the microcontroller. The LCD also contains a backlight which is controlled by the LED+ and LED- pins. In order to allow the microcontroller to turn the LED off when it is not needed the LED+ pin is connected to PT0 through a 10K resistor. LED- is the ground voltage for the backlight so it is tied to ground.

**GPS Module:**

The GPS module used for the training system is the GPS18 LVC made by Garmin. The GPS has six connector pins used for its operation. These pins are MPO, VIN, GND, TXD, RCV, and GND. The two GND pins are connected to ground, and VIN is connected to the five volt supply voltage. The MPO pin is not needed for this specific application so it will be left unconnected. The other two pins, TXD and RCV are connected to the microcontroller using the SCI pins TXD1 and RXD1 located on the microcontroller. The TXD pin is used to transmit the location data to the microcontroller so that the position can be displayed. The RCV pin is the receiving pin and is used to receive messages from the microcontroller in order to tell what data should be sent and when.

**Computer Interface and SCI:**

The GPS training system is specified to have the capability to connect to a computer through the serial port in order to download the workout information. The information must be sent from the microcontroller to the DB9 connector through an SCI driver. The driver used for this is the SP232A which is a 16 pin package capable of converting two SCI lines to RS-232 capability. Four of the pins C1+, C1-, C2+, and C2- are connected so that there is a .1 uF capacitor between the + and the -. The VCC pin is connected to the five volt supply, and the V+ pin is connected to the five volt supply through a .1 uF capacitor. The GND pin is connected to ground, and the V- pin is connected to ground through another .1 uF capacitor. The rest of the pins in the package are devoted to the input and output of the SCI signals. The GPS only requires one SCI output to be converted, so a connection is made between the TXD0 and RXD0 on the microcontroller to the TXD0IN, and the RXD0IN on the SP232A chip. Two additional lines are connected from the SP232A to pins 2 and 3 on the DB9 connector so that the GPS can communicate with the computer. Pins 1, 4, and 6 are tied together on the DB9 as well as pins 7 and 8. Pin 5 in the ground pin, and pin 9 is left as a no connect.

**BDM:**

In order for the microcontroller to be programmed with the appropriate program a BDM connector must be a part of the system. The connector has a total of ten pins which are connected to the microcontroller and power. The BDM has two GND pins which are connected to ground. The MODA and MODB pins are connected directly to the MODA and MODB pins on the microcontroller. The VPP and NC pins are left as no connects, and ECLK is connected to ECLK on the microcontroller through a 22 ohm resistor. The BKGD pin is connected to the BKGD pin on the microcontroller with a 4K pull-up resistor connected to five volts. The VDD pin is the power pin for the BDM and is
connected directly to the five volt power supply. The last pin is the active low RESET pin which is connected to the RESET pin on the microcontroller.

**Low Voltage Reset:**

The low voltage reset used is the MAX6314 which is a four pin package. VCC is connected directly to the five volt power supply, GND is connected directly to ground, RESET is connected to the RESET pin on the microcontroller, and the MR pin is left as a no connect. The purpose of the low voltage reset is to reset the microcontroller when the voltage drops below the safe level.