Engineering Safety Critical Systems:

ISO 26262- Anti-lock braking systems:

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High-Level and Low-Level requirements for Anti-lock braking system of Automobiles

Abstract Requirements:

- System should run diagnostic test for ABS failure on ignition
- System should notify driver and display signal light for ABS failure
- System should prevent from sudden wheel lock on applying
- System should shift to normal breaks if ABS fails
- System should reduce acceleration gradually upon applying ABS
- System should disable ABS if speed is below 20 km/h and vice versa

High level requirements:

System should run diagnostic test for ABS failure on ignition

- Upon Ignition,
    - ECU should run diagnostic test on ABS system and check it's integrity
    - If any fault is found, system should notify the driver by turning ABS malfunctioning signal on

System should notify driver and display signal light for ABS failure

After running diagnostics,

- If there is a fault in system,
    - Driver should be notified by turning ABS failure signal light on in driver assistive system.

System should prevent from sudden wheel lock on applying

Upon applying brakes,

- ECU should sense the speed,
- Modulator should analyze the caliber of force being applied on hydraulic pump,
- Press brake caliper with enough force that will stop the vehicle gradually rather than locking wheels.

- System should prevent wheel locking

System should shift to normal breaks if ABS fails

On applying brakes,

- ECU should quick check the integrity of ABS,
- If there is something wrong, braking mechanism should be shifted to normal breaks

System should reduce acceleration gradually upon applying ABS

On applying brakes,

- ECU should sense the speed of car,
- Configure the modulators accordingly,
- Apply enough pressure on brake calipers that it stops the car gradually;
- Preventing wheel lock to avoid skidding.

System should disable ABS if speed is below 20 km/h and vice versa

On applying brakes

- ECU should check speed of car, using speed mechanism
- If it's less than 20km/h, ABS should be disengaged.
- Controls shall be shifted to normal breaks.
- And vice versa.

Low level requirements:

1 System should run diagnostic test for ABS failure on ignition and display signal light:

Upon ignition

- 1.1 ECU should run diagnostic test on ABS system and check it's integrity
    - ECU should check if speed sensor is working (ABS depends upon it)
        - ECU should check toothed ring around RIM, inside breaks
    - ECU should check if modulator is working,
        - If modulator fails, controls shall be shifted to normal breaks
        - Or backup
    - ECU should check if hydraulic pump reading are correct (i.e. constraints to limit),
        - If faulty, controls shall be shifted to normal breaks
        - Or backup
    - ECU should check if enough power is available to apply ABS
        - Controller needs power for mechanism to work,
        - If no power is available, controls shall be shifted to normal breaks
        - Or backup
- 1.2 If fault is found,
    - Try backup (analyze the speed using speed sensor, if it's working)
    - If that fails too,
        - Transfer controls to normal breaks

- o Notify the driver about ABS failure
  - ▪ Turing notification light on Drivers Assistant Control panel

2 System should prevent from sudden wheel lock on applying

- 2.1 ECU should sense the speed
  - o Upon pressing the brake pedal,
  - o ECU will take input,
  - o Quick check integrity of system, if working or not
    - ▪ If not, shift the control to normal breaks
  - o Obtain the speed of car from speed mechanism
    - ▪ If not working, shift the control to normal breaks
    - ▪ If lower than 20km/h shift controls to normal breaks to prevent accident.
- 2.2 Modulator should analyze the caliber of force being applied on hydraulic pump
  - o If pump is not working, transfer control to normal breaks
- 2.3 Modulator should press brake caliper with enough force that will stop the vehicle gradually rather than locking wheels
  - o Check: if ABS fails, transfer control to backup or normal breaks.
  - o Check force being applied,
  - o Press brakes caliper accordingly,
  - o Stop the car gradually
    - ▪ Prevent skidding.
- 2.4 System should prevent wheel locking
  - o See section 2.1, 2.2, 2.3

3 System should shift to normal breaks if ABS fails

On applying breaks,

- 3.1 ECU should quick check the integrity of ABS,
  - o On start, see section 1.
- 3.2 If there is something wrong, braking mechanism should be shifted to normal breaks
  - o See section 2

4 System should reduce acceleration gradually upon applying ABS

On applying brakes,

*assuming section 1 have been gone through

- 4. 1 ECU should check if speed sensor is working (ABS depends upon it)
  - o ECU should check toothed ring around RIM, inside breaks
  - o If it's not working, transfer breaking controls to normal breaks
- 4.2 Configure the modulators accordingly
  - o Modulators are responsible for configuring braking pumps
  - o If modulators aren't working, try backup.
- 4.3 Apply enough pressure on brake calipers that it stops the car gradually;
  - o See section 2.3, 2.4
- 4.4 Prevent wheel to avoid skidding

5 System should disable ABS if speed is below 20 km/h and vice versa

On applying brakes

- 5.1 ECU should check speed of car, using speed mechanism
  - See section 4.1
  - See section 2.1