Bicycle Speedometer

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Introduction

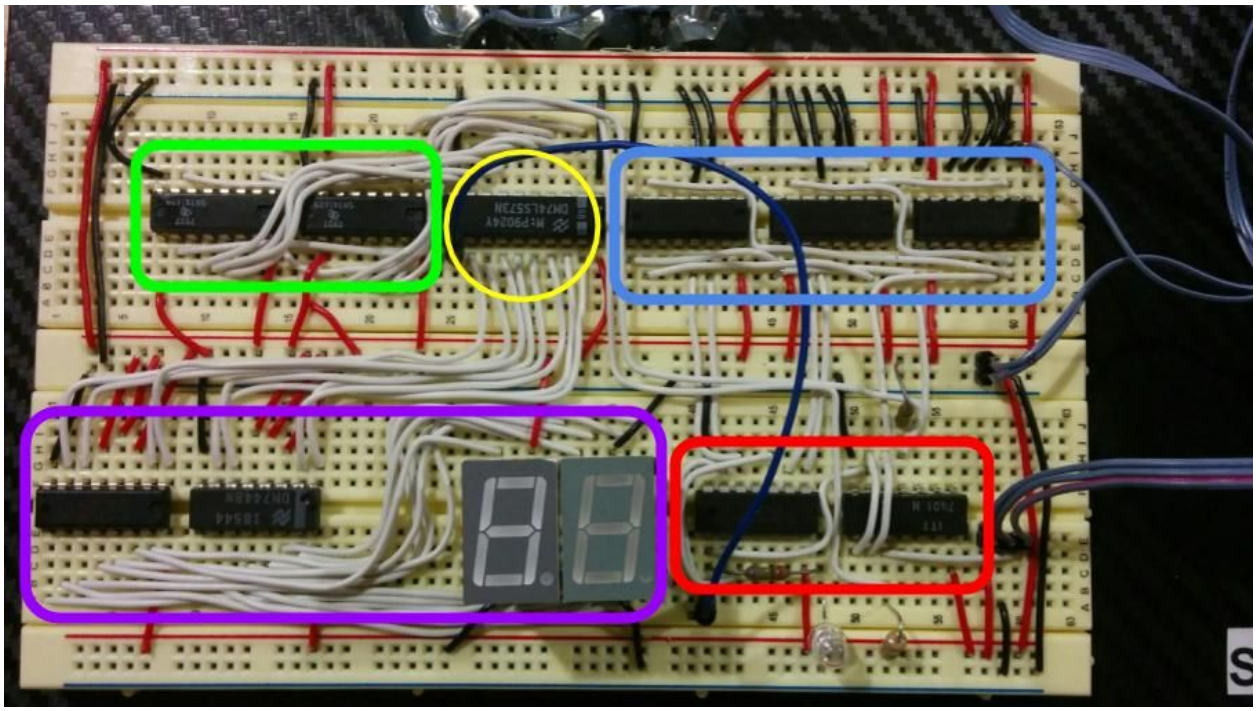
Project Goals

The goal of this project was to create a bicycle speedometer out if 74XX series logic chips. The readout needed to be on a seven segment display and in MPH. A low refresh rate was something I was hoping to accomplish; I ended up with a final refresh rate of 3.75s which I found suitable.\

Project Concept

The speedometer has two counter circuits; one is for counting revolutions of the wheel, and the other for the refresh rate. The refresh rate counter's frequency and max number were calculated to allow a decent refresh rate, no multiplication of the revolution counter, and based on a 21" diameter wheel. The readout is on two seven segment displays; readout is displayed on refresh by using an 8 bit to 8 bit parallel latch. Gates were used for resetting counters and latching the display, 1 quad AND gate & 1 quad NAND gate.

Circuit Overview



Rotation Counter (Green)

The rotation counter is responsible for counting how many rotations the wheel did. This is accomplished with two 74LS162 synchronous decade counters. Ten bit counters were used for compatibility with the seven segment displays. The output from the counters are wired into the inputs of the 8 bit latch shown in yellow. The clock signal which increases the count is received from the hall effect sensor.

Refresh Counter (Blue)

The refresh counter is responsible for resetting the rotation counter and latching output. This is accomplished with three 74LS161 asynchronous 4 bit counters. This counter receives a clock from a frequency generator. The frequency and reset number were calculated to allow the output of the rotation counter to directly equal the mph the wheel is traveling at. The refresh counter is set to a frequency of 267hz and counts to 960. The 8 bit latch is triggered at 960 and both counters resets at 961. The refresh counter is not reset in the typical way but instead the inputs are all set to zero and the LOAD input is pulled low to feed in the input. This was done due to the counter using an immediate reset and not on the next clock pulse. The counter take approximately 3.75s to reach its count.

Seven Segment Display (Purple)

The two seven segment displays are used for showing the rotation counter before reset which represents a 21” wheels speed in MPH. Both displays require resistors for all the segments. One of the displays is common anode and the other common cathode due to accidentally blowing the segments on one of my common anode displays. The CA display is driven by a 74LS47 and the CC driven by a 74LS48 both have the same pinouts. Input is received from the 8 bit latch.

Latch (Yellow)

The latch is an 8 bit parallel by parallel latch. This is responsible for latching the last reading from the rotation counter to the seven segment displays. This is a accomplished with a 74LS573. When the LE (latch enable) pin is driven high it latched the output of the rotation counter and is given to the inputs of the seven segment drivers.

Gates (Red)

The gates are used to reset counters and provide a clock input from the hall effect sensor to the rotation counter. Two gates were used, 7401 quad NAND gate (right) 7408 quad AND gate (left). The AND gate takes in 4 bits from the refresh counter; these bits add up to 960. 3 AND gates were used to have a final output. This output is used to latch the displays. Since the counters reset function is low and active high, the output needed to be inverted. The NAND gate is used to invert the output; also it takes in a second input from the LSB of the first counter, this causes the reset to occur at 961. A second NAND gate was used taking the same input from the first NAND gate but output is tied to the clock input of the rotation counter. Also the output of the hall effect sensor (trigger low) is tied to the clock input. This was done because the 74LS162 used for the revolution counter is not an instant reset but requires a clock pulse; thus when sending a reset signal to the timer a clock pulse is also sent.

Simulated Bicycle Wheel

The simulated 21” bicycle wheel is powered by a geared motor. The motor can take input from 1V-10V safely. This can accomplish speeds of over 20 mph simulated. The motor has a CD disk attached to it; on the edge of the disk is a small neodymium magnet with its south pole facing down. Below the disk on the edge is a HAL506 hall effect sensor. The sensor works on 5v and has a triggered low output. The sensor is triggered by the proximity of the south side of a magnet. This works extremely well and gives a very accurate rotation count.

Testing

During testing I ran into many issues. The biggest was with my initial design of the simulated wheel. I used copper tape on the bottom of the CD and copper tape on the surface below. When the disk passed by it made those contacts short. This produced a very inaccurate due to contact being poor on some passes and debounce. I had many issues with the counter resets; first being that for the refresh counter I could not use the reset pin because the counter would get stuck at zero and stop counting. Also I could not reset the revolution counter and latch the display output at the same time, as that resulted in zero being displayed; this was resolved by latching first and then resetting a bit later. Last issue with the revolution counter was the need for a clock pulse after receiving a reset signal; this was solved with a NAND gate.