RF Test System R&S®TS 7810

Testing tire pressure sensors in the automotive industry

The RF Test System R&S®TS 7810 is designed especially for the fast growing market of tire pressure sensors. By using standard equipment such as the Spectrum Analyzer R&S®FSP 3 or the Open Test Platform R&S®CompactTSVP, the R&S®TS 7810 can be quickly adapted to meet project-specific requirements. For use in production, development and quality assurance, Rohde & Schwarz provides both the turnkey system and individual system components.

Tire pressure sensors are becoming standard

In the recent years, the safety of automobiles has continuously increased. Nevertheless, in 30% of the serious accidents that occur due to technical defects of the vehicle, the accident cause can be attributed to the tires. A number of tragic accidents in the USA, for example, happened as a result of a specific tire model having too low a pressure. In the coming years, in the USA all vehicles up to five tons must therefore be equipped with a tire pressure monitoring system (TPMS).

Primarily, two different methods are currently used for measuring tire pressure: An indirect measuring system that uses ABS sensors, and a direct measuring system that uses sensors with radio interface built into the tire. The indirect measuring system uses the information of the ABS sensors for calculation and calculates changes in tire pressure from the different tire speeds. This system can be implemented economically but has the disadvantage that tire speed cannot be measured when the vehicle stops or when the pressure of two tires drops simultaneously. Direct measuring systems with sensor technology are thus expected to gain the upper hand on the market.

In addition to tire pressure, tire temperature and acceleration are also transmitted to the central control unit in the vehicle. The tire pressure sensor is a potted, LSI module and basically contains a sensor chip with µ-controller and an ISM transmitter that generates the RF signal. It is powered by a lithium battery with a lifetime of up to 100 000 km. There are also ways to supply power by means of the tire vibration energy or by using an external magnetic field via a coil within the wheel housing. The European Union already supports this tech-

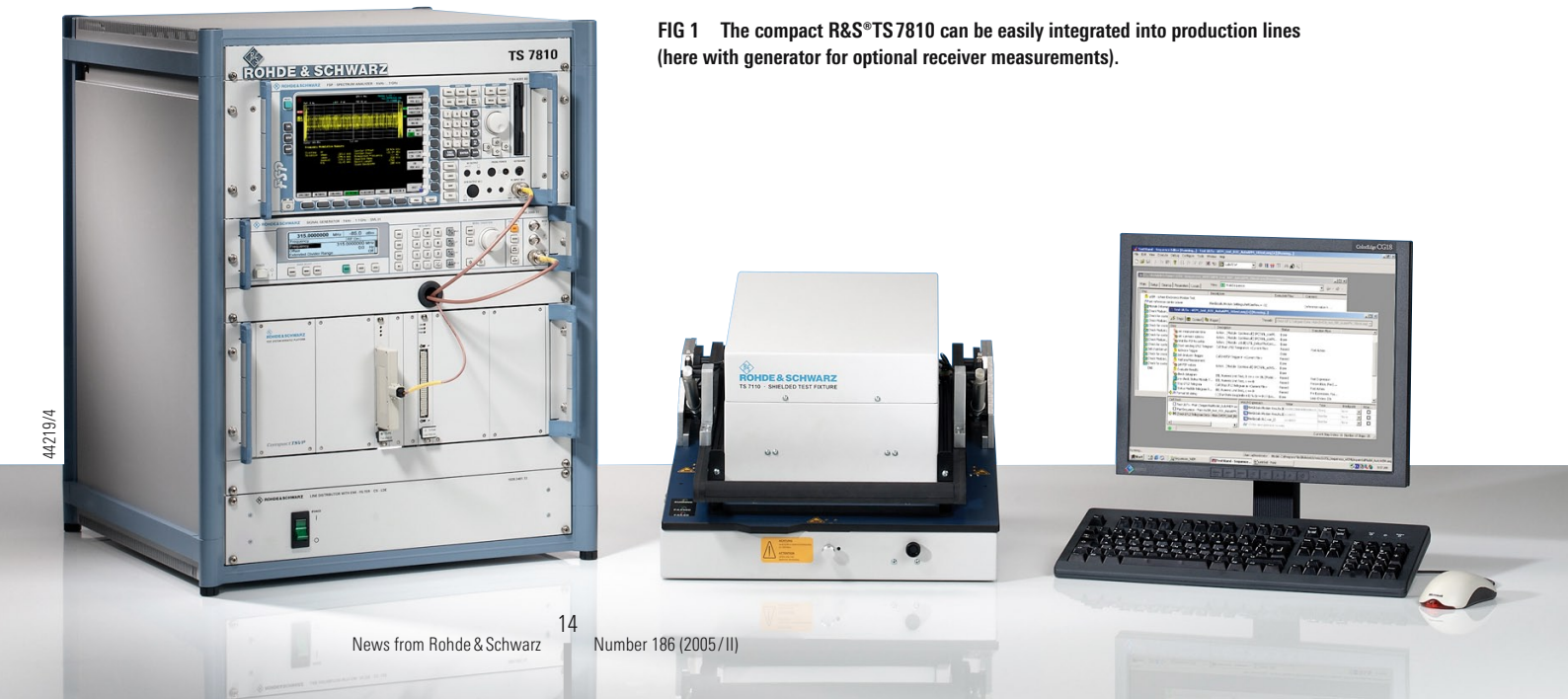

FIG 1 The compact R&S®TS 7810 can be easily integrated into production lines (here with generator for optional receiver measurements).

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nology with research programs, and tire pressure sensors are expected to become standard equipment in all vehicles over the next ten years.

Versatile and compact

With the R&S®TS 7810, Rohde & Schwarz now provides an all-in-one test solution for the fast growing TPMS market (FIG 1).

This test system includes the CompactPCI/PXI-based Open Test Platform R&S®CompactTSVP [1], the R&S®GTSL system software, the Spectrum Analyzer R&S®FSP 3, the Shielded RF Test Fixture R&S®TS 7110 [2] as well as customer-specific test sequence adaptations.

A pressure-proof chamber simulates tire pressure inside the R&S®TS 7110 test fixture. Different pressure values can be set by means of a programmable pressure control unit. Since the R&S®TS 7110 is RF-shielded, several test systems can be operated in parallel without affecting each other.

Which standard?

There are a number of license-free radio bands (ISM: industrial, scientific, medical) in the frequency range from 100 MHz to 3 GHz. They are used for transmitting short data packets. Europe transmits in the 433 MHz and 868 MHz bands while the USA and Japan use the 315 MHz and 915 MHz bands. The 2.4 GHz band is freely accessible worldwide.

The Spectrum Analyzer R&S®FSP 3 covers this wide frequency range. By adding the optional FM Measurement Demodulator R&S®FS-K7, the R&S®FSP 3 also measures the different modulation modes such as on-off keying (OOK), amplitude shift keying (ASK) and frequency shift keying (FSK).

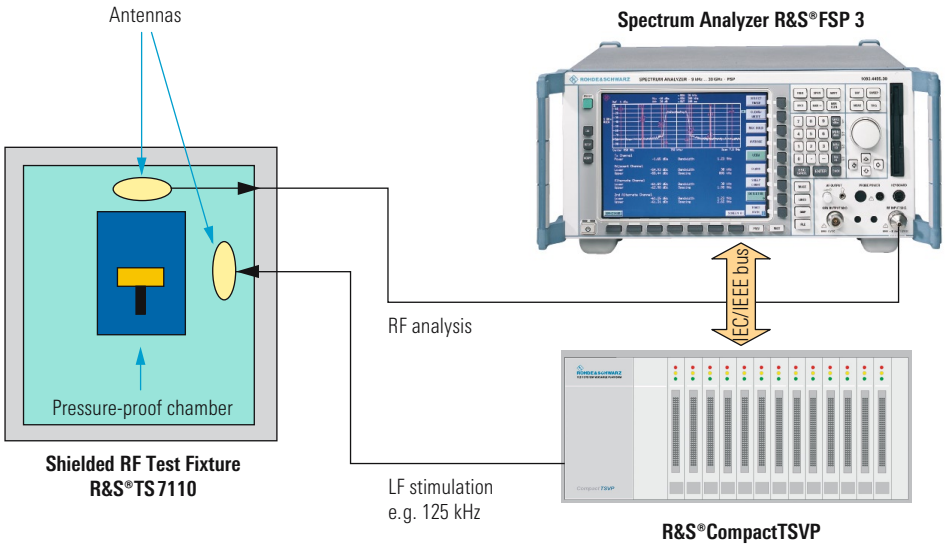

FIG 2 Stimulation and measurement of a tire pressure sensor.

TPMS receiver modules can be easily tested simply by expanding the R&S®TS 7810 by a signal generator. The RF test system thus covers applications not only in the automotive industry but also in industrial and consumer electronics.

Comprehensive tests

The automotive industry requires its suppliers to perform extensive tests including documentation of the test results for each single part. Only an automatic test system such as the R&S®TS 7810 can meet this requirement.

The R&S®GTSL system software, which controls all test runs, issues the start command for a measurement. The software's open architecture makes it easy to integrate the R&S®TS 7810 into fully automatic production lines. The Open Test Platform R&S®CompactTSVP, which was specially designed for testing modern automotive electronics, then generates a 125 kHz LF data telegram that stimulates the tire pressure sensor in the test fixture (FIG 2). If necessary, you can expand the R&S®CompactTSVP with additional CompactPCI/PXI measurement and control cards for communicating with the production cell or for programming µ-controllers on printed boards, for example.

An antenna module with an amplifier in the R&S®TS 7110 transfers the transmitted data to the Spectrum Analyzer R&S®FSP 3, which measures the most important RF parameters such as RF power, RF frequency offset and frequency deviation in one cycle and demodulates the data telegram (FIG 3). The R&S®FSP 3 then transfers the digitized data telegram content to the controller, where the system software analyzes the data telegram content together with the TestStand® sequencer from National Instruments. Contents such as pressure or temperature are displayed clearly and concisely.

If the vehicle is moving, each tire pressure sensor transmits three to five data packets per minute with a period of approx. 10 ms and makes variable pauses of about 100 ms between each packet (FIG 4). The individual data telegrams of the four tires can superimpose on each other and can no longer

be properly decoded. The method used therefore ensures that the packets in the next transmission window are sent with a time delay and that each individual tire is clearly detected by the central receiver module.

Transparent data analysis

Software libraries in the standard programming language C let you change data telegram analysis without any special knowledge. An open source code allows quick adaptation to customer-specific requirements. Since all these functions interact optimally, test times are extremely short, making for high throughput in the production line.

Each tire pressure sensor transfers a unique ID number together with the pressure, temperature and acceleration data. The central receiver can thus clearly detect the respective tire, even after a tire change (FIG 5). A checksum at the end of the data telegram prevents erroneous analysis of the content.

Summary

With just 15 height units, the compact R&S®TS 7810 can be easily integrated into any production line. As an all-in-one turnkey solution, the system is also ideal for development, quality assurance and incoming goods inspection. If you want to integrate your own system components during a project, you can complement them with individual units and software modules of the R&S®TS 7810, for example to retain the software user interface you are familiar with.

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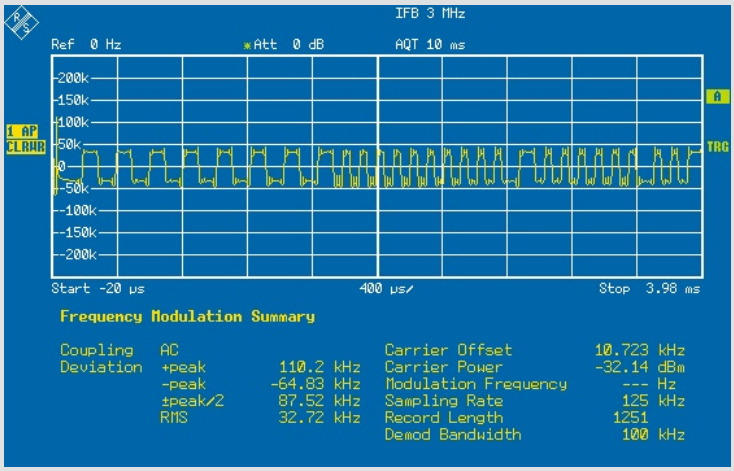


FIG 3
Demodulated data telegram with the FM Measurement Demodulator R&S®FS-K7.

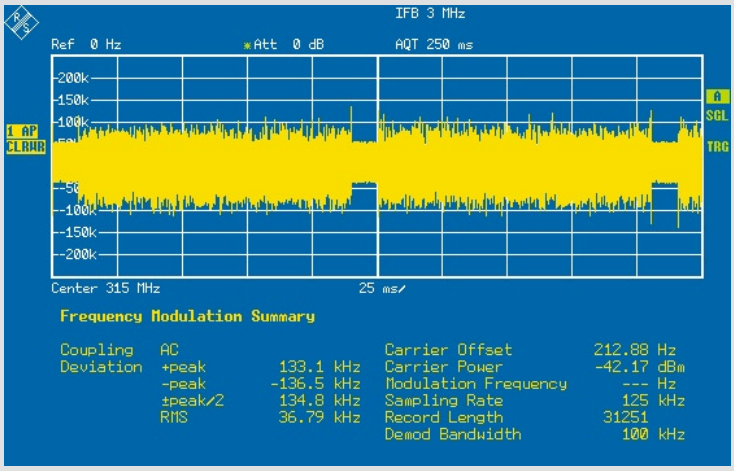
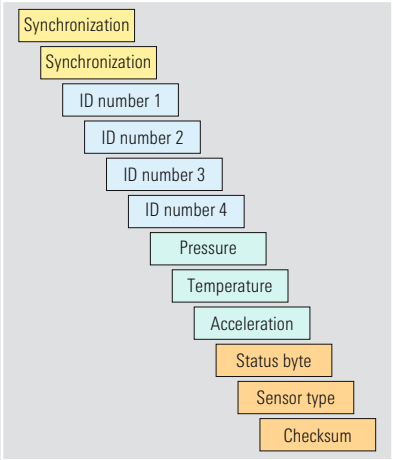


FIG 4
Repetition of three consecutive data telegram with variable pause.

FIG 5
Typical structure of a data telegram (12 bytes).



More information at www.testsystems.rohde-schwarz.com (production test)

REFERENCES
[1] Open Test Platform R&S®CompactTSVP: Modular test equipment based on CompactPCI/PXI. News from Rohde & Schwarz (2003) No. 180, pp 14–20
[2] Versatile Shielded RF Test Fixture R&S®TS 7110: Test fixture for modules and units with radio interface. News from Rohde & Schwarz (2003) No. 179, pp 4–7