MPXY80XX Application Mounting

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SYNOPSIS

Tire pressure has long been known to be a significant factor in the driving experience and vehicle performance. Keeping the recommended level of pressure, as specified by tire and/or car manufacturers, is a very important part of the overall vehicle maintenance affecting the vehicle's suspension, steering, braking systems, and tire wear among others.

Following popular concerns regarding tire pressure security and in response to a mandate in the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act of 2000, the National Traffic Highway Safety Administration (NHTSA) issued a ruling mandating installation of Tire Pressure Monitoring Systems (TPMS) that warn drivers when a tire is significantly under-inflated. This new Federal Motor Safety Standard mandates that vehicle manufacturers and TPMS suppliers, over time, equip all light vehicles with such systems. For the newest timeline and for more information on TPMS requirements, please refer to http://www.nhtsa.dot.gov/.

Within its extensive portfolio of pressure sensors, Freescale Semiconductor, Inc. offers highly integrated solutions for tire pressure monitoring systems – the MPXY80xx family.

This application note deals with considerations pertaining to the mounting of the MPXY80xx family sensors in the end user's applications.

MPXY80XX FAMILY

Freescale's MPXY80xx tire pressure monitoring sensor is a capacitive pressure sensing element, a temperature-sensing element, and an interface circuit with a wake-up feature, all on a single chip. The die is housed in Freescale's Super Small Outline Package (SSOP). The SSOP's size and enhanced media protection make it the perfect package solution for the TPMS.

Tire pressure monitoring systems operate in potentially corrosive environments that could lead to device failures if no protection is implemented. For that reason, the MPXY80xx family sensors use a media filter as the protection method. The filter allows pressure equalization on both sides of the filter. This, in turn, subjects the sensor's silicon diaphragm to the true tire pressure.

Despite these precautions, the tire's rapid and wide temperature variation, in concert with high humidity levels, present a major challenge in terms of pressure sensor operability.

Figure 1. MPXY80XX Sensor Package

MODULE MOUNTING CONSIDERATIONS

MPXY80xx sensors are designed to be mounted inside the tire either in valve stems or on the rim.

On-rim module installation typically requires that the module's case, containing the sensor and the rest of the system components, is mounted on the rim inside the tire as depicted in Figure 2.

Valve-stem installation typically involves mounting the combination of the valve stem and module casing on the outside rim as depicted in Figure 3.

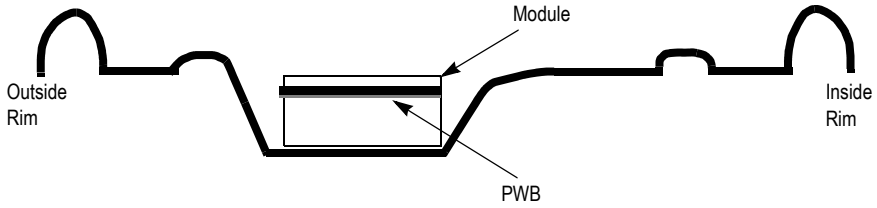

Figure 2. In-Rim Mounting Conceptual Depiction

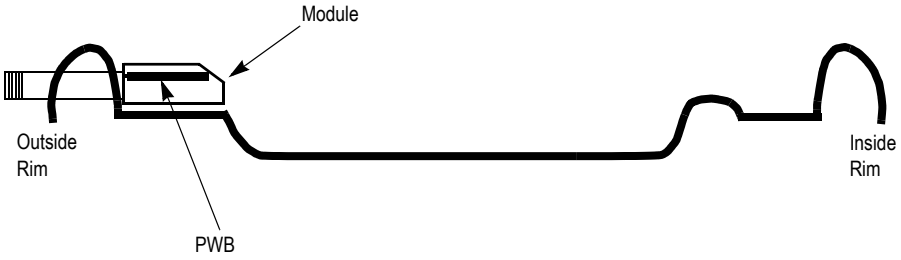

Figure 3. Valve-Stem Conceptual Depiction

SENSOR MOUNTING CONSIDERATIONS

Moisture Related Considerations

The MPXY80xx family integrated filter provides media and humidity protection needed for demanding automotive environments. The devices have been successfully qualified to a stringent list of qualification tests based on the Automotive Electronics Council (AEC) – Q100 requirements. These tests include accelerated humidity testing, long-term pressure and temperature cycling, as well as exposure to chemicals commonly found in Tire Pressure Monitoring applications. The integrated filter's ability to provide sensors with sufficient humidity and media protection, while not causing any false electrical signals from the devices due to acceleration forces in system applications, demonstrates the capabilities of this innovative packaging solution.

In order to maximize the media protection benefits from the integrated filter, the sensor's position needs to be carefully considered. Position of the MPXY80xx sensor in its final application is an important design decision since, in the extreme case where liquid would accumulate inside the tire and settle on top of the sensor package, the media filter may become obstructed (see Figure 4).

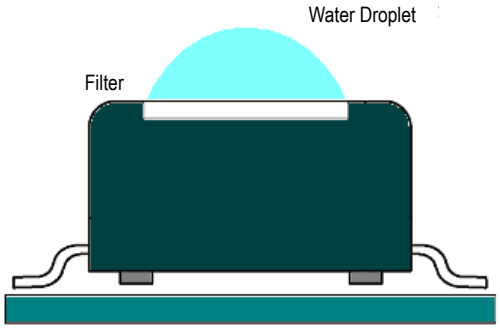

Figure 4. Filter Blockage

In addition to liquid possibly obstructing pressure transmission, liquid can be forced through the filter if it is present on the filter's exterior surface at a time when the device sees rapid pressurization such as when a tire is first installed on a rim.

In order to minimize the likelihood of liquid impacting the device's performance, it is suggested that the media filter on MPXY80xx family sensors faces outward and away from the wheel axis as depicted in Figure 5. This position of the sensor will take advantage of the strong radial forces experienced by the tire allowing for removal of water captured on top of, or inside, the package.

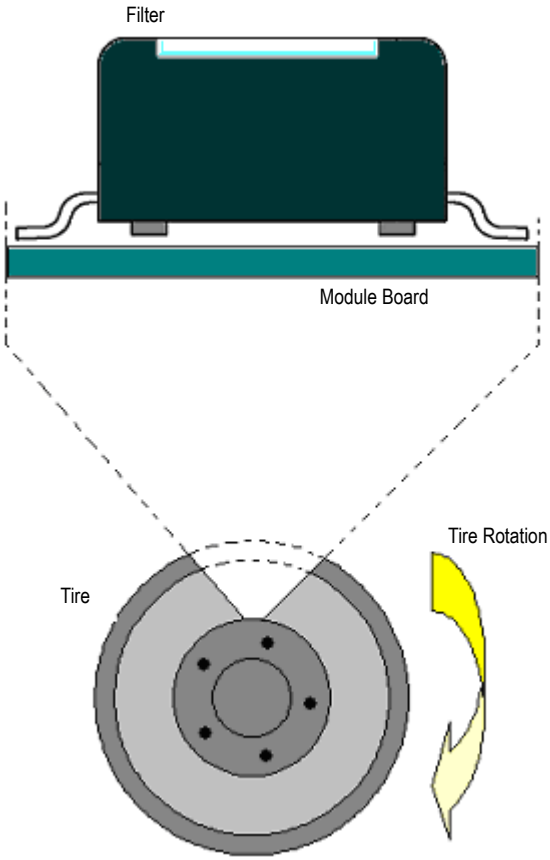

Figure 5. Filter Orientation

Vibration Related Considerations

During normal driving conditions, tire pressure monitoring systems are subjected to high levels of vibrations and strong dynamic forces as shown in an example of the P215/50R16 tire (refer to Figure 6). To ensure that the MPXY80xx family of sensors can withstand these harsh conditions, they are tested to acceleration and shock forces of up to 2000g.

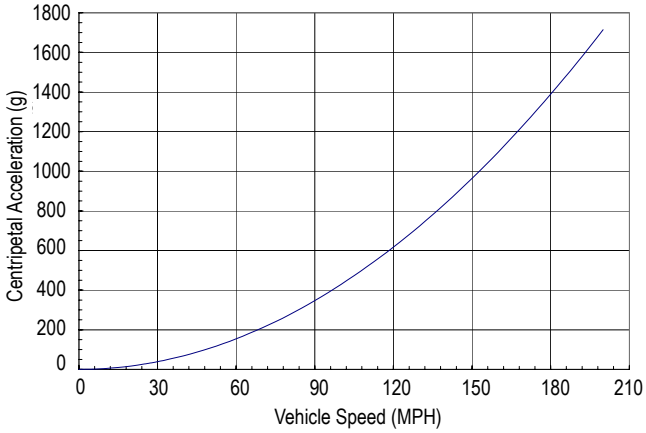

Figure 6. Centripetal Acceleration On a Rim Mounted Pressure Sensor for a P215/50R16 Tire

Due to these dynamic forces caused by the road conditions, the package leads may oscillate with the varying frequency. In order to prevent the board-level vibration failure caused by the driving dynamics, appropriate steps need to be taken when mounting the MPXY80xx family sensors to the system board. Quality automotive-grade components and assembly need to be used in order to prevent such failures. In addition to electrically protecting the MPXY80xx sensor's pins, potting and/or conformal coating techniques may help with the vibration failures and are commonly used as the final step in manufacturing the tire pressure monitoring systems.

SUMMARY

There are several important mounting considerations for the MPXY80xx family of sensors. In-tire environment demands that the sensor faces away from the wheel axis; this position takes advantage of the radial forces which will help remove any possible accumulated liquid off the integrated filter. The sensor position within the tire needs to be chosen such that the sensor is not immersed in the liquid for prolonged periods of time.

Dynamic forces induced by the driving conditions require that the board housing the MPXY80xx family of sensors is made with quality, automotive-grade materials. A non-conductive, potting material needs to be applied in order to protect electrically active parts on the system board from creation of unintended, electrically conductive paths.

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