Tire Pressure Monitoring, Part 2

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In Part 1, we examined Porsche's 959 tire pressure monitoring system, a world first. That system, known as *Reifen Druck Kontrolle* (or Tire Pressure Control) was added to Rest of World 928s for 1989 and to U.S. 928s built for 1990. Despite its promise, RDK was discontinued after just a few years. Why? The system was expensive, and some found it more of a hassle than a help.

For 2004, Porsche introduced a new, more advanced RDK system on its Cayenne SUV. The Carrera GT supercar also got RDK, and the system became available as an option on 2005's 997-based Carrera and 987-based Boxster. RDK became standard equipment on all Porsches built for sale in the U.S. after September 2007. While Porsche service documentation for the 997 refers to the system as Tire Pressure Monitoring System (TPMS), the RDK designation is used in all other models. You can, however, consider the two names interchangeable.

RDK has made a comeback because it had to. All new vehicles weighing less than 10,000 pounds sold in the U.S. after September 1, 2007 had to have a tire pressure monitoring system. The mandate comes under the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, signed into law on November 1, 2000 as a direct response to over 100 deaths caused by roll-over accidents attributed to tread separation on under-inflated tires.

Two general types of TPM technology exist: Direct Reading and Indirect Reading. Porsche has always utilized Direct Reading systems, which use a sensor in direct contact with the air pressure inside of the tire to transmit data to the car's onboard monitoring system.

Most Indirect Reading systems monitor the rotational speed of each tire through the anti-lock brake (ABS) system.

While the car was stationary, we induced a Stage 2 warning—as seen on this 997 Turbo's central information screen. The TPMS alert symbol with its exclamation point is on, as well.

As a tire loses air pressure, its rotational diameter becomes smaller. At any given vehicle speed, a smaller-diameter tire will rotate faster than a fully inflated tire. Indirect systems identify a faster rotating tire over a period of time; if the trend continues, the system determines the tire has lost pressure. If the rotational speed differential changes quickly enough, the system decides that the tire is going flat and alerts the driver. Indirect TPMS systems are less expensive to manufacture, but do not respond as quickly while tending to provide more false alerts.

When it became clear that tire pressure monitoring would become mandatory in the U.S., Porsche AG was already ahead of the game. Back in the 1980s, the company had recognized the advantages of tire pressure monitoring through racing and had developed a system for production vehicles — one more example of how racing improves all cars.

This time around, Porsche has developed a Direct Reading system that responds quickly to changes and provides the driver with internal tire-pressure data to help maintain the best handling performance while maximizing fuel economy. Besides safety and performance aspects, Porsche documentation identifies extended tire life as a benefit of correct inflation pressure. That's because reducing tire air pressure by just 4.3 psi from the recommended inflation can reduce a tire's service life by 25 percent.

This *Tech Forum*, then, will examine Porsche's latest take on RDK.

RDK for the 21st Century

The newer system utilizes advancements in electronics and battery technologies to allow for a system communication approach using high-frequency radio transmissions. The primary components are four wheel-mounted sensors (one per wheel), four signal-receiving antennae, a system control unit, and a pictogram display on the instrument cluster. Each wheel-mounted sensor contains a pressure-and-temperature-sensing unit, control electronics, a lithium battery, and a signal-transmitting antenna attached to each wheel rim at the valve stem. One RDK signal-receiving antenna is mounted in each of the four wheel housings, hidden from view by the fender liners. Each antenna sends its signals directly to the RDK control unit via a wiring harness. The pictogram responds to output information from the control unit.

Like the RDK system found in the 959 and 928, this more advanced RDK/TPMS system provides a two-stage warning. A pressure loss of 2.9–5.8 psi triggers a Stage 1 notification, where the pictogram illuminates and indicates the internal air pressure reading of the affected tire in real time. In the event of a Stage 1 warning, Porsche recommends drivers stop at the next suitable opportunity to correct the pressure loss. A loss greater than 5.8 psi (or a loss of more than 2.9 psi in less than one minute) triggers a Stage 2 alert, causing the pictogram to illuminate in red and indicate that the affected tire is going flat. In a Stage 2 warning, Porsche says that the driver should reduce speed and stop immediately to inspect the tire.

Each wheel sensor transmits specific information to the control unit including the sensor's unique ID number, the current absolute pressure in the tire, the air temperature in the tire, the status of the internal battery, and the status of the sensor's electronics. The sensor determines the interval at which data will be transmitted, either in the normal or high-speed mode. If tire pressure readings remain consistent, the sensor transmits data in the normal operating mode, measuring pressure and temperature every three seconds and transmitting the values once every 54 seconds. If the sensor measures a pressure loss of 2.9 psi in less than a minute, it starts to transmit in the high-speed mode, where both measurements and signal transmission take place every 0.8 second. If the pressure loss is corrected and remains stable, the sensor returns to the normal mode.

The wheel sensor's lithium battery has an expected useful life of five to ten years, with seven years considered the average. Porsches built for sale in North and South America or Europe utilize wheel sensors that transmit at a radio frequency of 433 MHz, while Porsches built for Asia or Africa utilize 315 MHz. Note: System components with one frequency range are not compatible with those using the other frequency.

RDK System Learning

When a wheel is removed for cleaning, brake work, or tire installation and then reinstalled at the same position on the car, the RDK system should not be affected. However, if a new wheel sensor is installed or if the positions of existing wheel sensors are moved (such as during a tire change or rotation), the system must go through a multi-part identification and learning process.

TOP LEFT: Close-up view of wheel sensor and valve stem shows how valve stem and sensor attach with a thread-locking screw. Valve stem mounts through wheel with black gasket sealing against inside of wheel rim. Lower left corner of the wheel sensor has a reference to 433 MHz. TOP RIGHT: 2008 wheel sensor, Porsche part number 997.606.021.01; a quarter provides a sense of sensor's size. ABOVE: 433 MHz receiving antenna next to a quarter; one is mounted at each corner of the car and hidden by the wheel liner. LEFT: Making a choice here starts the wheel sensor learning process.

Because each wheel sensor transmits its unique ID number, the RDK control unit will learn and remember each wheel sensor's ID number and, most importantly, which position on the car that sensor ID number is mounted. This is how the system can identify pressure loss at a specific wheel.

To initiate the learning process, first make the system aware that a change has taken place through the on-board computer's "RDK Settings" menu. For safety reasons, this menu can only be accessed by the driver when the vehicle is stationary. In Cayennes, enter or reconfirm wheel size; in 987/997 Boxsters,

Carreras, or Caymans, enter or reconfirm between winter and summer tires.

Your entry will trigger RDK's learning mode, where it identifies specific wheel-sensor ID numbers as well as where each sensor is located. Failure to initiate the learning phase will cause the system to stop functioning. That's because RDK will identify that the wheel-sensor ID number(s) and/or locations have changed as soon as the vehicle is driven. The instrument cluster will then display "Wheel Change? Check Settings." RDK remains non-operational until the learning process is completed.

The vehicle must be driven during the two learning phases that follow. The system receives each of the four wheel sensors' radio-transmitted ID numbers multiple times (once every 54 seconds). As the system continues to receive the same four signals repeatedly, it begins to recognize these four specific ID numbers and then expects to receive them. Be sure that no other wheel sensors are in the car during this phase, as another signal may prevent the system from identifying the pertinent sensors.

Since no pressure monitoring occurs during the first part of the learning process, the RDK warning display remains illuminated. Once RDK has learned the four wheel-sensor ID numbers, the warning display turns off and it begins the next step. As the car continues to be driven, RDK's control system associates each wheel sensor ID number with a wheel position on the vehicle. Each wheel housing has an RDK signal-receiving antenna and the control unit identifies the antenna at which the strongest signal is received for each wheel-sensor ID number, then assigns the sensor to that location.

Porsche says that the overall learning process can take up to 30 minutes. Keep in mind that, after initiation of the learning phase, the vehicle must be moving for the remainder of the process. Wheel-sensor ID numbers and their positions on the car will remain in the system's memory until a change is detected or the system is prompted to restart the learning process. Each time the ignition is turned on, the system will reconfirm all data in its memory and, if changes are detected, RDK will stop functioning.

System Problems

Any fault in the RDK system will cause the system to shut down and no display will be available. In order to access and diagnose all issues within the RDK/TPMS system, a Porsche Integrated Workstation Information System (PIWIS) should be utilized. However, other code readers or diagnostic testers may provide system access; when using an aftermarket code reader, check with the equipment manufacturer for its recommendations.

The most common problem with modern RDK occurs when a wheel sensor's battery voltage drops below the minimum threshold value necessary to continue operation. Another common problem is wheel sensor electronics failure. When this happens, the warning pictogram may illuminate with dashed lines next to the wheels (----), indicating that no signal is being received from the sensor.

To test the wheel sensors of a Cayenne, a technician will connect a Porsche tester to the car, proceed to the TPM section, and select the "Last Identification Received" category. In the next screen, he or she should choose all four options: 1. Wheel Identification; 2. Wheel Electronics; 3. Remaining Service Life of Identification; 4. Relative Tire Pressure (actual). After hitting "Enter," the next screen should show the ID number of the wheel sensor in question; however; the critical information is Remaining Service Life of Identification. The sensor is either "IO" (in operating specification) or "NIO" (not in operating specification). Any sensor showing NIO must be replaced.

All other Porsche models use another process to identify a wheel sensor's remaining battery life. After connecting a Porsche or other suitable testing system to the vehicle, access the TPM section and choose the "Actual Values" option, then choose "Remaining Service Life of Battery." The system tester will then identify the expected remaining battery life in months. If the sensor shows zero battery life, it must be replaced.

To avoid having a wheel sensor battery expire unexpectedly, remaining battery life should be determined before replacing tires — as access to the wheel sensor is only possible when the tire is off of the wheel. Consider the miles you drive per month to determine the approximate timeframe when your new tires will be worn and require replacement. The remaining sensor battery life must easily exceed expected tire life. If not, the sensor(s) should be replaced.

Cayenne-specific RDK Problems

A problem relating to the 2004 (manufactured in 2003) Cayenne S and Cayenne Turbo is a loss of communication between the RDK control unit and the multi-function instrument cluster display. When pressure loss exceeds the system's warning threshold of 5.8 psi, the display illuminates. However, the warning cannot be cleared when pressure is corrected — even after repairing or replacing the tire.

The problem can be repaired by resetting the RDK control unit. To do so, briefly — *with the ignition off* — remove and reinstall fuse #24 on the dashboard fuse box to interrupt power. The fault memory can now be erased and the RDK system should operate. If this problem persists frequently, replacing the original control unit (part number 955 618 160 03) with the later version (part number 955 618 160 04) will resolve this issue.

Another issue with the Cayenne RDK system is its first-generation wheel sensor electronics, which are not compatible with second-generation units. Corrosion at grounding connections and at crimped wiring locations can also create issues; cleaning the contacts is the solution. Additional issues with damage to wheel-sensor antennae as well as cable routing have also been identified.

997/987-specific RDK Problems

Some 2005–08 997 sensors provide incorrect tire-pressure values, which can vary from relatively minor to significant inaccuracies. To confirm proper operation, check the values on the RDK/TPMS readout against those taken with a high-quality tire-pressure gauge when the tire's temperature is cold (68° F).

The right and left tires on each axle should be set at the same pressure. An example would be 36 psi for front tires and 44 psi for the rears. If the tire-pressure gauge's reading indicates that both left and right front tires have a consistent pressure reading of 36 psi while the RDK system indicates that the left front is 36.5 psi while the right front reads 29 psi, a discrepancy obviously exists. The system should be checked with a PIWIS tester, but it's likely that a front wheel sensor needs to be replaced. It should be noted that absolute pressure value readings between the RDK system and a tire-pressure gauge may vary somewhat.

Another issue seen on 2005–08 997s occurs when a driver goes to open the TPMS settings menu to set tire type to start the learning function and the menu cannot be found because the information window on the instrument panel has gone blank. This problem requires a full reprogramming of the instrument cluster.

Second-generation 997 RDK

The 2009-on 997 comes with a number of technical and system advances.

One is the second-generation Tire Pressure Monitoring System. Pressure information is displayed much sooner after engine start and the learning process for wheel-sensor ID numbers as well as sensor position has been improved.

The system configuration also changed to utilize a digital central antenna located in the center tunnel, between the coolant lines. This antenna receives signals from the wheel electronics, which are digitized at the antenna and sent to the control unit via two Local Interconnect Network (LIN) bus lines. Each of the four wheel housings still have an antenna, but these units now send a 125 KHz triggering signal to their respective wheel sensor electronics at each corner of the car. The triggering signal tells the wheel sensor that it's time to send data to the central antenna. The 997-2 TPMS control unit is designed to receive both 433 and 315 MHz signals. However, if a replacement control unit is installed, the unit must be coded to receive the zone-appropriate frequency. North and South America and Europe retain the 433 MHz signal.

The wheel sensor includes pressure and temperature sensors, a roll switch, measuring and control electronics, a receiver, a transmitter, and a battery. The roll switch identifies whether the wheel is turning or stationary and switches the wheel electronics off when it's stationary for a long period of time.

Each wheel sensor's electronics receive a send request (trigger) from the control unit to send information once per minute when the vehicle is moving. Each trigger sequence starts with the left front wheel and goes clockwise around the car to the left rear wheel. The use of this triggering signal and sequence makes it easier for the control unit to identify and learn the wheel sensor's ID number and position because each wheel sensor is responding to the control unit's request.

The process of learning the ID numbers and their position on the car must still take place. However, once the tire type is entered in the TPMS menu and the car is driven, the learning process should take only a few minutes. Every time the vehicle is unlocked, a trigger sequence takes place so that tire pressures will be available about five seconds after the engine is started. If one wheel sensor fails, the system will continue to operate — a clear advantage over the earlier system.

The latest system generates "soft" and "hard" warnings depending on pressure loss and vehicle speed. A soft warning is

issued if tire pressure is down 4.0–7.0 psi over a long period of time and a vehicle speed between 0 and 100 mph is maintained. The soft warning illuminates for approximately 10 seconds in white text when the ignition is turned on or off. A hard (or puncture) warning comes when tire pressure loss exceeds 7.0 psi for speeds up to 100 mph, or if pressure loss exceeds 6.0 psi at speeds over 100 mph and/or if tire pressure is decreasing faster than 3.0 psi per minute. The hard warning display illuminates in red whenever the pressure losses or speed criteria is exceeded; this display will remain on until the pressure is corrected.

Conclusion

Whether your Porsche has a tire pressure monitoring system or not, check tire inflation values at least once a month and correct them as needed. If your RDK/TPMS system is not working properly, find out why and get it corrected — as this technology can pay real dividends.

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