RF Test System R&S®TS7810

Testing tire pressure sensors in the automotive industry

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®TS7810 can be easily integrated into production lines (here with generator for optional receiver measurements).
technology with research programs, and
tire pressure sensors are expected to
become standard equipment in all vehi-
cles 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 Spec-
trum Analyzer R&S®FSP3, 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 pres-
sure 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, medici-
al) 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®FSP3
covers this wide frequency range. By
adding the optional FM Measurement
Demodulator R&S®FS-K7, the R&S®FSP3
also measures the different modula-
tion modes such as on-off keying (OOK),
amplitude shift keying (ASK) and fre-
cquency shift keying (FSK).

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 applica-
tions not only in the automotive indu-
try but also in industrial and consumer
electronics.

Comprehensive tests

The automotive industry requires its sup-
pliers to perform extensive tests includ-
ing 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 soft-
ware’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 test-
ing 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 mea-
surement and control cards for commun-
icating with the production cell or for
programming µ-controllers on printed
boards, for example.

An antenna module with an ampli-
 fier in the R&S®TS 7110 transfers the
transmitted data to the Spectrum Ana-
lyzer R&S®FSP3, 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®FSP3 then transfers the digi-
tized data telegram content to the con-
troller, where the system software ana-
yzes 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 pres-
sure 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 tele-
grams of the four tires can superim-
pose 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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