Shaurya Gupta
18BLC1092
Embedded System Design (ECE4003)
Prof. Prakash V

Digital assignment-3

TOPIC: Anti-lock braking system

(i) Embedded design Process

Requirements

Purpose: It is a safety system in automobiles to prevent the wheels from locking while braking. The purpose of this is to allow the driver to maintain control of the steering under heavy braking & in situations, to shorten the braking distances by allowing the driver to hit the brakes fully without skidding or loss of control.

Inputs: Sensors -

- Temperature sensor
- Oil pressure sensor
- Hall effect sensor
- Wheel speed sensor

Outputs: Actuators -

- Hydraulic actuator
- Pneumatic actuator
- Electric actuator
- Thermal or magnetic actuator
- Mechanical actuator

Functions of the system:
Braking system -

- A hydraulic brake circuit has fluid filled master and slave cylinders connected by pipes.
- When you push the brake pedals it depresses a piston in the master cylinder, forcing fluid along the pipe.
- The fluid travels to slave cylinders at each wheel and fills them, forcing pistons out to apply the brakes.
- Fluid pressure distributes itself evenly around the system.
- This system totally works mechanically, no electronic part is included in the system.

Anti-lock braking system –

- ABS include a central electronic control unit (ECU), four-wheel speed sensors, and at least two hydraulic valves within the brake hydraulics.
- The ECU contently monitors the rotational speed of each wheel, if it detects a wheel rotating significantly slower than the others, a condition indictive of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster.
- Conversely, if the ECU detects a wheel turning significantly faster than the others, brake hydraulic pressure to the wheel is increased so the braking force is reapplied, slowing down the wheel.
- The process is repeated continuously and can be detected by the driver via brake pedal pulsation. Some anti-lock systems can apply or release braking pressure 15 times per second.
- Because of this, the wheels of cars are equipped with ABS are practically impossible to lock even during panic braking in extreme conditions.

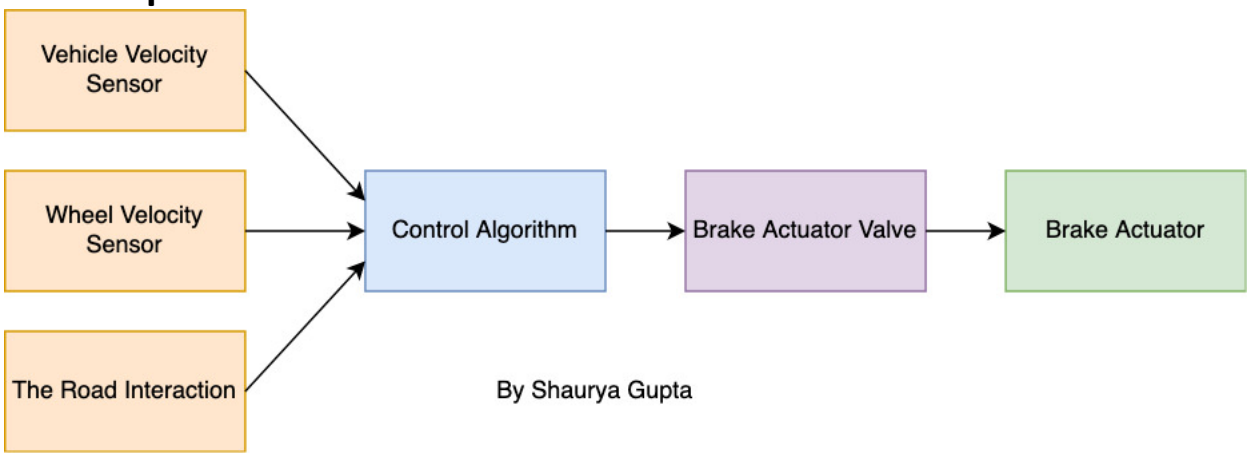
<u>Specifications</u>

- Brake is the only thing user will be using to activate the ABS.
- ABS confirms a stable braking characteristics on all road surfaces, hence avoids overturning of the vehicle.

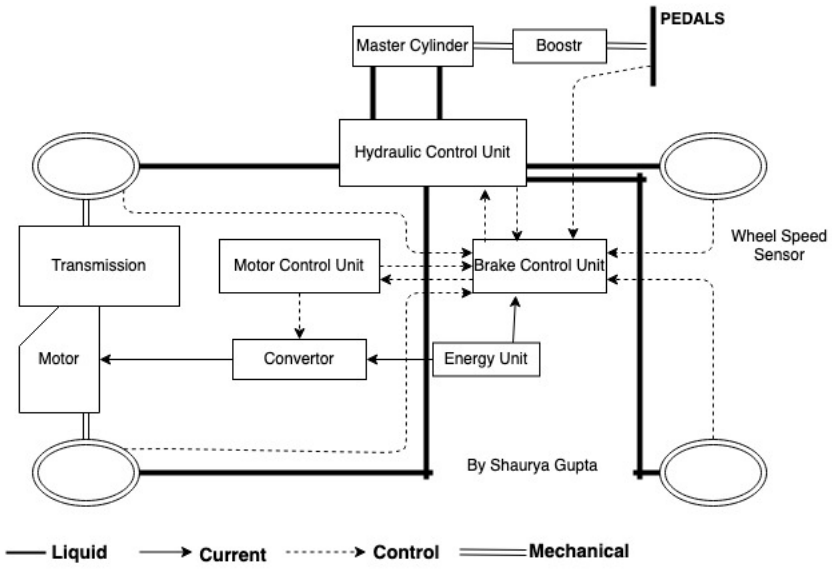
- ABS reduces friction on wheels and road, thus increases efficiency of tires.
- Vehicle with ABS can be stopped without going any further.
- Vehicle can be steered smoothly while braking as steering control is much smoother.

Architecture

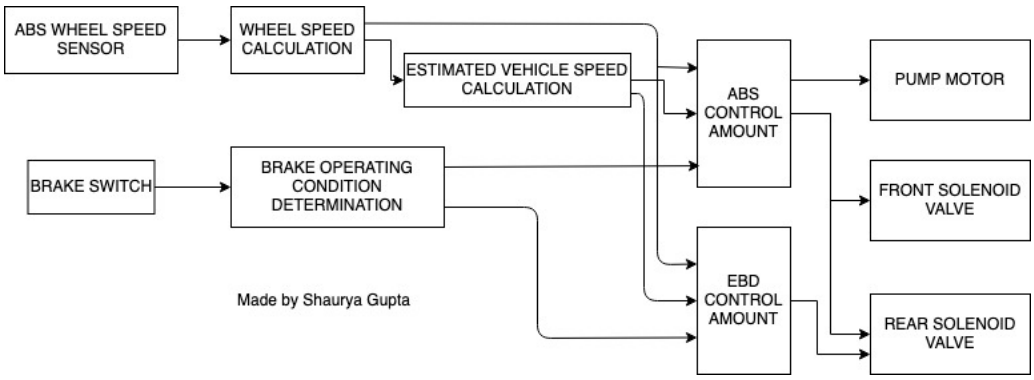
Block representation of an ABS



Hardware diagram



Software diagram



Components

There are four main components of ABS: wheel speed sensors, valves, a pump, and a controller.

- **Speed sensors:** A speed sensor is used to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a Hall Effect sensor
- **Valves:** There is a valve in the brake line of each brake controlled by the
  ABS. The majority of problems with the valve system occur due to clogged valves. When a valve is clogged it is unable to open, close, or change position. An inoperable valve will prevent the system from modulating the valves and controlling pressure supplied to the brakes.
- **Speed sensors:** The pump in the ABS is used to restore the pressure to the hydraulic brakes after the valves have released it. A signal from the controller will release the valve at the detection of wheel slip.
- **Controller:** The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller.

System Integration

Test and validation: The system test must determine if any errors are present in the ABS. If any errors are present, the ABS must shut itself off and send a message to the car's main computer that an error has occurred in the system and to turn an ABS failure light on the driver's

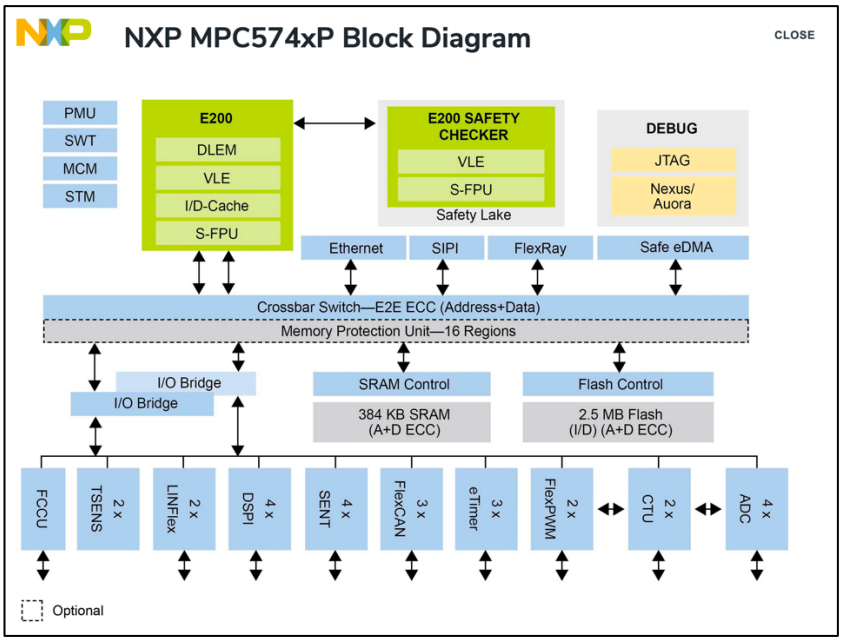
console. Normal breaking must not be affected by the termination of the ABS.

The system test will also exhibit these conditions:

- The system test will engage when the car is turned on
- The system test will engage each time the brakes are applied
- The test that is engaged when the car is turned on is a different test sequence than the test that is engaged each time that the brake is applied

(ii) Embedded processor selection

The **MPC574xP MCU** family features a 32-bit embedded Power Architecture. It meets the highest functional safety standards for automotive and industrial functional safety applications.



The primary input of the ABS system is the wheel speed sensor interface. Comparison of wheel speed sensor inputs can determine if individual wheels are slipping. Wheel speed sensors are typically Hall Effect, with preconditioning required to generate a readable digital PWM input to the MCU.

An automotive-grade ARM based microcontroller is used to compare speed sensor data, control brake cylinder pressure and control the return pump for each wheel brake cylinder.

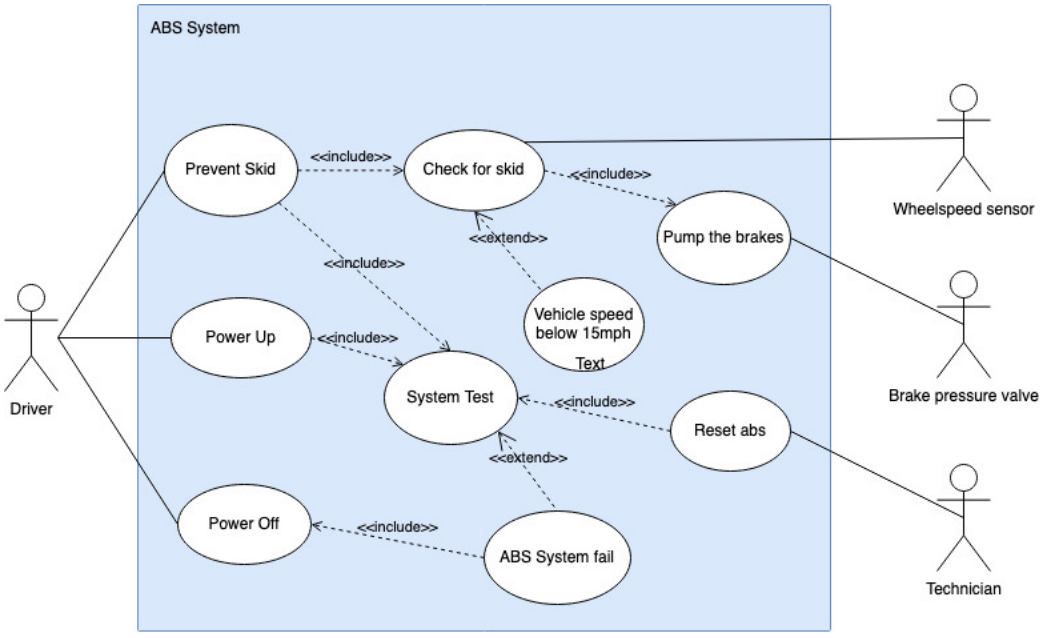
(iii) Embedded memory selection

We will be using **EEPROM 1-2KB.**

In road vehicles equipped with electronically controlled or regulated devices, such as electronic anti-lock brake control, it is common practice to design the microprocessors in the electronic control devices as mask-programmed microprocessors. It has also become common practice in series production to use flash EEPROM memories as program and data memories for the microprocessor.

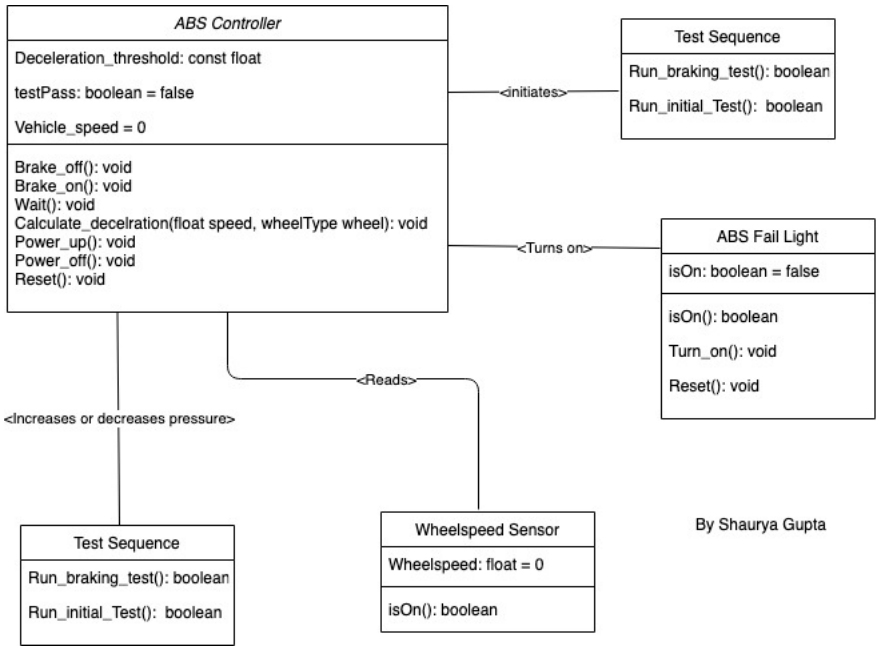
(iv) UML diagram

Use case diagram



By Shaurya Gupta

Class diagram



Sequence diagram