3 HL_10000 System and functional description

3.1 SR_10001010 - System description

The third generation system consists of just 5 components. It meets current EMC and radio guidelines as well as legislative requirements (especially NHTSA FMVSS 138).

The compact control unit has an integrated receiving antenna. The RF receiving properties are designed to ensure axle detection is possible for a wide range of vehicles by means of evaluating the reception level.

The wheel electronic units belonging to the system use a high-integrated sensor (HIS) with pressure and temperature measurement, 2-axle acceleration measurement, LF receiver, RF transmitter, power management, and integrated µC.

The **primary function** of the system is **monitoring tire inflation pressure** while the vehicle is in operation. The most important additional function of the system is the capability of detecting the wheels installed on the vehicle (own wheels) and their installation location automatically.

The compact control unit is installed at a non-centralized location in reference to the vehicle axles. The reception level of the RE is rated statistically to detect the mounting location of the wheel electronic unit. This process determines the average value of the received field intensity of the individual RE. After a certain number of telegrams, the system checks which wheels were received at higher (average) reception levels and which were received at lower reception levels. The higher reception levels were received from the REs which are installed closer to the receiving antenna. This makes it possible to allocate wheel electronic units for the front or rear axle.

Direction of rotation is detected within the wheel electronic unit itself. The RE contains a 2-axle acceleration sensor that measures radial and tangential acceleration, from which it derives the direction of rotation.

3.2 SR_10003010 - Functional requirements for TSS system Gen3

Following are the most important functional requirements for the third generation system:

- Pressure/temperature in the wheel
- Rapid availability of pressure warning information, self diagnostics, and wheel management
- Automatic own wheel detection, typically within the first minute after the startup process
- Independent axle detection by evaluating average levels
- Independent wheel position allocation, typically within the first minute of driving at > 30km/h after the startup process in normal road traffic and pavement surface
- Independent wheel position allocation within the first 12 min of driving at > 30km/h after the startup process
- Calibration of tire pressures
- Probe calibration (via bus command)
- US warning algorithm
- Connection to the vehicle bus via CAN bus
- Fast and reliable diagnostics of components
- Flashing in Customer Service
- Reliable process for simple mounting of wheel electronic unit
- Diagnostics via CAN

4 HL_20000 Wheel electronic unit (RE)

This section contains excerpts from the RE specification G3Only; for current version see SR_1003060.

4.1 HL_0700001 General information about RE

4.1.1 SR_07000010 – General description of RE HIS

The wheel electronic units are mounted inside the tire. They measure tire inflation pressure, temperature, direction of rotation, and their battery voltage.

Each wheel electronic unit has its own ID which is sent along with each data transmission. Data is transferred at high frequency in the range of 433MHz, in the so-called ISM band, or in the range of 315MHz in some countries.

The wheel electronic unit measures the tire inflation pressure at regular intervals (for example every 3s) and the wheel electronic unit temperature and sends the resulting data at a regular transmitting interval (for example every 30s) or upon trigger request (LF 125kHz) from the tire.
If there is a change in pressure > 20kPa within two successive pressure measurements, the wheel electronic unit immediately switches into fast transmitting mode. In this state the wheel electronic unit measures and transmits the data from the tire described above at short intervals (1s).
This process ensures that a system with relatively little measurement data transmission is still sufficient for monitoring tire inflation pressure, because it is also able to detect a rapid drop in pressure.
The wheel electronic unit has two acceleration sensors to detect rotary movement and direction of rotation. Detection is possible during the startup process or while driving. When the direction of rotation is detected, a telegram burst is sent (see SR_0702001).

The wheel electronic unit and software are designed for minimum power consumption. The selected battery is typically able to ensure a service life of 10 years. Power management supports the transmitting function even towards the end of service life and at low temperatures.

4.1.2 SR_0700002 - Development goal of RE

The current EMC and radio guidelines (see section "Release tests") and legislative requirements (especially NHTSA FMVSS 138) in force at the time of development must be observed.

Pressure measurement range 0.05 to 6.375 bar abs.
Temperature measuring range -40 to +120°C

4.1.3 SR_0700401 - Application range of RE

The wheel electronic unit is designed for installation in passenger car wheels. The flexible connection between the valve and housing makes mounting possible in most rims between 14" and 21". Due to the wide variety of rim shapes, checking through the vehicle manufacturer is required in each case to determine whether the wheel electronic unit can be mounted.

4.2 HL_0702800 Modes

4.2.1 SR_0702801 - Operating modes

The wheel electronic unit can assume different operating states.

Mode 0: Storage mode/test mode
Mode 1: Normal operation, for operating while stopped or driving
Mode 2: Fast transmitting mode after a fast change in pressure is detected
Mode 3: Fast transmitting mode before an overtemperature shutdown
Mode 4: Control data burst/ detection of direction of rotation in startup process

4.2.2 SR_0702806 – Constants

M = 3	O = 40
P = 1	R = 25
T = 20	U = 10
Y = 5	Z = 5

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