REPORT N° INTG/99018/GM

COMPARATIVE TESTS BETWEEN PARKING AID DEVICES

Components tested

VALEO ULTRASOUNDS DEVICE

EPS ELECTROMAGNETIC PARKING SYSTEM PROXEL
SUMMARY
The two systems have been subjected to comparative tests for determine the characteristics of answer in different conditions of use.

CONCLUSIONS
FINALITY OF TEST

Comparative test of the performance between the EPS (Electromagnetic Parking System) by PROXEL and the ultrasounds parking device by VALEO.

USED INSTRUMENTATION

· data acquisition system TESSERACT and DALO software
· phonic wheel with encoder 360 impulses/turn model ELCIS 59C15-360-824/5-M-B-CV-R-03

![Fig.1 Phonic wheel](image)

TEST CONDITIONS

For each performed test it has been acquired the covered space (at a frequency of 100 Hz). Known therefore the initial space is possible determining the distance of the car from the obstacle in each instant. Acquiring in the same time the signal furnished by the sensor and elaborating the data graphically, it is possible to draw the different areas of influence in base at the different tone and frequency of the signal.

On the drawings it has drawn at the same time graphic of the speed in function of the time obtained for derivation of the space.

The resolution of the phonic wheel is of 5 mm/pulse and the error that is committed on the measures of the space is of around 2-3 cm (acceptable value for the type of characterisation that is needed). This error is due to the fact that, in phase of arrest of the car, sometime it is counted some impulse in more because of the inactivity of the phonic wheel.

WORKING PRINCIPLE OF THE EPS SYSTEM

The electronic unit is connected through a cable to the antenna sensor installed to the inside of the bumper for all his length. When an obstacle enters the zone of influence of the electromagnetic near field generated by the antenna sensor, the same field suffers a variation of his physical characteristics due to the modification of the environment and this variation is as greater as more the obstacle is near to the same antenna sensor.
At the first activation of the unit a self-adjustment of the system is obtained. The time of this automatic operation is around 15-40 seconds and after that a sound of "OK" is heard from the acoustic unit signal (three different notes in rapid succession). This operation is necessary only during the first installation of the system and is made in order to adapt the unit parameters to the installation characteristics.

At the engaging of the back gear a control of the connection of the sensor is performed (absence of interruptions of the cable of connection to the antenna sensor or of interruption of the same): in case of anomalies the acoustic device gives a sound of alarm composed by two notes a tall and a low for 3-4 seconds.

If the control is regular the acoustic device gives in about 2 seconds after the activation three different notes in rapid succession for confirm the normal operation of the system (sound of OK).

During the approach to an obstacle the electronic unit activates the acoustic signaller beginning from a distance between bumper and obstacle (measured in the central zone of the bumper) of around 50-60 cm with 3 separate types of signalling.

a) increasing sequence of "BEEP" which makes the driver informed that an obstacle is approaching (Pre-alarm)

b) continuous sound at a more acute frequency when the obstacle is in proximity of the bumper at a distance of 20 to 30 cm measured in the central zone of the bumper. The continuous sound is maintained for a time of about 2 seconds.

c) continuous sound at a different higher frequency when an obstacle is in a very close proximity of the bumper (3-20 cm) giving an alarm of possible contact.

In presence of relevant variations of temperature (10 °C) in the place were the electronic unit is allocated (inside the car if the unit is mounted in the trunk or outside the car if the unit is mounted on the bumper) the electronic module performs a self-adjustment in order that the sensitivity of the system should not be interested by the weather conditions.

The beginning of the signalling is function of the speed of approach to the obstacle: higher it is the speed and sooner it will start the signal of pre-alarm and the continuous one for allow a good arrest of the car. Finally, if there is not a relative movement of approaching between the car and the obstacle, the acoustic device does utter no sound.

**OPERATING FEATURES OF THE VALEO SYSTEM**

This device is essentially constituted by four ultrasonic transducers disposed on the back bumper, and connected to an electronic control unit. Two of them are disposed at around 250 mm from the centre of the bumper and at a height from earth of 440 mm while the other two respectively to around 680 mm and 555 mm. The ultrasonic transducers utter the impulses and receive the signal reflected from the obstacle transmitting it to the electronic unit for the evaluation of the distance.

When the system is activated, by the insertion of the back gear, it is emitted issued a sonorous signal from the loudspeaker for point out that the system is ready to work. At the recognition of the obstacle the system generates an alternate signal of pre-alarm that increases its frequency as the distance is reduced, up to become a permanent signal.
MAPPING OF THE DETECTION ZONE OF THE REAR PARKING DEVICE

Before performing the test in external environment the measurement of the three areas of detection by means of the aid of a pneumatic piston connected to a trolley has been proceeded (you see Fig.2).

The frontal dimensions of the trolley are: width 600 mm and height 850 mm. Regulating the flow of air through two air cock it has been performed the tests at three speed of reference: 10, 20 and 30 cm/s. The following charts show the results in cm obtained for the different areas and speed.

![Fig.2 Mapping device](image)

PROXEL DEVICE

The following chart shows the results in cm obtained for the different areas and speed.

<table>
<thead>
<tr>
<th>Orthogonal approaching of the trolley towards the bumper centre</th>
<th>10 cm/s</th>
<th>20 cm/s</th>
<th>30 cm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-alarm</td>
<td>61</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>1st continuous signal</td>
<td>28</td>
<td>36</td>
<td>41.5</td>
</tr>
<tr>
<td>2nd continuous signal</td>
<td>18</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

| Orthogonal approaching towards the bumper corner-edge |  |
|---|---|---|
| Pre-alarm | 45 | 50.5 | 59.5 |
| 1st continuous signal | 20.5 | 23.5 | 30 |
| 2nd continuous signal | 13.5 | 15 | 19 |

| Orthogonal approaching towards the bumper according to the longitudinal axis of the car body |  |
|---|---|---|
| Pre-alarm | 21.5 | 24 | 25 |
Concerning the last measurement it has not been indicated the distances of the continuous signals owing to a little bit difficulty in appreciating the right value in this condition. Indicative values at a speed of 20 cm/s could be around 5-6 cm for the 1° continuous signal and 1 cm for the 2° continuous signal.

Through a metallic bar of diameter 50 mm, applied to the trolley, it has been detected the superior limits of the zones of influence. The following values represent the heights from the ground.

<table>
<thead>
<tr>
<th>Vertical section in the middle of the bumper</th>
<th>10 cm/s</th>
<th>20 cm/s</th>
<th>30 cm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-alarm</td>
<td>76</td>
<td>82</td>
<td>85</td>
</tr>
<tr>
<td>1° continuous signal</td>
<td>65</td>
<td>66</td>
<td>68</td>
</tr>
<tr>
<td>2° continuous signal</td>
<td>62</td>
<td>64</td>
<td>65</td>
</tr>
</tbody>
</table>

The following figures represent graphically the zones of protection obtained.
Fig. 3 Superior and section view at 10 cm/s
Fig. 4 Superior and section view at 20 cm/s
Fig. 5 Superior and section view at 30 cm/s
VALEO DEVICE

This device is not influenced by the speed of manoeuvre. For such a motive it has been performed an only tests at a constant speed of 10 cm/s with the trolley perpendicular to the middle of the bumper.

<table>
<thead>
<tr>
<th>Pre-alarm</th>
<th>150-170 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° continuous signal</td>
<td>37.5 cm</td>
</tr>
</tbody>
</table>

The following features have been observed:

- loss of the signal when the goes itself off (fact not serious in as if it increases the distance from the obstacle there it is not danger of collision)
- Loss of the signal, after some second, when the trolley stops at the maximum distance and at any passage of person in front of the transducers.

After this test the determination of the cones of influence of the system has been proceeded to, using the metallic tube of diameter 50-mm. Like it is displayed in the Fig.6 it has been maintained active an only of the two transducers at the centre of the bumper, annulling the others with a piece of adhesive ribbon.

The tube has been positioned and moved most possible perpendicular to the ground. In this test it has been noticed that according to the inclination of the bar the transducer sometime is able and sometime not to receive the reflected signal; from this fact it is possible already to notice that the system is therefore influenced from the surface of reflection and from the geometry of the obstacle.

![Fig.6 Determination of the cone of influence of a single transducer](image)
The Fig. 7 shows the area of the continuous signal and that of pre-alarm of the device. These zones have been drawn multiplying on the four transducer the cone of influence resulted for one single transducer (in base to as formerly described). It is not therefore told that the general area corresponds perfectly to that drawn, but surely to a sort of influence of the four.

Fig 7. Zones of detection
Fig. 7 displays the sight in plant of the area of pre-alarm (green colour), designed in base to the values of the underlying chart, and that of the continuous signal (red colour).

<table>
<thead>
<tr>
<th>Angle as regards the axis of the transducer</th>
<th>Radial distance from the centre of transducer (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>160</td>
</tr>
<tr>
<td>10°</td>
<td>155</td>
</tr>
<tr>
<td>20°</td>
<td>60.5</td>
</tr>
<tr>
<td>30°</td>
<td>48.5</td>
</tr>
<tr>
<td>40°</td>
<td>53</td>
</tr>
<tr>
<td>50°</td>
<td>53.5</td>
</tr>
<tr>
<td>60°</td>
<td>38</td>
</tr>
</tbody>
</table>

As it is possible to see, the course of the graph is not very regular for the alternate signal while for the continuous what it has been obtained is a ray of 30 cm and an opening of 120°. In transversal section for the alternate signal it was difficult to obtain a precise measurement; approximately it is possible to say that departing from 20 cm off the transducer and for the length of 1m the area of influence has a height between the 60 and the 70 cm from the ground. The continuous signal instead has an opening of around 37° (it well to notice that the axis of the transducers is not perfectly parallel to the longitudinal axis of the car, but rotated of around 2.5° upwards).

An important verification which has been made is the following: we suppose to call A and B the nearer transducer to the centre of the bumper, lets activates only A and put the vertical tube to the inside of the area with ray 30 cm of A. The system furnishes a continuous signal. Now without move the tube we open B and we close A. The signal becomes alternate. Finally with both open a continuous sound is obtained. This experiment doesn't serve to anything else than to approximately demonstrate that the signal that detected is the corresponding one to the nearer transducer nearer to the obstacle.

The tests performed with this sensor-device have been made by activating and deactivating the system, as it has been noticed that at the activation the device answers with better efficiency.

**EXTERNAL ENVIROMENT TESTS WITH THE PARKING DEVICE MOUNTED ON THE REAR OF THE CAR**

The tests have been performed using different types of obstacles of different dimensions for verify the efficiency of the system when used in a normal operating conditions.

Like told already in the descriptive paragraph regarding the conditions of test, the graphic of each test reports the signal of the sensor and the indication of the distance in cm from the obstacle at which the different signalling happen. Besides the corresponding areas of the different signals have been coloured in a different way.

The initial distances of the car from the obstacle are measured from the centre of the bumper, except where otherwise indicated.
1) APPROACHING TOWARDS A METALLIC GATE

Dimensions
• height: 2 m
• width: 6 m

Proxel Device
Starting distance from the obstacle: 167 cm

Valeo Device
Starting distance from the obstacle: 299 cm

Orthogonal approaching

Fig. 8 METALLIC GATE

In this case the system has given also the fourth signal of anomaly at a distance of 12 cm from the gate
2) REVERSING TOWARDS Euro Cargo IVECO

Proxel
Starting distance from the obstacle: 215 cm

Valeo
Starting distance from the obstacle: 301 cm

Orthogonal approaching

Fig.9 Euro Cargo Iveco
3) APPROACHING TOWARDS A WOODEN POLE FOR AERIAL LINE

Diameter: 160 mm

Sensore Proxel
Starting distance from the obstacle: 178 cm

Sensore Valeo
Starting distance from the obstacle: 300 cm

Fig.10 Wooden pole
4) **REVERSING TOWARDS A METALLIC POLE**

Diameter: 50 mm

**Sensore Proxel**
Starting distance from the obstacle: 267 cm

**Sensore Valeo**
Starting distance from the obstacle: 210 cm
5) APPROACHING TOWARDS A METALLIC POLE FOR AERIAL LINE

Diameter: 150 mm

**Sensore Proxel**
Starting distance from the obstacle: 248 cm

**Sensore Valeo**
Starting distance from the obstacle: 238 cm

![Fig.12 Aerial line pole](image)

The Proxel system has given the fourth signal of anomaly to a distance of 15 cm from the pole (you see graphic).
Comparative test between Parking Devices

PROXEL/VALEO

Velocità [cm/s]
Segnale Valeo
Spazio [cm]
6) APPROACHING TOWARDS A WAYSIDE STONE

Dimensions:
- diameter: 500 mm
- height: 550 mm

**Sensore Proxl**
Starting distance from the obstacle: 265 cm

**Sensore Valeo**
Starting distance from the obstacle: 270 cm

*Fig. 13 Wayside stone*
7) APPROACHING TOWARDS A WAYSIDE STONE WITH THE CORNER-EDGE OF THE BUMPER

Dimensions:
- diameter: 500 mm
- height: 550 mm

**Sensore Proxel**
Starting distance measured from the corner-edge of the bumper: 147 cm

**Sensore Valeo**
Starting distance measured from the corner-edge of the bumper: 210 cm

*Fig.14 Wayside stone*
Comparative test between Parking Devices

PROXEL/VALEO
Comparative test between Parking Devices

PROXEL/VALEO
8) REVERSING TOWARDS GUARDRAIL

Height: 700 mm

Sensore Proxel
Starting distance from the obstacle: 194 cm

Sensore Valeo
Starting distance from the obstacle: 235 cm

Orthogonal approaching

Fig. 15 Guardrail
Comparative test between Parking Devices
PROXEL/VALEO
Comparative test between Parking Devices PROXEL/VALEO

Tempo [s]

Spazio [cm]

Segnale Valeo

Velocità [cm/s]
9) REVERSING TOWARDS GUARDRAIL

Height: 700 mm

**Sensore Proxel**
Approaching distance measured from the middle of bumper: 238 cm
Approaching angle: 30°

**Sensore Valeo**
Approaching distance measured from the corner-edge of the bumper to the obstacle: 72 cm
Approaching angle e: 30°

Approaching with angled movement

![Fig. 16 Guardrail](image)

Approaching with this inclination, the detection of Preoxel system is given by the final part of the antenna inside the lateral part of the bumper and therefore for this reason it is not possible to have a reference to the initial measured distance from the center of the bumper. The suitable distances on the graph have been obtained therefore from the mapping drawing made first at a speed of 10 cm/s tracing a tangent straight line to the varied areas of influence and tilted of 30° as regards the longitudinal axle of the vehicle. The speed of 10 cm/s is the real speed of approach to the obstacle, drawn multiplying the speed in the points, where the beginning of the different signalings start, for the sine of 30°.
Comparative test between Parking Devices
PROXEL/VALEO
Comparative test between Parking Devices

PROXEL/VALEO

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10) REVERSING TOWARDS A CAR SIDE

Sensore Proxel
Starting distance from the obstacle: 215 cm

Sensore Valeo
Starting distance from the obstacle: 300 cm

Orthogonal approaching

Fig.17 Car side
11) REVERSING TOWARDS A CAR SIDE

Sensore Proxel
Starting distance measured from the corner-edge of the bumper: 70 cm

Sensore Valeo
Starting distance measured from the corner-edge of the bumper: 150 cm

Approaching with an angle of 30°

Fig.18 Car side

Also in this case the distances reported on the graph for the Proxel have been reported in an analogous way as done for the test n.9.
12) APPROACHING TOWARDS A STEP

Height: 23 cm

Sensore Proxel
Starting distance from the bumper: 212 cm

Sensore Valeo
Starting distance from the bumper: 275 cm

Orthogonal approaching

Fig. 19 Step
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[Graph showing data points and lines, with annotations for Spazio (cm), Segnale Valeo, and Velocità (cm/s).]

Tempo [s]
Spazio [cm]
Velocità [cm/s]
13) APPROACHING TOWARDS A STEP

HEIGHT: 37 cm

Sensore Proxel
Starting distance from the obstacle: 306 cm

Sensore Valeo
Starting distance from the obstacle: 235 cm

Orthogonal approaching

Fig. 20 Step
14) APPROACHING TOWARDS A METALLIC WHEEL-GUARD

Dimensions:

- height: 500 mm
- diameter: 80 mm

**Sensore Proxel**

Starting distance from the obstacle: 245 cm

**Sensore Valeo**

Starting distance from the obstacle: 245 cm

*Fig. 21 Metallic wheel-guards*

These acquisitions on the curbstones have been made with both the system in operation.
Comparative test between Parking Devices

PROXEL/VALEO

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Velocità [cm/s] Segnale Proxel Spazio [cm]
Comparative test between Parking Devices

PROXEL/VALEO

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Velocità [cm/s]

Segnale Valeo

Spazio [cm]
15) APPROACHING TOWARDS A METALLIC WHEEL-GUARD

Dimensions:
- Height: 400 mm
- Diameter: 80 mm

**Sensore Proxel**
Starting distance from the obstacle: 253 cm

**Sensore Valeo**
Starting distance from the obstacle: 253 cm

![Fig.22 Metallic wheel-guard](image-url)

Acquisitions made with both the systems in operation. The Valeo sensor, like it is seen from the graph, has given only a continuous signal at a distance of 25 [cm] from the obstacle.
Comparative test between Parking Devices

PROXEL/VALEO

Velocità [cm/s]
Segnale Proxel
Spazio [cm]
Comparative test between Parking Devices
PROXEL/VALEO

[Graph showing data points and lines indicating velocity and space]
16) APPROACHING TOWARDS A METALLIC WHEEL-GUARD WITH THE CORNER-EDGE OF THE BUMPER

Dimensions:
- Height: 400 mm
- Diameter: 80 mm

**Sensore Proxel**
Starting distance from the obstacle: 91 cm

**Sensore Valeo**
Starting distance from the obstacle: 81 cm

The acquisitions have been made separately. The ultrasonic system gives almost no signal (you see graphic).
Comparative test between Parking Devices

PROXEL/VALEO

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17) APPROACHING TOWARDS AN ANGLED METALLIC TUBE

Dimensions:
- height from ground: 520 mm
- diameter: 50 mm
- inclination respect the ground: 35°

**Sensore Proxel**
Starting distance from the obstacle: 335 cm

**Sensore Valeo**
Starting distance from the obstacle: 335 cm

The acquisitions have been made together. The ultrasonic system doesn’t give any signal.
17) APPROACHING TOWARDS AN ANGLED METALLIC TUBE

Dimensions:
- height from ground: 580 mm
- diameter: 80 mm
- inclination respect the ground: 26°

Sensore Proxel
Starting distance from the obstacle: 199 cm

Sensore Valeo
Starting distance from the obstacle: 199 cm

The acquisitions have been made together. The ultrasonic system doesn’t give any signal.
Comparative test between Parking Devices

PROXEL/VALEO
Comparative test between Parking Devices

PROXEL/VALEO

Velocità [cm/s]
Segnale Valeo
Spazio [cm]
19) REVERSING TOWARDS A PERSON

Sensore Proxel
Starting distance from the obstacle: 253 cm

Sensore Valeo
Starting distance from the obstacle: 240 cm

Fig. 26 Approaching towards a person
20) REVERSING INTO A CAR-BOX

Dimensions:
- height: 2.6 m
- width: 2.7 m
- length: 5.4 m

**Sensore Proxel**
Starting distance from the obstacle: 177 cm

**Sensore Valeo**
Starting distance from the obstacle: 185 cm

Orthogonal approaching

![Fig.27 Box](image)

While the car begins to enter the box, the sensors have given a signal of pre-alarm owed to two columns that are at the entry of the same box and that reduce the section of passage up to 2.24 m accordingly.
Besides to the inside of the box have been introduced some objects like it is seen in the Fig.28. in a particular way on the leading wall of the box a bicycle has been positioned as regards which it has been measured the initial distance reported in the preceding page.

![Fig.28 Objects in the box](image)

The VALEO ultrasonic system, for all the time in which the car was inside the box, has given an alternate signal of difficult interpretation, mainly during the insertion of the back-gear. This could depend on different factors: reflection or rebounds of the impulses owed to the objects to the inside of the box, sides walls at the inside of the area of detection of the transducers, etc.

The continuous signal gives the distance of the car from the bicycle positioned on the leading wall.
21) REVERSING TOWARDS A PLASTC DOOR

**Sensore Proxel**
Starting distance from the obstacle: 290 cm

**Sensore Valeo**
Starting distance from the obstacle: 290 cm

**Orthogonal approaching**

![Fig.29 Plastic door](image)

The acquisition on the two systems have been made at the same time. For the Valeo system it is difficult to give a distance of pre-allarm because, at a distance of 3 m it gives an alternate signal due probably to the presence of the rug.
Comparative test between Parking Devices

PROXEL/VALEO

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Graph showing the comparison between Spazio, Segnale Valeo, and Velocità over time.
22) APPROACHING WITH WET BIMPER TOWARDS LATERAL SIDE OF A CAR

Sensore Proxel
Starting distance from the obstacle: 242 cm

Sensore Valeo
Starting distance from the obstacle: 205 cm

Orthogonal approaching

Fig. 30 Car lateral side

The Valeo syste doesn’t give any signal
23) APPROACHING TOWARDS A CAR WITH THE BUMPER COVERED BY MUD

Sensore Proxel
Starting distance from the obstacle: 235 cm

Sensore Valeo
Starting distance from the obstacle: 35 cm

Orthogonal approaching

Fig. 31 Car bumper

The VALEO system has given only the continuous signal close the obstacle at a distance of 33 mm.
24) APPROACHING TOWARDS A PERSON WITH BUMPER COVERED BY MUD

**Sensore Proxel**
Starting distance from the obstacle: 260 cm

**Sensore Valeo**
Starting distance from the obstacle: 220 cm

The Valeo system, on the contrary of the previous test, doesn't give any signal. This depends, besides to the fact that the transducers are dirty, from the reflecting surface of the obstacle.
25) APPROACHING TOWARDS AN IRON CHEST WITH BUMPER COVERED BY MUD

**Sensore Proxel**
Starting distance from the obstacle: 260 cm

**Sensore Valeo**
Starting distance from the obstacle: 210 cm

**Orthogonal approaching**

*Fig.33 Iron chest*

The Valeo system doesn't work properly, with a loss of the alternate signal before the continuous one.
26) APPROACHING TOWARDS AN ANGLED IRON CHEST

**Sensore Proxel**
Starting distance e from the obstacle: 205 cm

**Sensore Valeo**
Starting distance e from the obstacle: 245 cm

*Fig.34 Iron chest*

The Valeo ultrasonic system has given a signal only at 17 cm from the obstacle.
Comparative test between Parking Devices
PROXEL/VALEO
27) REVERSING TOWARDS A METALLIC NET

As a last acquisition has been reported a peculiar case of backing towards a net slightly tilted with a sweater of 50 x 70 mm. The two systems has been tested at the same time

Sensore Proxel
Distanza iniziale dall’ostacolo: 235 cm

Sensore Valeo
Distanza iniziale dall’ostacolo: 235 cm

Orthogonal approaching

Fig.35 Metal net
Comparative test between Parking Devices

PROXEL/VALEO

Velocità [cm/s]
Segnale Valeo
Spazio [cm]

Tempo [s]
REMARKS

PROXEL DEVICE

Analysing the graphics there is not always a correspondence between the detection zones obtained at the three speeds of reference and the distances from the obstacle at which the different signalling happen.

For instance for the metallic gate the pre-alarm is obtained at a distance of 70 cm, while the detection zone for the speed of 20 cm/sec furnishes a value of 74 cm. In an analogous way the two continuous signals are obtained respectively at 36 and 25 cm, while from the mapping drawing for the speed of 10 cm/sec is drawn 28 and 18 cm.

For the pole of wood the signalling happen nearer to the obstacle as regards as is drawn from the mapping drawing made for 30 cm/sec.

In general we could tell that the differences obtained are due essentially to the followings two factors that influence the sensibility of the sensor:

- surface of the obstacle: bigger it is the obstacle and first the sensor will give the signal of pre-alarm and the continuous signals
- variation of speed: repetitive values are succeeded to get only during the mapping, where the speed is constant.

Finally the system doesn't present anomalies of operation when the bumper is wet or covered by mud.

VALEO DEVICE

Also for this device, we could tell that its sensibility is influenced by the surface of the obstacle and by the geometry, important factors for the reflection of the impulses and the receipt of the signal of return by the ultrasonic transducers. Difficulty of signalling has been had with bumper covered by mud and wet, in the case of the metallic tilted bolts and in the car-box. It has also been observed that noises with a component of high frequency, like the agitation of keys, the compressed air, the noise of a grindstone etc. could cause a malfunction of the system which furnishes a signalling not in presence of obstacle.

In all the other tests the system has given fairly constant signals, with a pre-alarm at around 170 cm and a continuous signal at around 30 cm from the obstacle.