# TPM-167

# Tire Pressure Monitoring System

# User manual

## 1. Description

### 1.1 Application

System to check the pressure of all tyres of a passenger car that have a gross vehicle weight rating of 4,536 kg or less, to warn drivers of significant under-inflation of tires (and the resulting safety problems).
If there is a malfunction of the TPMS the driver has to be informed that there is a malfunction of the system.
The TPMS unit must contain all warning symbols and icons required to comply with the requirements of FMVSS 138 under the condition that a combined malfunction telltale is used. Further more, the display must provide a symbol that can display the status of transmission and reception of signals.
It must be possible to adjust the system to the type of tire and to the manufacturer's recommended cold inflation pressure. It also must be possible to change the units of measurement for pressure and temperature. These car specific adjustments should be done during the installation of the system. For assistance, a small menu has to be integrated into the display unit.

### 1.2 Electrical connection

The operating voltage for the system will be supplied by the battery of the car. Additionally the ignition must be connected to wake up the display.

### 1.3 Functional description

#### 1.3.1 Standby mode

In standby mode the system is working without the display unit to reduce the power consumption. The display will be switched on when the ignition is switched to the "On" / "Run" position. If there is an alert only the beeping function is working. When the ignition is switched off the display will be switched off also.

#### 1.3.2 Startup function test

On switching the ignition to the "On" / "Run" position, the display must start up, illuminating all function fields as a check of lamp function and displays for 3 seconds and the system have to beep once on completion of the test.

### 1.3.3 Normal operation

After startup of the system, the display must indicate the status of each tire, including its pressure and temperature in once cycle. For each tire and each condition, the information must be displayed at least one second. After this cycle, the system should switch to ordinary operating mode, thus switching the display to blank, unless there are any errors or malfunctions. The normal operation mode must be reached at least 15 seconds after switching the ignition to the “On” / “Run” position in combination with 2.3.1 (standby mode). Otherwise normal operation mode must be reached at least 60 seconds after switching the ignition to the “On” / “Run” position.

### 1.3.4 Loss of Signal

If one or more sensors’ signals have not been received during 10 minutes, while at least one signal has been received, the system must alert and warn the driver by beeping once for 1s and illuminating the transmission status indicator. Further more, the respective tire symbols must be blink for 60s and illuminated permanently after that time, until all signals have been received. The beep must be repeated each minute until the condition is improved or the driver pressed the button “CHECK”. The 3-digits 7-segment display will show nothing.

Loss of signal displayed:
(European and US version)

### 1.3.5 TPMS detection requirements

#### 1.3.5.1 Pressure alert stage one

If one or more tires’ pressure drops 25% or more below the preset reference pressure or below the tire specific pressure (Table 1), whichever is higher, a pressure alert must be triggered. To realise the requirements of Table 1 the customer can change the alert threshold between 10% and 40% below the reference pressure.
The “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink for one minute and beep in the same frequency for 15 seconds. The driver must be able turn off the beeping

whenever he pushes the button. After this minute the “Pressure Warning” icon will be shown continuously. During this whole period, the 3-digit 7-segment section will show the current pressure of this tire. Additionally the backlight of the display will change to yellow to comply the requirement of FMVSS 138. This complete procedure will be repeated after 5 minutes until the condition is improved or the driver pressed the button “CHECK”. After this the “Pressure Warning” icon will be shown continuously and the 3-digit 7-segment section will show the current pressure.

Pressure alert stage one displayed:
(European and US version)


If more than one tire is affected, the system will cycle through the tires affected, showing each under-inflated tire’s pressure for 2 seconds continuously.

Whenever this condition applies to the spare tire, the “Pressure Warning” icon will be shown and the icon of the spare tire will blink (1 Hz) and beep in the same frequency for 15 seconds showing the corresponding pressure (only once when ignition is turned on). When all other tires are OK and therefore the corresponding icons will be shown but the icon for the spare tire will keep on blinking and the “Pressure Warning” icon will be shown. In spite of the incorrect pressure of the spare tire, the 3-digit 7-segment section will show nothing and the backlighting will turn off after one minute.

| Tire Type | Maximum inflation pressure | | Minimum activation pressure | |
|---|---|---|---|---|
| | (kPa) | (psi) | (kPa) | (psi) |
| P-metric –<br>Standard load | 240,<br>300 or<br>350 | 35,<br>44 or<br>51 | 140<br>140<br>140 | 20<br>20<br>20 |
| P-metric –<br>Extra load | 280 or<br>340 | 41 or<br>49 | 160<br>160 | 23<br>23 |
| Load Range C | 350 | 51 | 200 | 29 |
| Load Range D | 450 | 65 | 240 | 35 |
| Load Range E | 550 | 80 | 240 | 35 |

**Table 1 –Minimum activation pressure corresponding type of tire**

**1.3.5.2 Pressure alert stage two**

If one or more tires' pressure drops 50% or more below the preset reference pressure, a pressure alert must be triggered. A 3 Step Indication procedure will be used to highlight this conditions:

Step 1. The "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink for 90 seconds and beep at the same frequency (1 Hz) for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 2. The "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink only with doubled frequency (2 Hz) for 90 seconds and beep at the same frequency for 15 seconds. Again the driver must be able turn off the beeping whenever he pushes the button.

Step 3. The "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink at a doubled frequency again (4 Hz) and beep at the same frequency for 15 seconds. And again the driver must be able turn off the beeping whenever he pushes the button.

Step 3 will be repeated continuously until the condition is improved (a normal or warning condition has been met).

During this whole period, the 3-digit 7-segment section will show the current pressure of this tire. Additionally the backlight of the display will change to red.

Pressure alert stage two displayed:
(European version: red; US version: yellow)


If more than one tire is affected, the system will cycle through the tires affected, showing each under-inflated tire's pressure for 2 seconds continuously.

Whenever this condition applies to the spare tire, the "Under Pressure Alarm" icon will be shown and the corresponding icon will blink and beep in the same frequency (1 Hz) for 15 seconds showing the corresponding pressure (only once when ignition is turned on). When all other tires are ok and therefore the corresponding icons are shown continuously, the icon for the spare tire will keep on blinking and the "Under Pressure Alarm" icon will be shown. In spite of the incorrect pressure of the

spare tire, the 3-digit 7-segment section will show nothing and the backlighting will turn off after one minute.

### 1.3.5.3 Rapid loss of pressure

If one or more tires are reporting a pressure loss of 0.2 bar or more within 60 seconds, the system must alert the driver of a fast leaking tire. A 3 Step Indication procedure will be used to highlight this condition:

Step 1. The “Fast Leaking” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink for 90 seconds and beep at the same frequency (1 Hz) for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 2. The “Fast Leaking” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink only with doubled frequency (2 Hz) for 90 seconds and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3. The “Fast Leaking” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink at a doubled frequency again (4 Hz) and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3 will be repeated continuously until the condition is improved (a normal or warning condition has been met).

During this whole period, the 3-digit 7-segment section will show the current pressure of this tire.

If more than one tire is affected, the system will cycle through the tires affected, showing each under-inflated tire’s pressure for 2 seconds continuously.

Rapid loss of pressure displayed:
(European version: red; US version: yellow)

**1.3.5.4 Over Pressure alert**

If one or more tires' sensors are reporting a pressure that exceeds 125% of the preset reference pressure or the tire type specific maximum pressure (Table 1), the system must alert the driver. A 3 Step Indication procedure will be used to highlight this condition:

Step 1. The "Over Pressure Alarm" and "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink for 90 seconds and beep at the same frequency (1 Hz) for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 2. The "Over Pressure Alarm" and "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink only with doubled frequency (2 Hz) for 90 seconds and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3. The "Over Pressure Alarm" and "Pressure Warning" icon will be shown and the icon of the corresponding tire will blink at a doubled frequency again (4 Hz) and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3 will be repeated continuously until the condition is improved (a normal or warning condition has been met).
During this whole period, the 3-digit 7-segment section will show the current pressure of this tire.

If more than one tires are reporting an over-pressure, the system must display each affected tire's pressure for 2 seconds and reduce the blinking of the tire indicator for the other tires to a rate of 0.5Hz.

Over pressure alert displayed:
(European version: red; US version: yellow)


Whenever this condition applies to the spare tire, the "Over Pressure Alarm" icon will be shown and the corresponding icon will blink and beep in the same frequency (1 Hz) for 15 seconds showing the corresponding pressure (only once when ignition is turned on). When all other tires are ok and therefore the corresponding icons are shown continuously, the icon for the spare tire will keep on blinking and the "Over Pressure Alarm" icon will be shown. In spite of the incorrect pressure of the

spare tire, the 3-digit 7-segment section will show nothing and the backlighting will turn off after one minute.

There is no over-pressure alert available if the reference value is 430 kPa or above.

### 1.3.5.5 Tire temperature alert

If one or more tires are reporting a temperature in excess of 85°C (185°F), the system must alert the driver. A 3 Step Indication procedure will be used to highlight this condition:

Step 1. The “High Temperature” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink for 90 seconds and beep at the same frequency (1 Hz) for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 2. The “High Temperature” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink only with doubled frequency (2 Hz) for 90 seconds and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3. The “High Temperature” and “Pressure Warning” icon will be shown and the icon of the corresponding tire will blink at a doubled frequency again (4 Hz) and beep at the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button.

Step 3 will be repeated continuously until the condition is improved (a normal or warning condition has been met).

Tire temperature alert displayed:
(European version: red; US version: yellow)


During the alert, the numeric field must display the temperature of the tire and the pressure of the respective tire, cycling for two seconds each. If more than one tire is affected, the system will cycle through the affected tires, displaying each tire information for 2 seconds while reducing the blinking rate of the tires not displayed to 0.5Hz.

### 1.3.6 TPMS malfunction

A general malfunction is present, if, for example, a sensor's signal has not been received for more 15 minutes or if the input voltage of the system exceeds or undershoots a range of between 9.5 and 15.5 Volts.
In this case, and in accordance with FMVSS 138, and 2.3.3.7 the "Pressure Warning" icon will blink for one minute and beep in the same frequency for 15 seconds. The driver must be able turn off the beeping whenever he pushes the button. After this minute the "Pressure Warning" icon will be shown continuously. During this whole period, the 3-digit 7-segment section will show nothing.
Additionally the backlight of the display will change to orange/yellow to comply the requirement of FMVSS 138. After this cycle, the display will be continuously illuminated as long as the malfunction exists. This alert must be repeated each time the ignition system is switched to the "On" / "Run" position until the situation causing the malfunction has been corrected.

### 1.3.7 Measurement frequency

The maximum allowed time between two measurements of pressure and temperature of each tire must not exceed 3.4 second.

## 1.4 Contents of display

### 1.4.1 General notes

The TPMS display must be designed in a way that allows the system to be readable from a distance of up to 70cm under normal conditions and from a horizontal angle of 120 degrees and a vertical angle of 90 degrees. The display casing must be designed in a way that it allows for easy mounting, thus the outer dimensions of the housing must be minimized wherever possible.

### 1.4.2 Display technology

The display must be an LCD display, containing all the required icons and functional fields. The display must be illuminated by a backlight device. The backlight device must be changeable in its illumination colour. In order to accommodate for the requirements of the FMVSS 138 for a yellow colour of the warning symbols and increased visual attraction of warning lights, the display must be able to display a yellow illuminated warning. This requirement is also deemed fulfilled, if the backlight colour of the display is changed to yellow in case of an alert 1 situation. In case of an alert 2 situation the display colour will changed to red (Europe version only). The US version should be activated when the end consumer will use "psi" and "°F" as units of the measurement fields.

### 1.4.3 Symbols and fields

#### 1.4.3.1 Vehicle view symbol

The display must provide a schematic birds-eye view of the vehicle with oversized icons depicting the tire positions of up to seven tires (front single tires, rear double tires, spare tire). The vehicle view icon must be designed in a way, so that it is clearly visible, which side is the front and which one is the rear. The vehicle must be visible at all times during the operation.

Vehicle view symbol (without rear double tires, but with spare tire):

The icons for rear double tires and spare tires will be included in the display whenever the system is configured for the presence of said tires. The icons for the rear double tires and the spare tire will behave in the same way as all other tire symbols and as outlined in paragraph 2.3. In case the system is configured for any such tire not being present, the respective icons will not be shown in the display.

#### 1.4.3.2 Numeric display

To display tire pressure and temperature, the display unit must contain a three digit numeric display (min. 23 fields including two dots / commas).

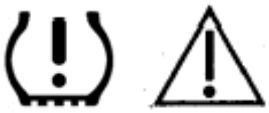
#### 1.4.3.3 Unit of measurement fields

To inform the driver of the unit of measurement and thus the information currently displayed in the numeric field, the display must indicate the current units of measurement: “bar”, “psi”, “kpa”, “°C” and “°F”. This indication must be located next to the numeric display to allow for easy association.

#### 1.4.3.4 Tire alert status field

To give additional information of the alert status, the display must contain either icons or text fields for the three different alert types: “Pressure Loss”, “Fast Leaking” and “Temperature Alert”.
These status field have to be positioned next to the vehicle view symbol.

Symbol “Pressure Warning”: 

Symbol “Fast Leaking”: 

Symbol “Temperature alert: 

**1.4.3.5 Transmission status field**

The transmission status field is a warning for the driver, in case one or more sensors’ signals have not been received for a prolonged period of time. The transmission status field must be an antenna symbol, optionally accompanied by bars, indicating the transmission strength or number of signals received by the system.

Transmission status symbol: 

**1.4.3.7 Malfunction alert symbol**

If there is a malfunction of the TPMS the complete display will be blank and the low tire pressure telltale (that does not identify which tire has low pressure) concerning FMVSS101 will be illuminated.

Malfunction alert symbol: 

Optionally an extra yellow warning lamp is allowed.

## 1.5 System default settings

The following default setting of the system should be realised:

Byte 1

- Bit 0 max pressure %
  0 = 150% of the preset pressure for the relevant axle

- Bit 1 pressure warning %
  1 = 75% of the preset pressure for the relevant axle

- Bit 2 pressure alert %
  1 = 50% of the preset pressure for the relevant axle

- Bit 3 spare wheel on display
  0 = no spare wheel on display

- Bit 4 6 wheel display
  0 = standard 4 wheel display only

- Bit 5,6,7 unit of measuring data
  010 = Bar and °C

Byte 2

- Bit 0 government requirements
  0 = European display
- Bit 1 display technology
  1 = multi colour display
- Bit 2,3,4 display colours
  110 = blue