Interface to switches and LEDs
Lecture Overview

- Interfacing to a switch
  - Debounce a switch
  - Connection to LEDs.

- REF: Chapters 1, 6, and 9 plus the 68HC11 reference manual.
Switch inputs

- In most embedded systems where you use a microcontroller you need to sense the outside world. A lot of this sensing is done by switches activated at specific pressures, temperatures, humidity, etc. or a push button switch momentary switch activated by the user.
  - Example: An automotive speed control. There is typically a switch on the brake (and clutch) pedal that disengages the speed control when it is pressed.

- Debouncing – The output of a switch at open and close is very, very noisy with multiple spikes in voltage. If not correctly debounced, these spikes could be seen as multiple switch closures (openings).
Debounce

- A de-bounce circuit
- In a typical application the switch signal is input to the microcontroller pin. Inputs to the chip need to be connected such that they are always driven to either Vdd or GND.
- The resistor is needed to current limit the circuit when the switch is closed and the output is a logic 0.
  - In a system with VDD of ~5V and a limit resistor of 330 ohms this gives a current of 0.015 Amp
A note on connection to pins

- All input pins on the chip MUST be connected to an input signal, or connected to Vdd or GND as appropriate.

- No input pin can be left floating. Why?
Switch DIP packages

- For computer interface there are DIP package switches.

For these the interface is the same as the switch interface looked at before.
Output to a LED device

- LEDs are often used as output devices.
- Single LED as a status indication.
- 7-Segment displays –
  - Each segment of display is a LED
- A positive logic circuit for driving a LED
  - Output is 0 – LED off
  - Output is 1 – LED on
LED and other devices

- Interface to LED (0=on)

- Below
  - Interface to relay
LED interface

- Interface structure when interfacing to a switch or LED.
- This circuit is one possible output structure to do the interface.
- What happens when a 1 is output?
- What happens when a 0 is output?
- What is the value of Rlm? Why is it needed?
The current limit resistors

- Example from the text shows how to size the resistors.

\[ R_L = \frac{V_{CC} - V_F - V_{CE(SAT)}}{I_F} \]

- \( V_{CE(SAT)} \) ranges from 0.1 to 0.5V

- Transistor is either in cutoff or saturation
More on Resistor Sizing

Example 10.1:

The LED illustrated in Figure 10.1 is to be interfaced to port B using a 2N3904 small-signal general-purpose NPN transistor with a $V_{CE(SAT)}$ of 0.3 V and a typical value of beta ($\beta$) of 150. Assume $V_{(PB0)}$ is typically 4.5 V. Calculate both $R_{LIMIT}$ and $R_B$.

Solution:

Using Equation (10.1),

$$R_{LIMIT} = (5 - 2.0 - 0.3)V/15\ mA = 180\ \Omega$$

Then, using Equation (10.2), we can find the base current-limiting resistor $R_B$,

$$R_B = [4.5 - 0.6]V/[15\ mA/150] = 39\ k\Omega$$

The actual practical selection of a base-limiting resistor $R_B$ should always be smaller than that calculated using Equation (10.2) to ensure sufficient base current for the needed diode current $I_R$. For this reason, select $R_B$ to be either a 27 k$\Omega$ or 33 k$\Omega$, 10% carbon composition resistor.

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Summary

- How do you interface a switch to the 68HC11
- How do you interface a LED or other device to the 69HC11.