Simple alarm using SSI devices

Digital Electronic Circuits

Laboratory session 2.5

1 Material

- Components: 1x7400, 2x1K resistor, 2xLED, 1xSPDT switch, 1xbuzzer.
- Components (optional): 1x7410.
- Instruments: power supply, multimeter or oscilloscope.
- Others: breadboard and wires.

2 Introduction

In this lab exercise, we will implement and test a simple digital alarm system. The circuit o design takes the signals from three devices: an on/off switch, a presence sensor (emulated by an IR proximity sensor) and a fire sensor (emulated by a temperature sensor).

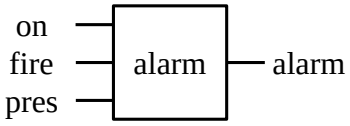
The alarm control system should trigger the alarm as follows:

- If the alarm is on, the alarm is triggered if there is fire or presence.
- If the alarm is off, the alarm is still triggered if there is fire, but not if there is only presence.

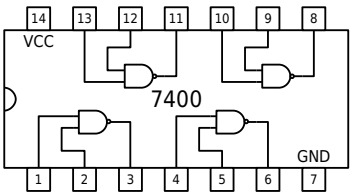
3 Theoretical exercise

1. Design a circuit that controls the alarm system. The circuit will have three inputs 'on', 'fire' and 'pres' for alarm activation, fire detection and presence detection respectively. The output 'alarm' should activate as describe in the introduction. Al input and output signals are active high.

   Use the Karnaugh map technique to design an optimal circuit. Be sure to obtain a circuit that uses only NAND gates since this is the type of gates we have available in our prototyping kit.



2. Draw the interconnections to implement the design using a 7400 IC. Also draw the rest of the devices to complete our prototype, including connections to the power supply (VCC and GND). These are:
   - A SPDT (Single Pole Double Throw) switch used to generate the 'on' input.
   - An IR sensor. Use a box with three connections: VCC, GND and the digital output of the sensor.
   - A temperature sensor. Use a box with three connections: VCC, GND and the digital output of the sensor.
   - An LED (with a current-limiting resistor) that lights when the alarm system is connected (on).
   - An LED (with a current-limiting resistor) that lights when the alarm is triggered.
   - A buzzer that will sound when the alarm is triggered (the buzzer symbol is included in the figure below).



4 Practical exercise

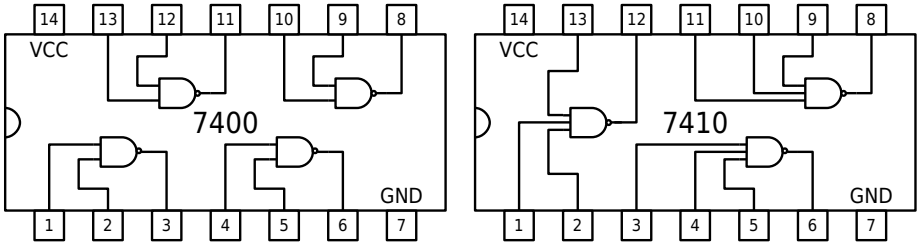
1. Mount the circuit using a breadboard and wires. Mount everything BEFORE connecting the power supply. Use appropriate jumper cables to connect the sensors' pins to the circuit. Use the sensors' digital output in case they have both analog and digital options.
2. Connect the power supply. Check that the sensors are working and detect presence (put your hand in front of the IR sensor) and high temperature (touch the temperature sensor with your fingers). You will probably have to calibrate the sensors. Use an screw driver to set the temperature sensor right at the point where only a small additional temperature will trigger the sensor's digital output.

3. Check that the system operates as expected. Try connecting and disconnecting the on switch and check the output LED and buzzer. If the results differ or the circuit just do not work, check the circuit and try to find out what is wrong. You may use these guidelines:
   - Is any of the ICs hot? Disconnect the power supply immediately!
   - Is the power supply connected and set to 5V? If the voltage cannot be set and there is a red light in the voltage source there may be a short-circuit. Disconnect the power supply from the circuit and check the connections.
   - Are the wires coming from the voltage supply correct? Sometimes the wires are broken inside the plastic cover.
   - Are the IC connected to the voltage supply (VCC and GND)?
   - Use a measure instrument (voltmeter or oscilloscope) to measure the voltage in the circuit nodes starting at the input nodes. Check if the voltage at each node is what is expected by taking into account the expected value of the inputs and the function of the gate connected to the node. If a gate's output is not what you expect and the IC is correctly polarized, the IC may be damaged. Try with another one.

5 Extension

Modify the alarm to include a new input 'door' that comes from a sensor in the front door. The procedure is the following:

1. Decide what sensor you will use for the door. You can emulate a contact sensor simply by using a cable or a switch, or you may use an IR proximity sensor attached to the door, etc.
2. Define the new logic function by drawing its Karnaugh map. You will have to decide if the new input is active low or active high depending on the sensor you are using for the door.
3. Find a minimal solution for your function. Take into account that we only have 7400 and 7410 devices available. One IC of each should be enough to implement your function.
4. Draw all the interconnections on paper, including all devices and sensors. You may use the template below.
5. Mount the new circuit. It is very similar to the previous one, so you may use part of the previous setup.
6. Test the circuit and find possible mistakes as in the first version.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VCC
7400
GND
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12
11
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VCC
7410
GND
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