Bedienungsanleitung TSS-System Generation 1.5 User Manual TSS-System Generation 1.5	Dokument-Nr.: *Document no.:*	Änderungsstand: *Revision status:*	Index: *Index:*
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1 System and function description

Section 15.19: Labeling requirements
This device complies with Part15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

Section 15.21: Information to the user
The user manual or instruction manual for an intentional or unintentional radiator shall caution The user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1.1 System description

The Tire Safety System (TSS) controls and monitors tire pressures.
The system comprises the following components:

- 1 TSS control unit
- 4 TSS wheel electronics units including valve
- 4 TSS digital antennas

The basic function of the system is to monitor tire pressure during driving.
An electronic unit fitted inside the tire measures the tire pressure and the temperature at regular intervals and transmits the data telemetrically via a HF link to a reception antenna fitted in the wheel housing. In the reception antenna the radio data telegram is decoded and forwarded as a digital signal to the electronic control unit. The control unit evaluates the received data and passes on the information as necessary to the driver, who is then made aware of the need to adjust tire pressures or of a possible puncture situation.

Benefits of the Tire Safety System:

- Safety
  An early warning of rapid pressure loss is given.
  Tire blowouts, resulting from excessive flexing energy caused by driving too fast at low pressures, are avoided.
  The driver is prompted to adjust the tire pressure as necessary.

- Convenience
  Checking of tires is simplified. It is only necessary to remove valve caps and use filling station air dispensers when an adjustment of tire pressure is actually required.

- Tire innovations
  Tires with flat-running capabilities mean it is no longer necessary to change a wheel immediately and make the spare wheel superfluous, but they do demand continuous monitoring of tire pressure.

- Durability and economy:
  Tire wear is minimized because correct air pressure is maintained.

The system's major additional function is its automatic facility to learn the wheels belonging to the vehicle in question (vehicle wheel identification) and the fitting positions of the vehicle wheels (wheel position detection).

During normal driving this enables the system to match the wheels to the appropriate wheel positions and set the correct pressures without involving the driver.

Optional additional functions cover tire pressure monitoring at standstill:

- Flat tire alert before driving off

2 Function description

The wheel electronics units are fitted inside the tires and measure the tire pressure and the temperature of the wheel electronics. A transmitter in the wheel electronics transmits the measured data from the wheel. For tire pressure monitoring a system with relatively infrequent data transfer is adequate, provided it also has the facility to detect rapid pressure loss. Consequently, the electronics in the wheel can be designed for minimal power consumption and be battery operated.

Each wheel electronics unit has its own ID which is transmitted along with every data transfer. The HF transmission is executed in the 433 MHz range, the so-called ISM band, or in some countries in the 315 MHz range.

Each wheel electronics unit transmits data every 54 seconds. It also measures the tire pressure and the wheel electronics temperature every 3 seconds. In the event of a pressure loss of > 0.2 bar relative to the last pressure value transmitted, the wheel electronics immediately switches to a fast-transmit mode, measuring and transmitting the data every 0.8 seconds.

This means the TSS measures and transmits a considerably greater volume of data than is essential to ensure basic functioning. Consequently, it is able to utilize a data transmission path which does not rely on error-free transfer of each individual data protocol. The data are transferred from the wheel to the vehicle by unidirectional HF transmission. In this mode of HF transmission data telegrams may be subject to disturbance from random external interference sources or from statistical fluctuations in the reception amplitude resulting from varying reception conditions in the wheel housing in respect of wheel rotation and position.

The data transmitted by the wheel electronics are received and decoded by the antennas mounted in the vicinity of the wheel. The decoded data are transmitted via a digital interface (LIN interface) to the control unit.

The control unit evaluates the received data and passes the information as required to the driver information system, so making the driver aware of the need to adjust tire pressures or of a possible puncture situation.

- A central warning algorithm and wheel management algorithm
- The vehicle-specific onboard power system interface and manufacturer-specific operator control and display philosophy

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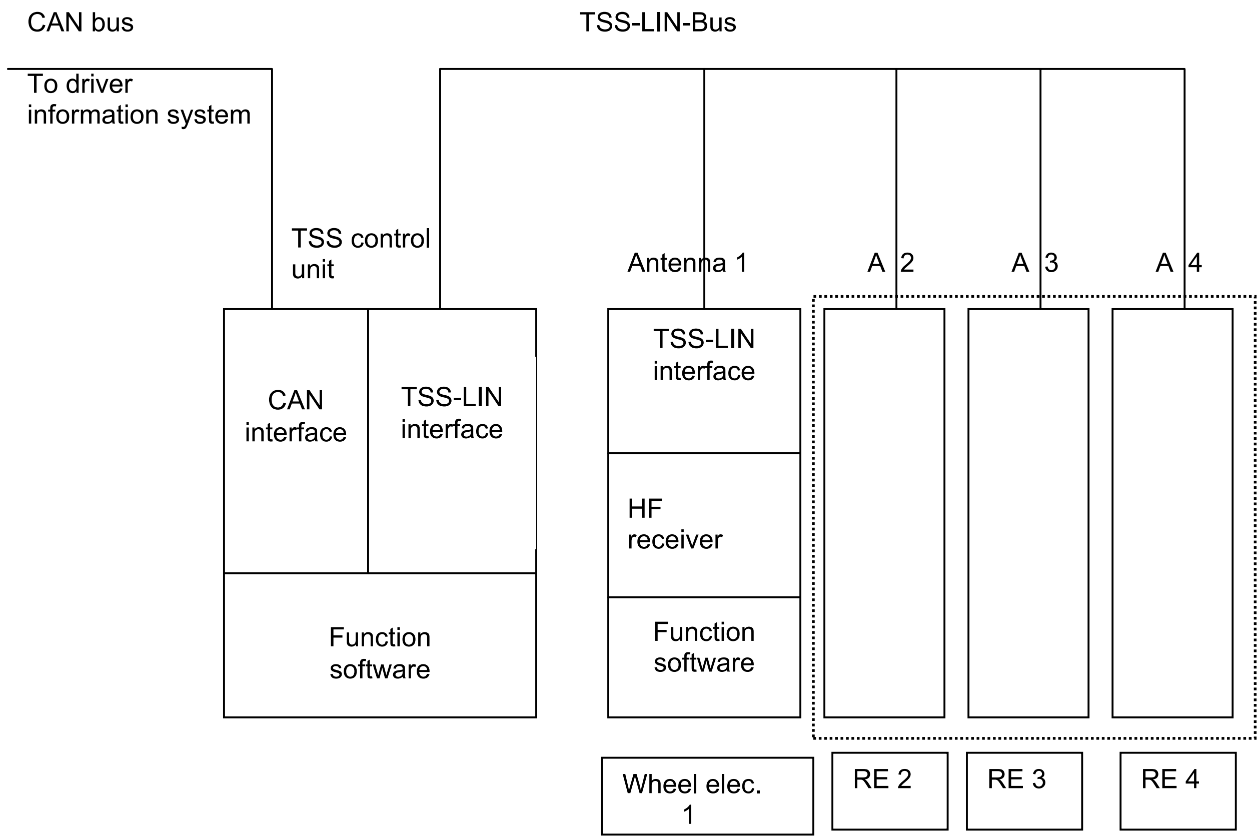


Figure 1 - Block diagram, TSS system generation 1.5

3 System components

The components of the TSS are presented in the following.

3.1 Control unit

The electronic control unit comprises a circuit board with a microprocessor control, a CAN bus interface and a TSS-LIN bus interface.

The control unit captures and evaluates the tire information received from the digital antennas. The pressure data, and warnings as and when required, are transmitted over the CAN bus to the vehicle's display systems.
The data from the digital antennas are transmitted via a LIN communication link to the control unit. The control unit is the LIN master, while the antennas operate as slaves. The following sections set out the key data of the control unit.

3.1.1 Temperature range

Operating temperature:	-40°C ... +80°C
Storage temperature:	-40°C ... 120°C

3.1.2 Voltage range

Terminal 30, rated voltage:	12V
Terminal 30, operating voltage:	9V ... 16V
Terminal 30, maximum voltage:	0... +27V, with inverse-polarity protection
Voltage overload shutdown:	Control unit shutdown at U_B > 27V
Low voltage shutdown:	Control unit shutdown at U_B < 6V

Number of suppliable digital antennas: 5

3.1.3 Terminal assignment

Design: Pin trough with 90° angled solderable pins
Number of contact pins: 32 pins

1	Terminal 31 Gnd	17	---------------------------------
2	Terminal 30 Battery positive 12V	18	---------------------------------
3	---------------------------------	19	---------------------------------
4	---------------------------------	20	---------------------------------
5	LIN GND RR	21	---------------------------------
6	LIN_DATA_RR	22	LIN_V1_RR
7	LIN_DATA_HR	23	LIN_V1_HR
8	---------------------------------	24	LIN_GND_HL
9	LIN_DATA_HL	25	LIN_V1_HL
10	LIN_DATA_VR	26	LIN_V1_VR
11	LIN_GND_VL	27	LIN_GND_VL
12	LIN_DATA_VL	28	LIN_V1_VL
13	---------------------------------	29	---------------------------------
14	---------------------------------	30	---------------------------------
15	CAN bus 1, high	31	CAN bus 2, low
16	CAN bus Gnd (= terminal 31)	32	---------------------------------

3.1.4 CAN bus interface

Bus: Convenience CAN system

CAN specification: CAN Low Speed Class B ISO DIS 11519

Communication partners: All systems on the convenience CAN, particularly instrument cluster and CAN/CAN gateway

3.1.5 CAN interface data

Driver block: TJA1054
Can H / Can L wire: Short-proof against GND and +UB

CAN bit rate: 100 kBaud +/-5%

3.2 Wheel electronics

The wheel electronics unit registers the tire pressure and the air temperature in the tire and transmits it over a predefined radio link together with the remaining battery life and the ID to the adjacent digital antenna.

3.2.1 Fit space

The wheel electronics unit is fitted together with a valve on the wheel rim, and sits in the well base.
The BERU fitting instructions must be followed.

3.2.2 Versions

Because of the differing country-specific approval conditions for radio-assisted electronic systems, based on local circumstances such as operation of military radio communications, private mobile radio systems etc., different variants of the wheel electronics units transmitting on different carrier frequencies are required.

- **433 MHz wheel electronics unit**
- **315 MHz wheel electronics unit**

3.2.3 Temperature ranges

Operating temperature: -40°C ... +120°C

3.2.4 Power supply

Battery life, averaged: 7 years

3.2.5 Pressure measurement

Measuring range: 0 to 6.375 bar, absolute

3.2.6 Temperature measurement

Measuring range: - 40°C to + 120°C

3.2.7 Battery monitoring

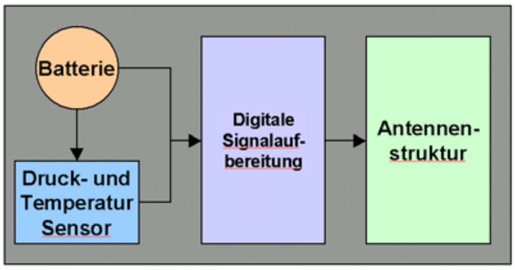
At the end of each transmission the remaining battery life is measured.

3.2.8 Transmission rate

9.6 k bps +/- 10%

3.2.9 Block diagram

The adjacent diagram shows the basic electrical structure of the wheel electronics.



For measurement of the absolute pressure a relatively low frequency of measurement data transmissions is sufficient, but a pressure loss must be transmitted immediately. The wheel electronics unit adjusts automatically to the various operating modes in order to carry out these functions at minimum power consumption.

Transmitting intervals

1. Normally each wheel electronics unit measures the tire pressure and the approximate temperature of the air in the tire every three seconds, but if the measured values are stable transmissions are executed only every 54 seconds.

2. At a pressure loss of more than 0.2 bar per minute, the wheel electronics unit switches temporarily to an alarm mode at a high transmission frequency.
   It then measures and transmits data every 0.8 seconds. This power management system permits battery-powered operation with adequate durability.

Safety instructions for battery:
Dispose of used batteries in accordance with local legislation.

3.3 Antenna

The digital antenna has a built-in signal processor (decoding processor) to receive and decode the HF signals transmitted by the wheel electronics. The processed information is transmitted via a LIN communication link to the TSS control unit.

3.3.1 General dimensions and data

Receiver bandwidth:	550kHz @ -85dBm / 20°C
Modulation type:	FSK, hard keyed
Radio data rate:	9.6 kBaud +/- 10%

3.3.2 433 MHz digital antenna

Radio reception frequency:	433.92 MHz +250kHz / - 250 kHz

3.3.3 315 MHz digital antenna

Radio reception frequency:	315.00 MHz +250kHz / - 250 kHz

3.3.4 Power supply

Supply cable:	Two-wire cable, U_{batt} , Gnd for each digital antenna
Supply voltage:	> (U_{batt} – 2V)

3.3.5 LIN communication with TSS control unit

The LIN communication of the antennas with the TSS control unit conforms to the LIN Consortium specification, version 1.1. The TSS control unit operates in master mode and the antennas in slave mode.

Key data:

LIN bit rate:	10 kBaud +/-2%
LIN driver:	Philips TJA 1020

3.3.6 Terminal assignment, socket connector

Design:	Pin trough
Number of contact pins:	4 pins
Pin design:	Sealed, gold-plated
Pitch:	2.54 x 2.54 mm

Pin:	Signal:	Description:
1	LIN_GND	Signal reference
2	LIN_V1_XX	LIN supply voltage
3	LIN_DATA_XX	LIN data line
4	LIN_GND	Signal reference

XX: Wheel position: Reference to control unit pin assignment

3.3.7 Block diagram

The diagram below shows the basic electrical structure of the antenna electronics.