HLR and LLR for ABS 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 and display signal light:**

* 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 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
  + 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
  + Upon pressing the brake pedal,
  + ECU will take input,
  + Quick check integrity of system, if working or not
    - If not, shift the control to normal breaks
  + 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
  + 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
  + Check: if ABS fails, transfer control to backup or normal breaks.
  + Check force being applied,
  + Press brakes caliper accordingly,
  + Stop the car gradually
    - Prevent skidding.
* 2.4 System should prevent wheel locking
  + 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,
  + On start, see section 1.
* 3.2 If there is something wrong, braking mechanism should be shifted to normal breaks
  + 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)
  + ECU should check toothed ring around RIM, inside breaks
  + If it’s not working, transfer breaking controls to normal breaks
* 4.2 Configure the modulators accordingly
  + Modulators are responsible for configuring braking pumps
  + If modulators aren’t working, try backup.
* 4.3 Apply enough pressure on brake calipers that it stops the car gradually;
  + 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