

Airbag Sensor

Klim Valeyev, Hesam Akbarnejad, & Marco Tundo

The Airbag is a very common automobile safety device and the goal of our research project was to be able to explain the processes that go on behind the scene whenever it is activated.

And so this is what we found out:

- Airbags are inflated by gas produced in a chemical reaction
 - Gas inflates the airbag with velocities of up to 320km/h
 - The entire process happens in 20-30 milliseconds
- The chemical reaction is triggered by an **ACU (Airbag Control Unit)**
 - The ACU has to decide whether or not to deploy the airbag once the sensors located throughout the car report a collision
 - The circuit has to be very reliable; no room for error is allowed
 - The ACU has to make the decision really fast; in less time than it takes for a collision to occur

Since we were studying electronics, our main goal was to model the circuitry of the ACU and show the entire process of airbag deployment:

1. Sensors detection collision
2. ACU receives and processes information
3. ACU decides to deploy airbags
4. Passengers survive the crash

There are numerous sensors scattered all over an average modern day vehicle:

- Accelerometers – measure acceleration/deceleration
- Impact sensors – detect collision and physical damage
- Pressure sensors – detect physical pressure applied to the vehicle
- Tachometers - wheel speed sensors

- Brake pressure sensors – monitor brake
- Gyroscopes - devices that detect rollovers

The ACU is programmed to deploy different airbags (front, side, knee etc.) depending on the different combinations of data received from sensors. For instance, if the on-board gyroscope detects that the vehicle has flipped over, the front airbags may not necessarily have to be deployed. However, side airbags will need to be activated because the person will likely fall on their side.

The following flow chart shows how the information is received and processed by the ACU

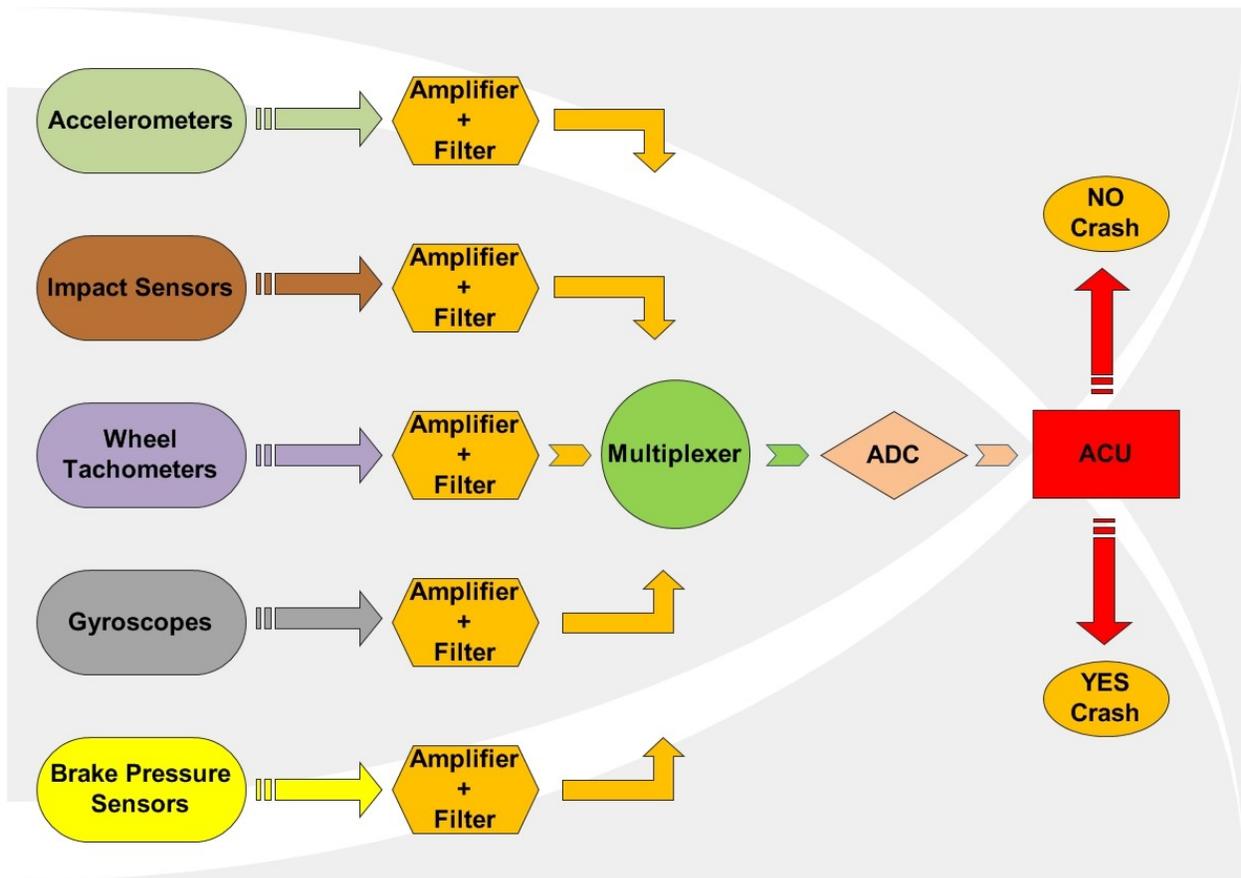


Figure 1 - Airbag activation process block diagram

Sensors are very small devices and the signals they produce are relatively weak. The signal has to be **amplified** in order to analyze it. However, amplification may interfere with the signal, so the signal must be **filtered** as well.

The signals are then sent to the Multiplexer. The **Multiplexer** receives numerous signals and presents them to the ACU in orderly fashion, because the ACU can only process one signal at a time.

Prior to that, the signal has to go through the **ADC (Analog-to-Digital Converter)**. The ACU is a digital device and can only accept digital signals communicated using machine code, whereas the electric pulses from sensors are examples of an analog signal. Thus they need to be converted first.

The following circuit diagram describes the circuit we built to implement the block diagram above:

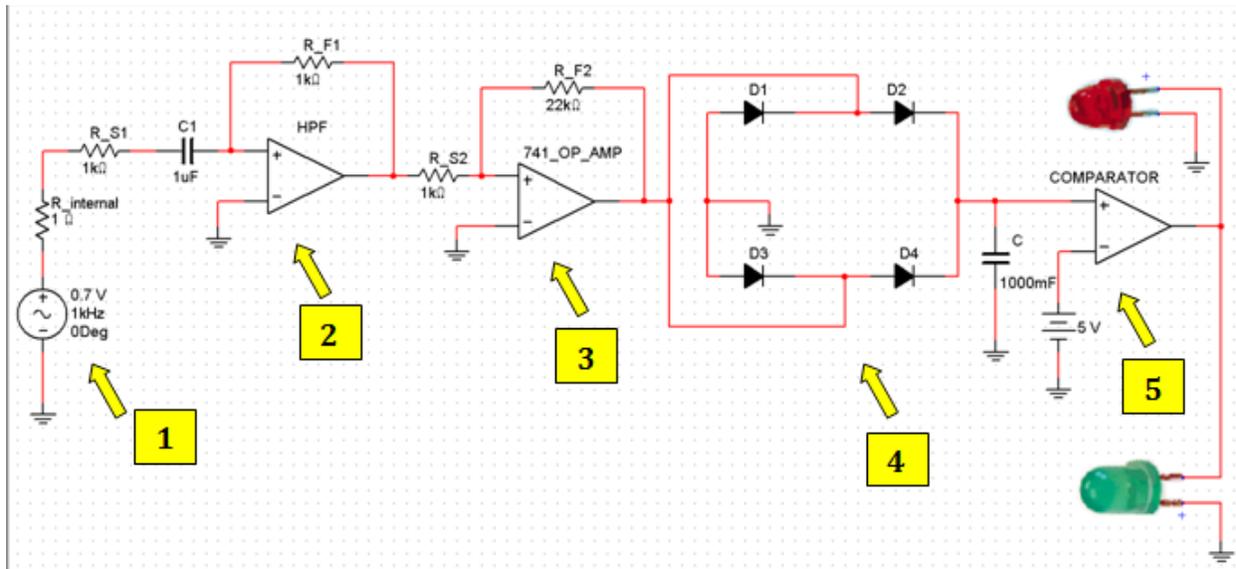


Figure 2 – Airbag activation circuit

- AC Voltage Source **(1)** models the output signal of a sensor
- High Pass Filer **(2)** filters the output signal
- 741 Operational Amplifier **(3)** amplifies the filtered signal
- Wheatstone bridge **(4)** is used to change the amplified AC signal into DC; this mimics the function of ADC (Analog-to-Digital Converter)
- Comparator **(5)** compares the received DC signal with the base 5V signal and depending on the difference in voltages, sends current to either the green LED (NO AIRBAG) or the red LED (YES ARIBAG). Comparator models the behaviour of the ACU by deciding which light should light up; similarly to how the ACU decides whether or not the airbag should be deployed.

The following image is that of the circuit we built in the lab:

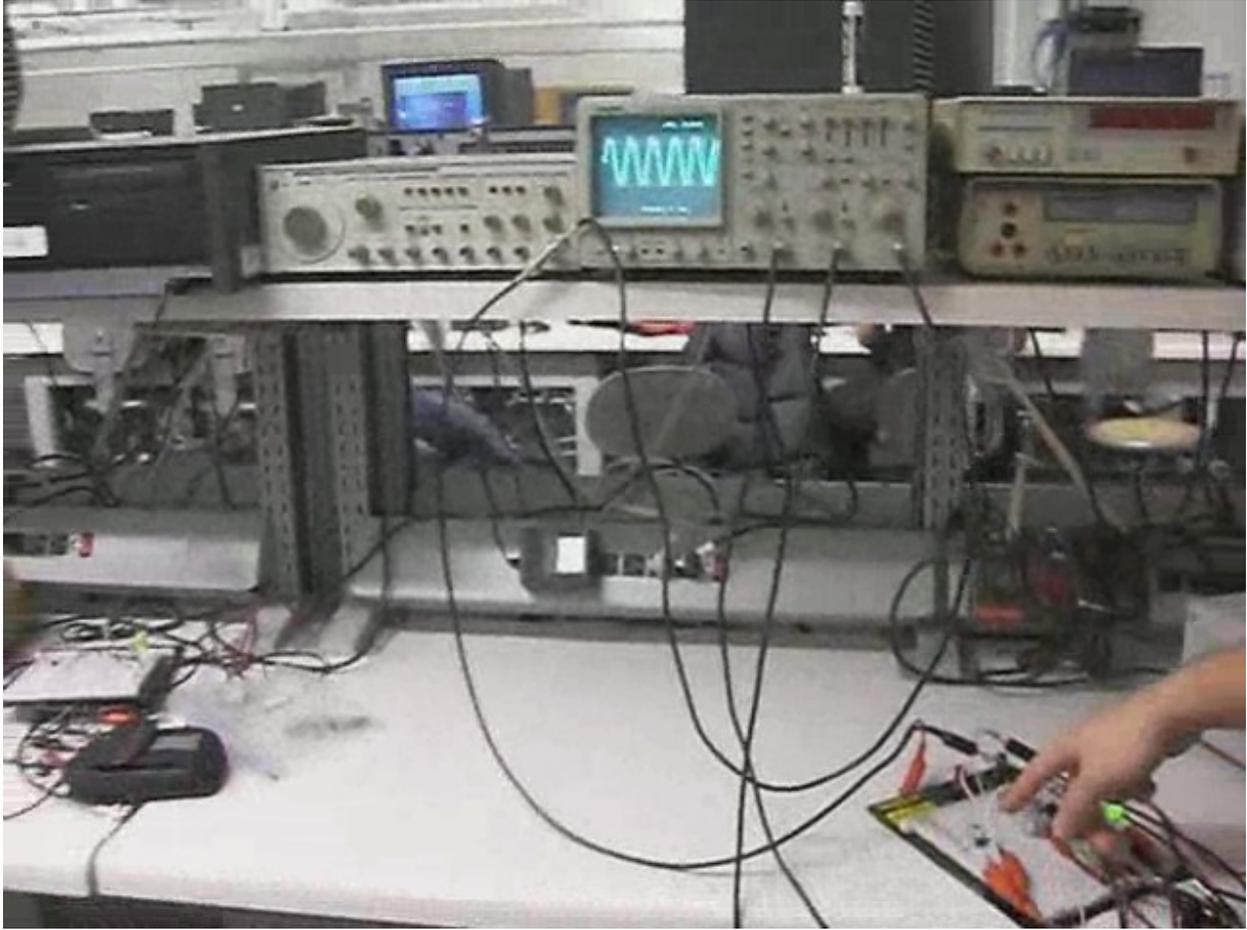


Figure 3 - Final Circuit