

Physics III E

Assessable Prac 1 "Intruder Alarm Circuit"

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AIM

To construct, test and explain the operation of a 4-input intruder alarm.

BACKGROUND

A Schmitt trigger has a snap action used when inputs are changing slowly (the capacitor for turning the tone on and off) or for noisy inputs. When they are changing slowly, the logic input may take some time to turn from logic 0 to logic 1, to avoid this we use Schmitt triggers. Schmitt inverters output logic 1 until the voltage rises to 1.7V and past that no change will happen, then it changes to logic 0. When the voltage falls below 0.9V, the output then changes to logic 1, if the voltage falls below this it will still be logic 1. They have a hysteresis range of 0.8V. A Schmitt inverter will change a wave from analogue to a digital square wave.

Logical operations of gates used in this circuit.

OR		
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

NAND		
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NOT	
A	Q
0	1
1	0

The Schmitt inverter has the same truth table as a normal inverter (NOT GATE).

METHOD

- (i) The circuit was constructed as on the schematic diagram.
- (ii) The frequency at X:
42 pulses were counted in 10 seconds, therefore the frequency at X is 4.2Hz

The frequency at Y:

On the CRO, the wavelength was 3.2 units when it was set on 0.1 milliseconds per unit, therefore frequency is

$$\frac{1}{3.2 \times 0.0001} = 3125 \text{ Hz}$$

- (iii) When the leads were connected to ground, the sound stopped and the lights turned off.
- (iv) When the leads were disconnected from ground the corresponding led lit up and the speaker emitted a high pitched tone about 4 times per second.
- (v) SECTION 1 – The NAND gate is a control gate for the oscillator, when one of the inputs is high and the signal from the capacitors on, the NAND gate output is low. This is inverted by the Schmitt inverter and changed into a square wave because of the snap action. The output from the inverter turns the transistor on, which allows the speaker turn on when the signal gets through, therefore causing the sound.

SECTION 2 – The three OR gates connected together means that when any of the inputs on the first two gates are high, then one of the inputs on the second gate is high, outputting logic 1. This setup acts like a four input OR gate. When any one of the inputs are high, a high signal goes to the control NAND gate in section 1, allowing the signal from the capacitors to get through, therefore turning on the sound.

SECTION 3 – When one of the inputs are high, the input of the inverter is high and therefore the output is low. This allows the current to flow from the +5V, down through the LED and sink to ground through the inverter. Because the output is low and in comparison to the +5V, looks negative, the current goes through the LED and lights it up.

SECTION 4 – When the inputs are grounded, the current goes through the pull-up resistors through the inputs and down into ground. When any of the inputs are taken out off ground the input of the OR gate is high. This is

because there is no path to ground, so no current flows through the resistor, little work is done in the resistor, and therefore the supply voltage is nearly the same as the input voltage and therefore high.