SYSTEM DESCRIPTION TPM KOMFORT ECU

1.1 TPM FUNCTIONALITY

The main function of the TPM system is to monitor all four tyre pressures during driving operation and at standstill.

LF trigger transmitters request periodically the wheel electronics to send datagrams containing information about tyre pressure and temperature. The system is able to detect the wheels fitted to the vehicle and their relative installation positions. This is achieved by analysing the triggering position and by performing a statistical analysis of the received information.

1.1.1 TPM System Interfaces

The trigger transmitter interfaces with the TPM Komfort ECU by means of a dedicated & proprietary LIN bus. The TPM control unit diagnoses the individual system components.

The TPM control module interfaces with the Driver Information Panel (DIP) and the Infotainment Unit (ZAB) by means of the Komfort CAN network.

1.1.2 TPM User Interface

The interface with the user is made via the ZAB and the DIP. The DIP shows to the driver any warnings in the form of TPM specific symbols and text. The ZAB presents information regarding the state and condition of each tyre pressure. The driver requests a system calibration (system learning) through the ZAB (shown below).

1.1.3 TPM System Configuration

There are two possible system configurations, dependent on radio frequency (RF) used:

- 315 MHz configuration for some Asian and African markets
- 433 MHz configuration for ROW (including NAR & Europe).

1.2 WHEEL MANAGEMENT

1.2.1 Overview

The TPM system detects automatically the wheels fitted into the vehicle. The system performs a statistical analysis of the received data in order to recognize which wheel electronics and in which position are the wheels installed in the vehicle.

In order to prevent other vehicles with TPM systems from causing interference at standstill, the "learning" or calibration is performed only when the vehicle is in motion.

The TPM system achieves wheel management by performing the following actions:

1) Wheel Detection	During this phase the system wheels are learned. If all wheel electronics respond with at least 2 datagrams to a trigger request, then all wheel electronics are marked as system wheels
2) Wheel Position Detection	The wheel position detection is done by using the response to the trigger signal. Once the positions of the wheel electronics have been clearly identified, the positions are stored in a non-volatile memory (EEPROM)

3) Running Wheel Detection	In order to support the wheel position detection a distinction is made between the spare wheel and the running wheels. This is achieved by using the information from the roll switch in the wheel electronics.
4) Confirmation	The confirmation phase enables the system to learn automatically any change of the wheel positions. This check is performed while the vehicle is in motion in order to avoid potential timeout because of non-reception while the vehicle is at standstill.

1.2.2 Wheel Detection

With the aim to perform wheel detection the system counts the number of responses to a trigger request. The system detects that a wheel is a system wheel when a wheel electronic (with its unique ID) has given at least two positive responses (2 or more) to trigger events at the same position and when the control unit has analyzed the result.

The system shall detect the wheels fitted within 3 minutes from the moment the vehicle is set in motion. If at least one of four wheels are not detected within three minutes then a DTC is recorded in memory and “System Fault” message is issued to the kombi.

1.2.3 Wheel Position Detection

An association matrix (ZOM), relating wheel electronics position and ID, is used to count the number of immediate responses that a wheel electronic (with unique ID) gives to the request of a trigger device. The counting is done in increments of 1.

Since the effective low frequency radio transmission sphere of a trigger device is limited, only one wheel electronic will normally respond to the request signal.

The wheel position detection is completed when:

- There is exactly one wheel ID with maximum counter value for each of the trigger positions, and if this counter value is higher or equal than a preset limit (parameter)
- The four running wheels have been clearly identified, i.e. no counter value for a certain trigger position will be higher than a preset value in the init- phase after the TSS sees first power supply.

The status “Assigned” is then reached.

The management of a spare wheel is not implemented.

1.2.4 Running Wheel Detection

The information of the roll switch contained in the wheel electronics is used to identify the running wheels.

The roll switch is designed in a way so that the wheel rotation will be detected above a tangential speed of typically approx. 20 to 30 km/h. This causes the corresponding bit in the wheel electronics datagram to be set to 1. The running wheel bit is used to distinguish between running wheel and spare wheel (wheel at rest).

1.2.5 Confirmation

After the status “Assigned” is reached a trigger request is issued. If there is a positive reply to this request then the status "Confirmed" is reached.

If the status "Confirmed" is not reached after the maximum admissible learning period has elapsed, a “System Fault” message is issued to the kombi. At the same time, a DTC is stored in memory. The aim of the confirmation phase is to ensure that the 4 assigned wheel electronics are in AutoTransmitOff-Mode[1].

1.3 TPM ELECTRONIC CONTROL UNIT

1.3.1 Overview and Installation

The TPM ECU is the “heart” of the TPM system. Ultimately, the ECU is responsible for requesting the trigger devices to issue a trigger event, to receive and decode the datagrams sent by the Wheel Electronic, to compute the hard and soft warnings, to interface with the DIP and ZAB, and to provide diagnostics to the required tools (E.g. VAS Tester).

The ECU will be installed outside the passenger compartment.

1.3.2 Electrical Specification

1.3.2.1 Electrical Characteristics and Constraints

The following table presents the electrical specification of the TPM ECU:

Table 1 – TPM ECU Electrical Specification

Item	Rated Values
Nominal Voltage	12 V
Operating Voltage	9 V … 16 V
Maximum Voltage	-27 V … +27 V
Over-voltage protection	U_B > 18 V No operation, no damage upon return to normal operating voltage
Under-voltage Protection	U_B < 6 V No operation, no damage upon return to normal operating voltage
Current Consumption	I < 220 mA (normal operation)
	I < 100 μA (sleep mode: no CAN bus activity)

Slow rise times of the battery voltage (0 to 10 V in 5 min), e.g. by charging a totally discharged battery, shall not cause failure - i.e. no uncontrolled switching of the controller, no threshold level changes and no destruction or damage to ECU or components.

[1] A wheel electronics starts transmitting data automatically if:
- Roll switch ON for more than 5 minutes
- Wheel electronics does not receive a trigger signal for more than 5 minutes

Interruptions to supply or ground pins, as well as short circuit of other pins to 0V or 12V, shall not cause undefined output states. All critical states and their effects should be defined considered during FMEA or FTA.

1.3.3 Interface Specification

The TPM ECU interfaces with the four trigger devices via a dedicated LIN bus. It interfaces with other vehicle systems (especially the DIP and ZAB) via the Komfort CAN bus.

Requirements

Section 15.19: Labelling 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.

IC statement according to RSS210
5.11 User Manual
Operation is subject to the following two conditions:
(1) this device may not cause interference, and
(2) this device must accept any interference, including interference that may cause undesired operation of the device

Formblatt

Constructional dataform for testing of radio equipment

Licence holder:	BERU AG		
Address:	Mörikestrasse 155, 71636 Ludwigsburg		
Manufacturer:	BERU AG		
Address:	Mörikestrasse 155, 71636 Ludwigsburg		
Type / Model Name:	TSSSG4G4		
Product Description:	Control unit TSS with 433MHz receiver		
Serial-No.:	-	Protection class:	-

Additional information to the above named model:

Antenna:			
transmitter:	Type:		
	Length/size:		
receiver:	Type: **Loop Antenna**		
	Length/size: **30mm x 30mm**		
Power supply of the transmitter:			
Type:	nominal voltage:		**V**
	lowest voltage:		**V**
	highest voltage:		**V**
	current consumption		**A**
Power supply of the receiver:			
Type: Battery	nominal voltage:		**12V**
	lowest voltage:		**9V**
	highest voltage:		**16V**
	current consumption		**220mA**

Ancillary equipment:

Description:		Type:		Serial-no.:	
Description:		Type:		Serial-no.:	
Description:		Type:		Serial-no.:	

Extreme temperature range in which the approval test should be performed:

X Category I: General (-20°C to +55°C)

O Category II: Portable (-10°C to +55°C)

O Category III: Equipment for normal indoor use (0°C to +55°C)

Connectable cables:

Name of the cable	Digital	Length/m	shielded
	O yes O no		O yes O no
	O yes O no		O yes O no
	O yes O no		O yes O no
	O yes O no		O yes O no
	O yes O no		O yes O no

Type designation:
TSSSG4G4

Name and type designation of individual units comprising the radio equipment:

Type of equipment:

☐ Radiotelephone equipment	☐ Remote-control equipment	☐ Radio maritime equipment	☐ LPD
☐ One-way radiotelephone equipment	☐ Inductive loop system	☐ Inland waterways equipment	☐ RLAN
☐ Personal paging system	☐ Radio-relay system	☐ Radio navigation equipm.	☒ SRD
☐ Satellite earth station	☐ CB radiotelephone equipment	☐ Antenna	☐
☒ Data transmission equipment	☐ Movement detector	☐ Aeronautical equipment	☐

Technical characteristics:

	Transmitter-receiver	Transmitter	Receiver
Frequency range			**433MHz**
Maximum no. of channels			-
Channel spacing			-
Class of emission ()			-
Maximum RF output power			-
Maximum effective radiated power (ERP)			-
Output power variable			-
Channel switching frequency range			-

Method of frequency generation	☐ Synthesizer		☒ Crystal	☐ Other
Lowest generated frequency				
Modulation	☐ Analogue	Type:	☒ Digital	Type: FSK
Frequency generation RX				
IF	1st IF **13,22MHz**		2nd IF **16MHz**	3rd IF
Integral selective calling				
Audio-frequency interface level at external data socket				
Modes of operation	☐ Duplex mode		☐ Semi-duplex mode	☒ Simplex mode
Power source	☐ Mains		☒ Vehicle-regulated	☐ Integral
Antenna socket	☐ BNC ☐ M ☒ None		☐ TNC ☐ UHF ☐ UFL	☐ N ☐ Adapter ☐

Test specifications:
ETSI 300330-1/-2, ETSI EN 301489-1/-3, EN60950-1
FCC Part 15

Declarations:

- We declare that the above information are correct and the named model was supplied with the maximum configuration to the accredited test laboratory.

Ludwigsburg, **date** 03.12.2009

place of issue

Seal and signature of applicant

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