Driving Two LEDs with a Single Microcontroller Port

Some boards need a quite few LEDs and the microcontroller doesn't have enough ports for each LED. This leaves the designer to either use an LED driver or use a microcontroller with more IO. Both of these options have an associated cost with it. The first option requires the designer to spend time to pick the LED driver and some more time to learn how it works. It also need more space on the board. Here is the solution to use a single port of microcontroller to drive two LEDs and being able to turn them off and on as they are connected each to one port.

Every engineering solutions is not the perfect solution (gain some, loose some). This solution is not apart from that concept. It required a bit more programming which is harmless as the associated cost is only once.

The following schematic shows the connection of the apparatus.

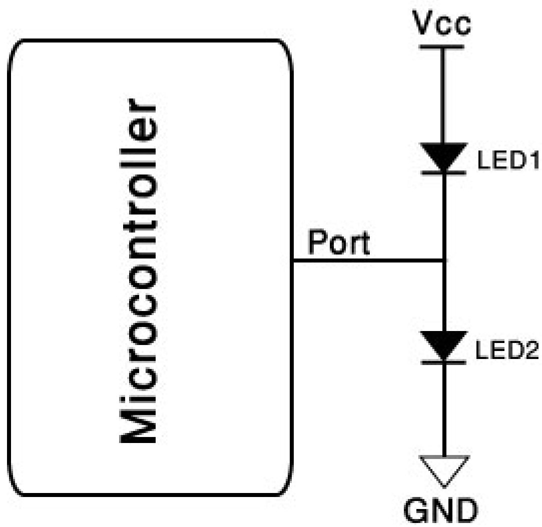

Figure 1: Schematic

Here is how it works:

The port is set as a general digital IO port therefore it can either be 0 or 1. Setting it to output and assigning 0 to it will turn on LED1 and turn off LED2. It should be clear how to turn on LED2 and turn off LED1. Setting the port to output and assigning 1 to it will do so. The challenging part is to make them both on or off.

To make both LEDs off, one should set the port as input. The high impedance state of this port will act as a virtual open between the port and where LEDs connect. As long as the Vss to ground voltage does not exceed the minimum voltages required to turn on both LEDs, LED1 and LED2 will stay off. For example, if the voltage drop of each LED is about 1.75V in on state, a minimum of 3.5V Vcc is required to turn on both LEDs. Now if the Vcc is only 3V, both LEDs stay off. In case that Vcc exceeds the two voltage drops, two resistors can be added to do the job as depicted in figure 2.

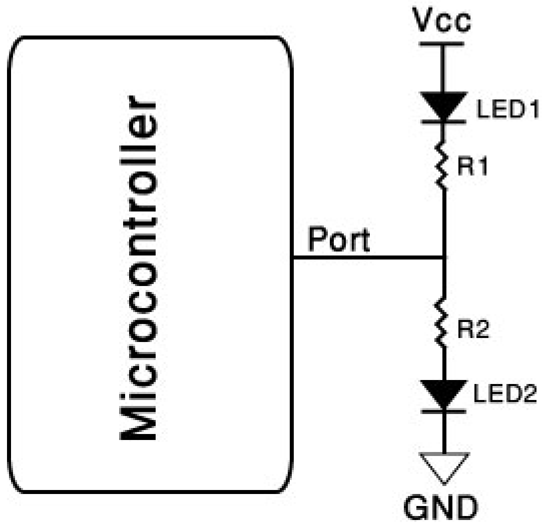

Figure 2: Resistor added to increase drop voltage.

Assuming GND=0; $V_{cc} < V_{drop(LED1)} + V_{drop(LED2)} + IR_1 + IR_2$

Now if the LEDs are identical and resistors are identical, $R > \frac{V_{cc} - 2V_{drop}}{2I}$. Selecting R1 and R2 somehow that the above equation is always correct will keep both LEDs off at the same time. But resistor value should be small enough to drive a single LED which means: $R < \frac{V_{cc} - V_{drop}}{I}$

The last step is how to make both LEDs on. This is where a little bit of programming comes into work. To keep both LEDs on, we should set the port as output and send a pulse to it. This will cause both LEDs to blink and as long as the blinking is fast enough, they both appear to be on. One can get creative here and actually play with the brightness of both LEDs by changing the duty cycle. Slow blinking can be acquired by decreasing the frequency of the pulse.

The following table should summarize what was discussed above:

Port direction	**Port state**	**LED1**	**LED2**
Output	0	ON	OFF
Output	1	OFF	ON
Input	X	OFF	OFF
Output	Pulse	ON	ON

Table 1: LEDs Truth Table

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