Analog Solutions – Robust Reliable Performance

Improving Motorcycle Safety with ABS

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Overview

Anti-lock braking systems (ABS) reduce accidents and save lives. This is well-known and proven for 2-wheel as well as 4-wheel vehicles. Although not nearly as widely implemented as on 4-wheel vehicles, 2-wheeled motorcycles and scooters have increasing reasons for ABS implementation to be far more extensive in the future.

Freescale Semiconductor is a leading supplier of semiconductors for ABS today and has been since the technology was widely introduced for ground vehicles in the 1980s. With this extensive history and application insight, Freescale is strategically positioned to understand and address industry requirements for 2-wheel and 1-wheel motorcycle and scooter applications.

Benefits of ABS for Motorcycles and Scooters

Initially introduced on high-end vehicles in 1978, ABS has been required on all new passenger cars sold in the European Union (EU) since 2007 [1]. In the United States, the National Highway Traffic Safety Administration (NHTSA) enacted FMVSS 126 as of September 1, 2011 that mandates the use of Electronic Stability Control (ESC) systems (which inherently include ABS) on passenger cars, multipurpose passenger vehicles, trucks and buses with a gross vehicle weight rating of 4,536 Kg (10,000 pounds) or less [2]. In India, ABS has just become mandatory for new passenger cars and other 4-wheel vehicles in 2015 [3].

With global sales of 99.5 million units in 2013, the motorcycle industry is forecast to grow 5.9% annually to 132.4 million units in 2018 [4]. Similar to automotive history, the first 2-wheel ABS control was installed on high-end motorcycles in 1988. While several manufacturers now offer ABS, primarily on high-end models, its acceptance has not expanded to the smaller displacement machines. In India and China which have the largest sales of 2-wheeled machines, motorcycles and scooters below 150cc represent about 90% of the market [5]. Figure 1 shows the increasing number of 2-wheeled vehicles in China and India. The worldwide ABS penetration in 2014 is estimated at less than 4% and it currently is 0% in India and China [5].

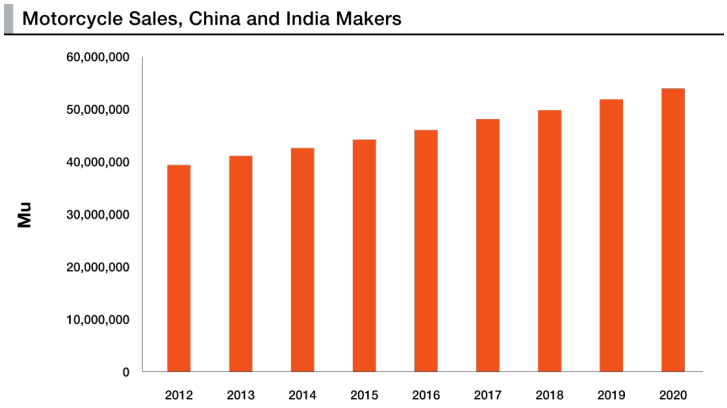

Figure 1. The growth of 2-wheeled vehicles in China and India by manufacturers in China and India [6].

The facts speak for themselves and demonstrate the effectiveness of ABS on 2-wheeled vehicles:

- In 2006, motorcycles accounted for 2% of the distance travelled, but accounted for 16% of the road deaths in the EU-25 [7].
- According to 2013 road accident data, 26.3% of all road crashes globally involved two-wheelers and the number of people killed in such accidents was 39,353 [3].
- Fatal crashes are reduced by 31% for motorcycles equipped with optional ABS compared to those same models without ABS according to the Insurance Institute for Highway Safety (IIHS), 2013 [8].

- Highway Loss Data Institute 2013 data says collision insurance claims for motorcycles with ABS are filed 20% less frequently than for motorcycles without it — 31% less when the ABS bikes have combined controls (ABS for front and rear) [8].
- ABS reduces stopping distance by 15% for the average driver traveling at 100 kph [9].
- ABS reduces the stopping distance of both new and experienced riders [8].

Figure 2 shows the impact of a motorcycle with and without ABS.

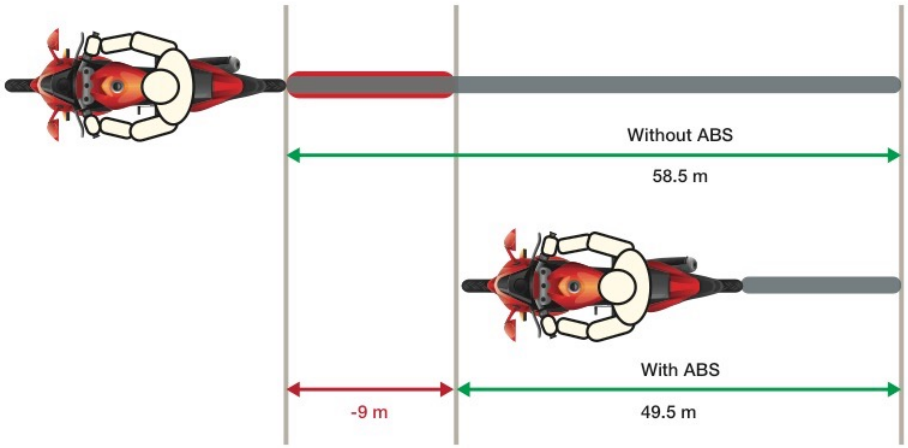

Figure 2. The typical braking distance of a motorcycle (with an average driver and starting speed of 100 kph) decreases significantly with ABS. With ABS and the shorter stopping distance, the driver has 31% less likelihood of being involved in a fatal crash [9].

Consumer Reports has called ABS the “most-valuable motorcycle feature [10].”

Legislation as an Implementation Driver

If the safety factors cited in the previous section have not created a sufficiently compelling case for 2-wheel manufacturers to add ABS to their vehicles, it has convinced governments around the world to require that they do so.

In 2016, ABS will be mandatory in the European Union (EU) for a new motorcycle that has more than a 125 cubic centimeter (CC) engine [8]. By 2019, ABS should be mandatory for 50CC 2-wheelers in the EU. It is expected that the EU directives will be applied in Asia and America.

Existing and future legislation could entice additional suppliers to develop ABS controls for 2-wheelers.

ABS Controls for 2-Wheelers

In ABS control, a wheel speed sensor or tone wheel measures the vehicle’s speed. A microcontroller (MCU) in the ABS electronic control unit (ECU) uses these measurements to determine if the vehicle is about to stop rotating. If this occurs, the MCU signals an analog mixed-signal (AMS) integrated circuit (IC) in the ECU to actuate a hydraulic valve and adjust the pressure of the brake cylinder on the brake caliper. This can occur several times per second. Figure 3 shows the location of these controls on the motorcycle.

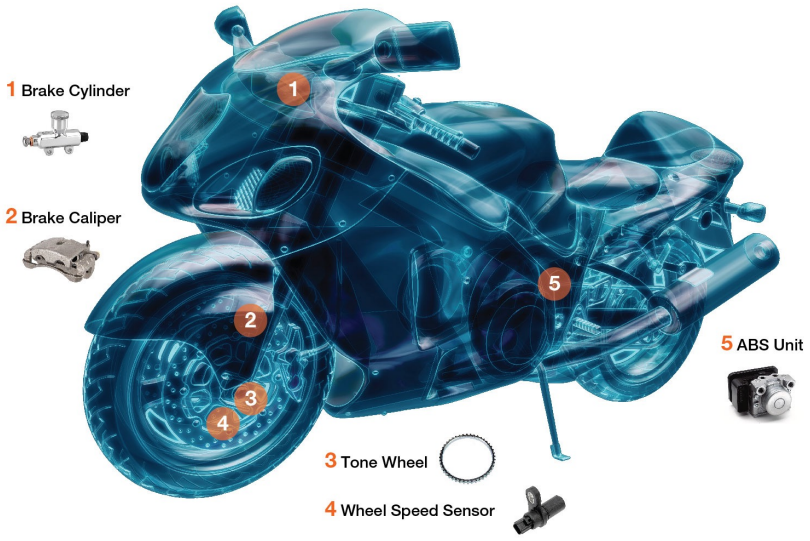

Figure 3. Motorcycle ABS components are similar to those of 4-wheel automotive systems [7].

Normally, tier one suppliers to motorcycle manufacturers address both 2-wheel and 1-wheel systems. With 2-wheel systems, an ABS AMS IC designed for passenger cars can be used because it has more than enough capability. However, for 1-wheel systems to be cost effective, a completely different approach must be implemented for controlling just one wheel - a discrete design. This requires two completely separate design/development paths. Figure 4 shows the combined and unused outputs of the car ABS AMS IC in the 2-wheel system with the associated disadvantages and the discrete solution for a 1-wheel system.

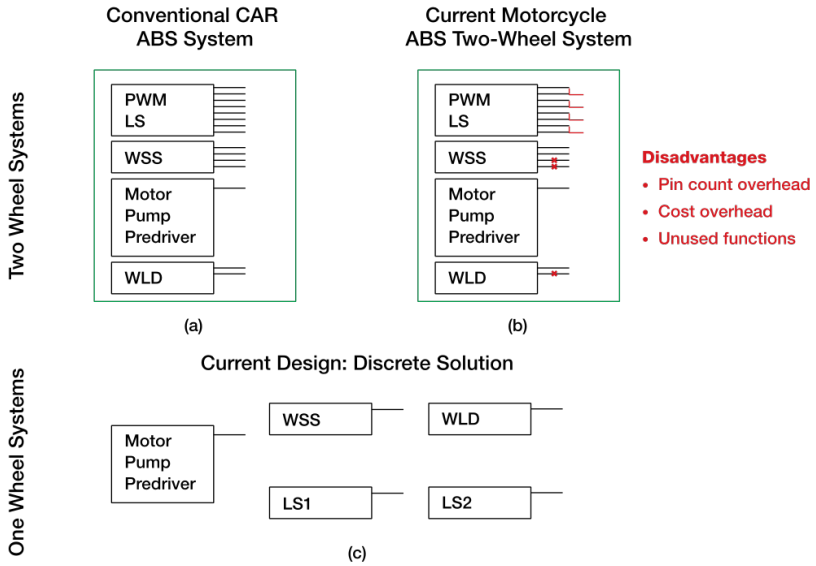

Figure 4. Today's (a) 4-wheel ABS IC used in a (b) 2-wheel ABS design and the (c) discrete approach used for 1-wheel ABS. Common blocks in all designs include: a pulse-width modulated (PWM) low side (LS) driver, wheel speed sensor (WSS), warning lamp driver (WLD) and the motor pump pre-driver blocks.

The ABS technology currently used on 2-wheel ABS and 1-wheel ABS controls is not optimized and requires considerable additional design effort to implement on both systems. The semiconductor industry has had a significant impact on addressing these situations in the past. Freescale expects that a fully integrated solution could improve a supplier's competitive situation and facilitate the industry's response to government legislation for increased ABS implementation on 2-wheelers.

Conclusion: Safer 2-Wheelers

Anti-lock braking systems have demonstrated their value for avoiding accidents, reducing injuries and preventing deaths in 2-wheeled transportation vehicles. In addition to increasing consumer demand, legislation will drive the implementation of the technology into more 2-wheel vehicle offerings worldwide. As a leading supplier of semiconductors for ABS since the technology was introduced for ground vehicles in the 1980s, Freescale is prepared and committed to continue its leadership with the introduction of highly integrated circuits for 2-wheel and 1-wheel motorcycle and scooter applications.

References

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Document Number: MOTORCYCLEABSWP REV 1