International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 4, October, 2014

Research Paper

ANTILOCK BRAKING SYSTEM (ABS)

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Antilock Breaking System (ABS) is used in advanced automobiles to prevent slip and locking of wheel after brakes applied. It is automobile safety system, the controller is provided to control the necessary torque to maintain optimum slip ration. The slip ration denote in terms of vehicle speed and wheel rotation. It's an automated system that run on principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking system. It response time is very faster so that makes easy steering for the driver. ABS generally offer advanced vehicle control and minimize the stopping distance in slippery and dry surface, conversely on loose surface like gravel or snow covered pavement, ABS can significantly increase braking distance, although still improving vehicle control.

Keywords: ABS, Antilock Brakes, Antilock Breaking system, Safety, Slip Factor, Advance Braking System, Vehicle Stability Control, Electrical Control Unit (ECU)

INTRODUCTION

Antilock braking system (ABS) prevent brakes from locking during braking. In normal braking situation the driver control the brakes, however during severs braking or on slippery roadways when driver the wheels to approach lockup, the antilock takes over here. The ABS modulates the brake line pressure independent of the pedal force to bring the wheel speed back to the slip level range that necessary to the optimal braking performance. The ABS does not allow full wheel lock under braking.

In simple terms, during emergency of braking, the wheel does not get locked even if you push a full auto brake pedal and hence the skidding does not takes place. It allowed driver to control the car easier, even on roads with low adhesion, such a rain, snow and muddy road. The brain of antilock braking system consist Electronic Control Unit (ECU), wheel speed sensor and hydraulic modulator. ABS is a closed circuit, hence it used the feedback control system that modulates the brake pressure in response to the wheel deceleration and wheel angular velocity to prevent the controlled wheel from locking.

SUBSYSTEM OF ANTILOCK BRAKING SYSTEM (ABS)

Wheel-Speed Sensors

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Figure 1: ABS in BMW Bike

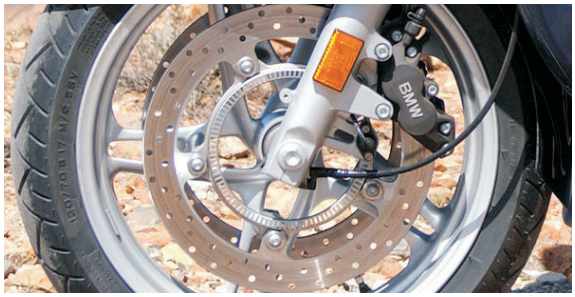
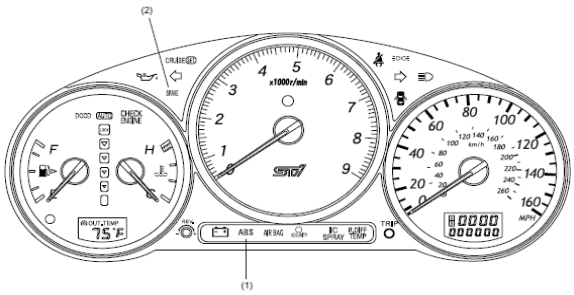


Figure 2: Car Dashboard Indicating ABS



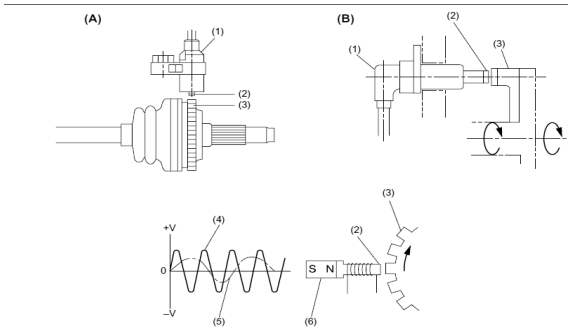
(1) ABS warning light
(2) Brake warning light (also functions as EBD warning light)

Each of the ABS wheel speed sensors detects the speed of the corresponding wheel. The sensor consists of a permanent magnet, coil and tone wheel. The magnetic flux produced by the permanent magnet changes as each tooth of the tone wheel (which rotates together with the wheel) passes in front of the magnet's pole piece. The changing magnetic flux induces voltages at a frequency corresponding to the wheel speed.

Electronic Control Unit (ECU)

The work of ECU is to receive, amplifies and filter the sensor signals for calculating the speed rotation and acceleration of the vehicle. ECU also uses the speeds of two diagonally opposite wheels to calculate an

Figure 3: Electronic Control Unit (ECU)

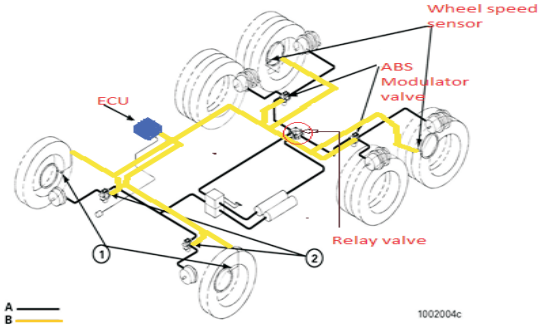


(A) Front
(B) Rear
(1) Sensor body
(2) Pole piece
(3) Tone wheels
(4) High-speed
(5) Low-speed
(6) Permanent magnet

estimate for the speed of the vehicle. The slip of each wheel is obtain by comparing the reference speed with the individual wheel. During wheel slip or wheel acceleration condition signal server to alert the ECU. The microcomputer alert by sending the trigger the pressure control valve of the solenoids of the pressure modulator to modulate the brake pressure in the individual wheel brake cylinders.

The ECU reacts to a recognized defect or error by switching off the malfunctioning part of the system or shutting down the entire ABS.

Figure 4: 4S/4M Configuration



A Air Lines
B Electrical Lines
1 Wheel Speed Sensors
2 ABS Modulator Valves
3 Relay Valve
4 ECU

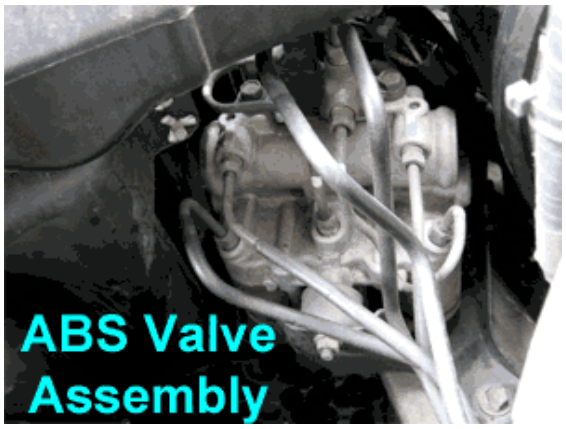
4S/4M Configuration

Hydraulic Pressure Modulator/ Hydraulic Control Unit

The Hydraulic pressure modulator is an electro-hydraulic device for reducing, restoring and holding the pressure of the wheel by manipulating the solenoid valve in the hydraulic brake system. ABS hydraulic modulator unit contain the valve, solenoid and piston. Under hard braking condition, this assembly control the holding and release of the different hydraulic brake circuit. During the normal condition the standard braking system used.

Whenever hard braking situation occur, the system sense the change in the rotation of the speed sensor and decide whether to hold or release pressure to a brake circuit. A tire has its best traction just before it begin to skid, once it begins to skid a portion of traction and steering will be lost.

Figure 5: Hydraulic Control Unit



ANTI-LOCK BRAKE TYPE

Different schemes of anti-lock braking system uses depending upon the types of brakes use. Depending upon the channel (valve) and number of speed sensors the antilock brake are classified.

Four Channel, Four Sensor ABS

It is a more preferable type, the speed sensor on all the four wheels and contain separate valve for all four wheels. By using this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force.

Three Channel, Three Sensor ABS

This type of system is can be found commonly in the pickup trucks with four wheel ABS, on each of the front wheels there is a valve and a speed sensor, and one valve and one sensor for both rear wheels. The speed sensor for rear wheels is located in the rear axle.

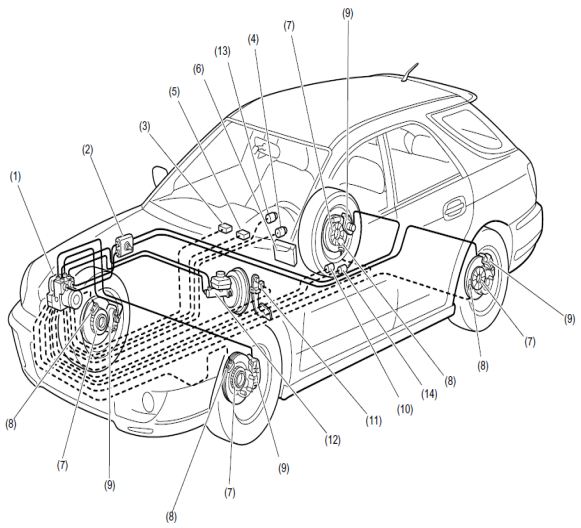
To achieve the maximum braking force, this system provides individual control to the front wheels. The rear wheels, however, are controlled together; they are both have to start to lock up before the ABS will active on the rear. With the help of this system, it's possible that one if the rear wheels will lock during a stop, reducing brake effectiveness.

One Channel, One Sensor ABS

This Arrangement can be seen in a pickup trucks and heavy trucks with rear wheel ABS. It consist one valve, which operate both rear wheel, and one speed sensor located in the rear axle. This is quite similar as the rear end of a three channel system. The rear wheel are monitored together and they both have to lockup before ABS starts its action. In this system there is also probability that one of the rear wheels will lock, results reducing in brake effectiveness. This system is easy to identify, usually there will be one brake line going through a T-fitting to both rear wheels.

FUNCTION OF SENSORS AND ACTUATORS

Figure 6: Sensors and Actuators



(1) ABS control module and hydraulic control unit (ABSCM & H/U)
(2) Two-way connector
(3) Diagnosis connector
(4) ABS warning light
(5) Data link connector (for SUBARU select monitor)
(6) Transmission control module (AT models only)
(7) Tone wheels
(8) ABS wheel speed sensor
(9) Wheel cylinder
(10) G sensor
(11) Stop light switch
(12) Master cylinder
(13) Brake & EBD warning light
(14) Lateral G sensor (STi)

Table 1: Function of Sensors Andactuators

Name		Function
ABS control module and hydraulic control unit (ABSCM & H/U)	ABSCM section	• It determines the conditions of the wheels and the vehicle body from the wheel speed data and controls the hydraulic unit depending on the result. • When the ABS is active, the ABSCM provides the automatic transmission control module with control signals which are used by the module for cooperative control of the vehicle with the ABSCM. • Whenever the ignition switch is placed at ON, the module performs a self-diagnosis sequence. If anything wrong is detected, the module cuts off the system. • It communicates with the SUBARU select monitor.
	H/U section	• When the ABS is active, the H/U changes fluid passages to the wheel cylinders in response to commands from the ABSCM. • It constitutes the brake fluid passage from the master cylinder to the wheel cylinders together with the piping.
	Valve relay section	• It serves as a power switch for the solenoid valves and motor relay coil. It operates in response to a command from the ABSCM.
	Motor relay section	• It serves as a power switch for the pump motor. It operates in response to a command from the ABSCM
ABS wheel speed sensors		These sensors detect the wheel speed in terms of a change in the density of the magnetic flux passing through them and

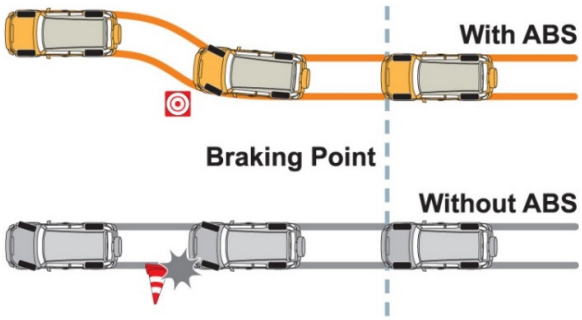
	convert it into an electrical signal. The electrical signal is sent to the ABSCM.
Tone wheels	They give a change in the magnetic flux density by the teeth around themselves to let the ABS wheel speed sensors generate electrical signals.
G sensor	It detects a change in acceleration in the longitudinal direction of the vehicle and outputs it to the ABSCM as a voltage signal.
Lateral G sensor (STi)	Converts the variation in lateral G on the vehicle into a change in capacity of the sensor condenser, and outputs a varying voltage to the ABS ECU.
Stop light signal	It provides information on whether the brake pedal is depressed or not to the ABSCM. The ABSCM uses it to determine ABS operation.
ABS warning light	It alerts the driver to an ABS fault. When the diagnosis connector and diagnosis terminal are connected, the light flashes to indicate a diagnostic trouble code stored in the ABSCM.
Automatic transmission control module	It provides gear controls (fixing the speed at 3rd or changing power transmission to front and rear wheels) in response to control signals from the ABSCM.
Brake warning light	It alerts the driver to an EBD fault. This warning light is also used for parking brake warning and brake fluid level warning.

IMPORTANTCE OF ABS

Stopping Distance

The Stopping distance is a one of the important factor when it comes for braking. Stopping distance is the function of vehicle mass, its initial velocity and the braking force. Stopping distance can be minimize by increasing in braking force (keeping all other factors constant). In all types of road surface there is always exists a peak in friction coefficient. An antilock system can attain maximum fictional force and results minimum stopping distance. This objective of antilock systems however, is tempered by the need for vehicle stability and steerability.

Figure 7: Effect of ABS



Stability

The fundamental purpose of braking system is to decelerating and stopping of vehicle, maximum friction force may not be described in some cases like asphalt and ice (p-split) surface, such that significantly more braking force is obtainable on one side of the vehicle than on the other side. So when applying full brake on both the sides will result yaw or skidding moment that will tend to pull the vehicle to the high friction side and results vehicle instability. Here comes the concept of antilock system that maintain the slip both rear wheels at the same level and minimize two friction coefficient peaks, then lateral

force is reasonably high thought not maximized. This contributes to stability and is an objective of antilock systems.

Figure 8: Stability by Using ABS

Steerability

Good peak frictional force control is necessary in order to achieve satisfactory lateral forces and, therefore, satisfactory steerability. Steerability while braking is important not only for minor course corrections but also for the possibility of steering around an obstacle. Tire characteristics play an important role in the braking and steering response of a vehicle. For ABS-equipped vehicles the tire performance is of critical significance. All braking and steering forces must be generated within the small tire contact patch between the vehicle and the road. Tire traction forces as well as side forces can only be produced when a difference exists between the speed of the tire circumference and the speed of the vehicle relative to the road surface. This difference is denoted as slip. It is common to relate the tire braking force to the tire braking slip.

After the peak value has been reached, increased tire slip causes reduction of tire-road friction coefficient. ABS has to limit the slip to values below the peak value to prevent wheel from locking. Tires with a high peak friction point achieve maximum friction at 10 to 20% slip. The optimum slip value decreases as tire-road friction decreases.

CONCLUSION

With development in a technology in automobiles the braking system is getting more and more advanced. Antilock brakes help drivers to have better control of a vehicle in some road conditions where hard braking may be necessary. In vehicles without antilock brake systems, drivers who encounter slippery conditions have to pump their brakes to make sure they do not spin out of control because of locked up wheels. Antilock braking system coordinates wheel activity with a sensor on each wheel that regulate brake pressure as necessary, so that all wheels are operating in a similar speed range.

ACKNOWLEDGMENT

I would like to express my greatest gratitude to the people who have helped & supported me. I am grateful to my teacher for continuous support for the project, from initial advice & contacts in the early stages of conceptual inception & through ongoing advice & encouragement to this day. A special thanks to Jasmin G. Kotak who helped me in completing this research & she exchanged her interesting ideas, thoughts & made this easy and accurate. I wish to thank my parents for their undivided support and interest who inspired me and encouraged me to go my

own way, at last but not the least I want to thank my friends who appreciated me for my work and motivated me.

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