ECE 265 – LECTURE 13

Interface to switches and LEDs

2/17/2012

Lecture Overview

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

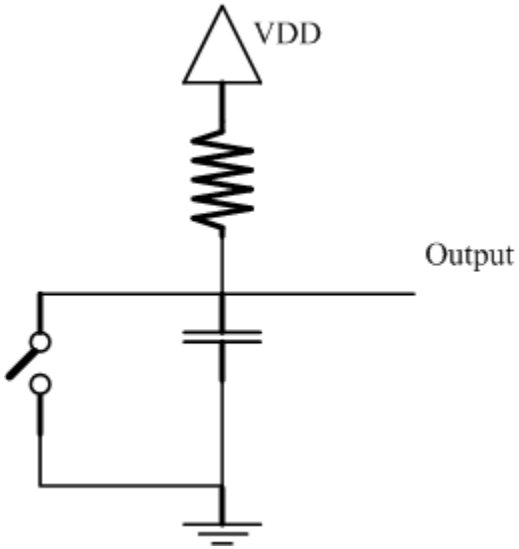
- REF: Chapters 1, 6, and 9 plus the 68HC11 reference manual.

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 swich 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

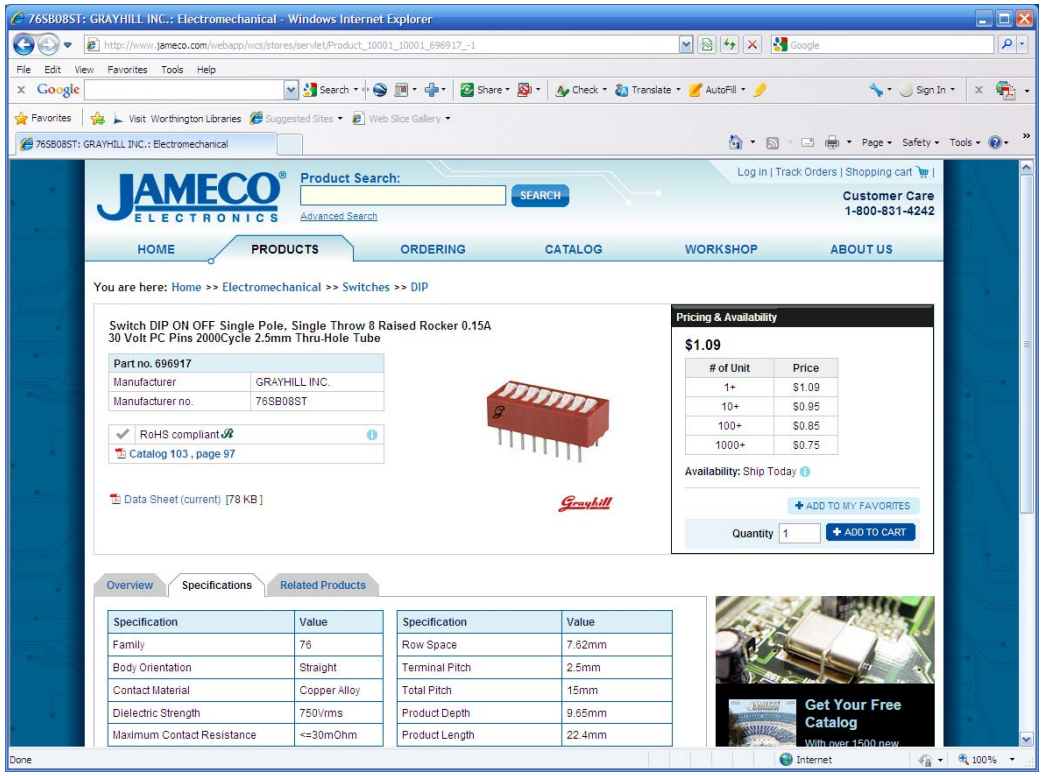
- All input pins on the chip MUST be connected to an input signal, or connected to Vdd or GND as appropriate.

- No input pin can be left floating. Why?

Switch DIP packages

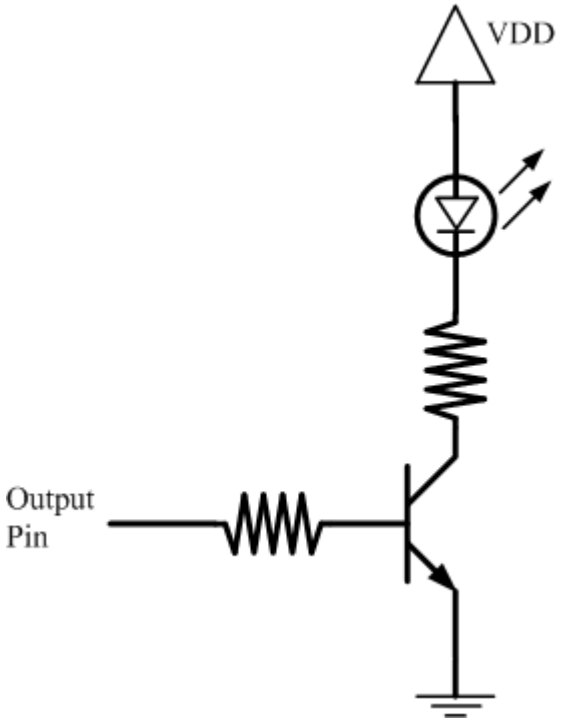
- For computer interface there are DIP package switches.

For these the interface is the same as the switch interface looked at before.



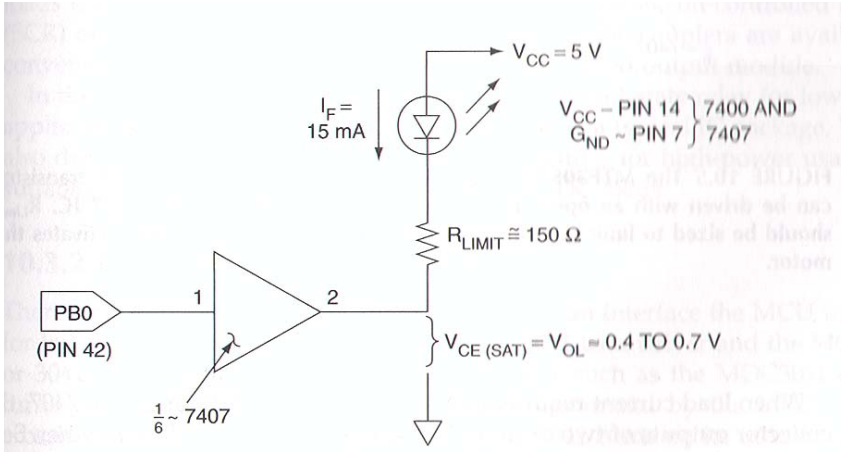
Ouput to a LED device

- 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
  - Ouput is 0 – LED off
  - Output is 1 – LED on

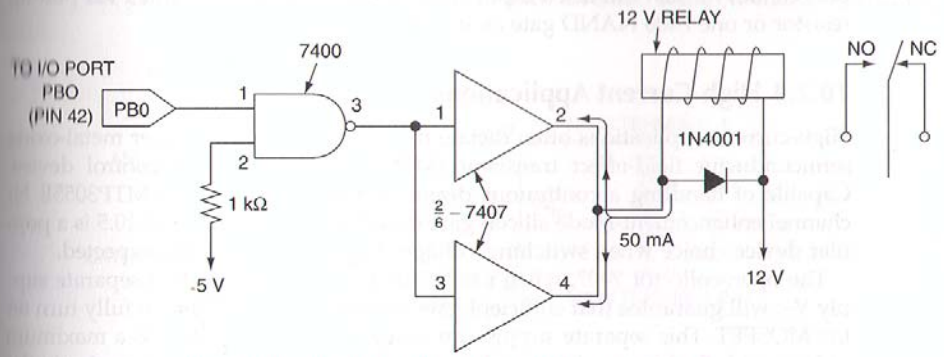


LED and other devices

- Interface to LED (0=on)
- Below
  - Interface to relay



(a) THE LED IS ON WITH A LOGIC 0 OR LOW INPUT AND OFF FOR A LOGIC I OR HIGH INPUT

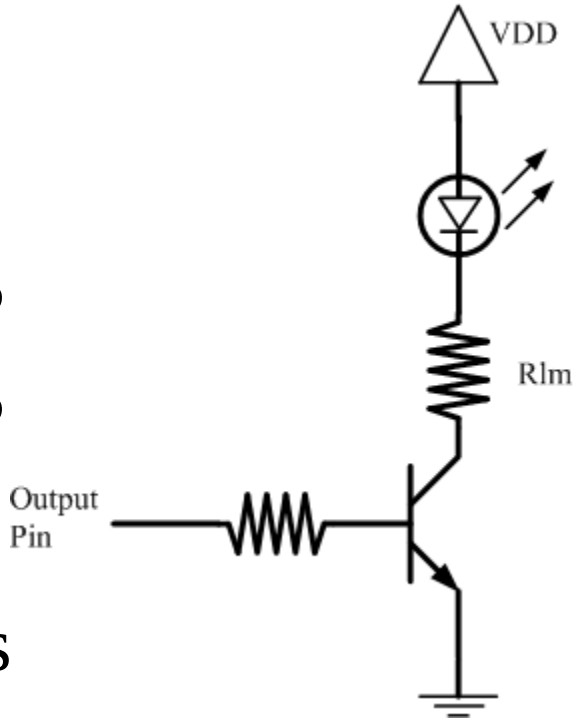


(b) OPEN-COLLECTOR 7407 OUTPUTS ARE CONNECTED TOGETHER (WIRE-OR) TO DOUBLE CONTROL CURRENT CAPACITY. A LOW INPUT AT PB0 OPERATES THE RELAY.

FIGURE 10.4 A single gate controls an LED in (a), and two wire-OR gates control a relay in (b).

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.

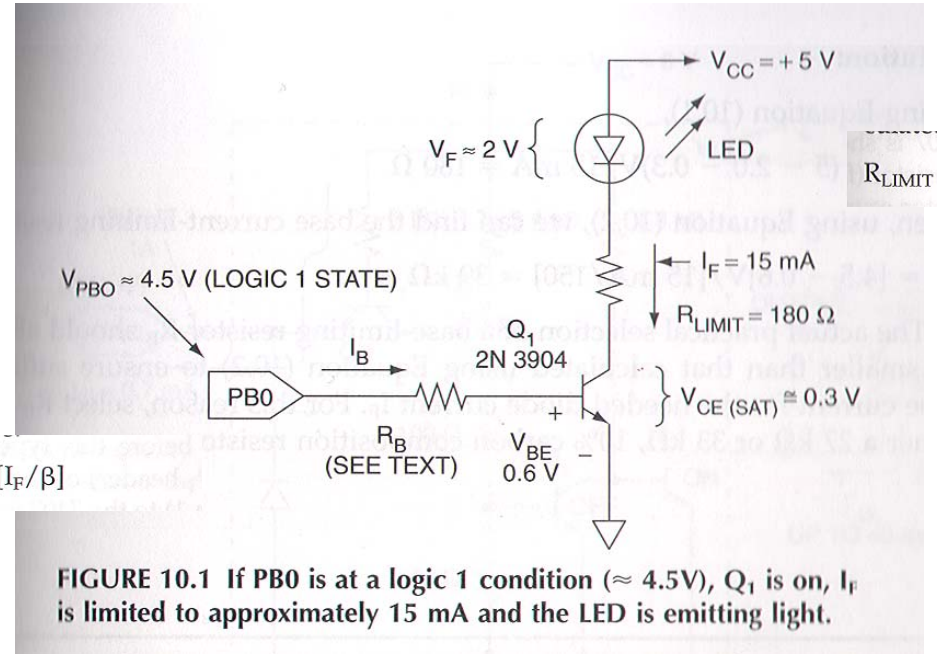


FIGURE 10.1 If PB0 is at a logic 1 condition (≈ 4.5V), Q_1 is on, I_F is limited to approximately 15 mA and the LED is emitting light.

$R_{LIMIT} = (V_{CC} - V_F - V_{CE(SAT)})/I_F$

$R_B \approx [V_{(PB0)} - V_{BE}]/[I_F/\beta]$

$V_{CE(SAT)}$ 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 (β) 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

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

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_F. For this reason, select R_B to be either a 27 kΩ or 33 kΩ, 10% carbon composition resistor.

Summary

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