Bestätigung des Kraftfahrt-Bundesamtes
gemäß ECE-R 13 Anhang 19 Anlage 6
für ein elektronisches Anhänger Bremssystem

Confirmation by the Kraftfahrt-Bundesamt
according to ECE-R 13 Annex 19 Appendix 6
with respect to an electronic trailer braking system

Das elektronische Bremssystem, beschrieben im anliegenden Technischen Bericht
– The electronic braking system described in the Technical Report attached

Prüfprotokoll Nr.: EB124.5E
Test report No.

vom 26.05.2009
dated

Hersteller:
Manufacturer:

WABCO Vehicle Control Systems
D-30452 Hannover

Bezeichnung des Systems: Trailer EBS
System name

entspricht nach Aussage der
- is, according to a statement issued by:

TÜV Nord Mobilität GmbH & Co.KG
DE-30519 Hannover und / and DE-45307 Essen

den Anforderungen an die speziellen Vorschriften für Anhänger mit elektrischer
Steuerung und /oder elektrischer Übertragung gemäß der ECE-Regelung Nr. 13
einschließlich Änderungsserie 11. (in accordance with the special requirements for
trailer vehicles equipped with an electric control line and/or electric control
transmission according to ECE-Regulation No. 13, series of Amendments 11.

Hinsichtlich des Verwendungsbereiches und der Ein- bzw. Anbauvorschriften wird
auf die Festlegungen im oben genannten Technischen Bericht hingewiesen. (For
details to the range of use and the installation or mounting regulations consult the
aforementioned Technical Report.)

Confirmation: TÜV Nord Mobilität GmbH & Co. KG is accredited by the German Federal Motor Transport Authority as a Testing Laboratory for braking systems according to Directive 71/320/EEC and ECE Regulation No. 13 and is registered under the No. KBA-P 00004-96.

Anlagen: 1 Technischer Bericht. EB 124.5E 
(Annex) 1 Technical Report No. EB 124.5E

Ort - Place: DE-24932 Flensburg
Datum - Date: 22.07.2009
Unterschrift: Im Auftrag
Signature: (Stegemann)
0. General

This Test Report is issued in addition to the TÜV NORD ABS approval report No. EB123.8E (Annex XIV to Directive 71/320/EEC and Annex 19 to ECE-Regulation No. 13) to cover the special provisions relating to electronic braking systems (EBS) for trailers with an electric control line and an electric control transmission.

With respect to the previous TÜV NORD Report EB124.4E this report covers also:
- The additional Appendix 2 ‘CAN Repeater / Router’
- New additional EMC approvals
- An assessment with respect to the new annexes 16 and 17 requirements

With respect to national approvals of road trains with multiple trailers, a special report about the ‘Trailer EBS’ incorporating a CAN Router is available under TÜV NORD report No. EB124_CanRou_0E.

The WABCO numbers not fully specified in this report indicate that deviations from the listed equipment/components are possible. These, however, have no influence on the function and effect with regard to the inspection performed.

For the sake of simplicity the Manufacturer’s Information Document (Trailer Electronic Braking System Information Document ID_EB124_5) of the Trailer EBS D system is abbreviated to ID_TEBS.

1. Identification

1.1 Manufacturer: WABCO Vehicle Control Systems
Am Lindener Hafen 21
D - 30453 Hannover
1.2 System name/model: Trailer EBS

1.2.1 System variant: E (see also paragraph 1.3 of ID_TEBS)

 Versions:
- with TCE (Trailer Central Electronic)
- with CAN Repeater
- with CAN Router

Note: Regarding the description of the above mentioned different versions see paragraph 2.1.3 of ID_TEBS. These additional equipments are optional.

2. System and Installation

2.1 Range of application: One or multi-axle trailers of categories O3 and O4 according to the framework Directive 2007/46/EC (70/156/EEC), Annex II or as defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) with air suspension and either drum or disc brakes.

All system configurations as defined in 2.3 below may be used on semi- or centre-axle trailers.

On full trailers only 4S/3M configuration may be used.

2.2 Types of interface: The system has been designed to operate with towing vehicles having compressed air braking systems and the following interface connections:

- one pneumatic supply line and one pneumatic control line (see paragraph 5.1.3.1.1 of ECE Regulation 13)

or

- one pneumatic supply line, one pneumatic control line and one electric control line (see paragraph 5.1.3.1.2 of ECE Regulation 13)

or

one pneumatic supply line and one electric control line (see paragraph 5.1.3.1.3 of ECE Regulation 13)

Note: The interface connection with one pneumatic supply line and one electric control line (see paragraph 5.1.3.1.3 of ECE Regulation 13) is currently prohibited for a towing vehicle or trailer to be approved. However to ensure forward compatibility the system supports this interface connection as well (see also ID_TEBS, paragraph 2.2)
2.3 System configurations: 2S/2M - 2S/2M+SLV - 4S/2M - 4S/2M+1M - 4S/3M
See also para 2.1.4 and Appendix 1 of ID_TEBS

2.4 “End-of-line” programming: The list of “Parameter Setting” is defined in ID_TEBS, paragraph 2.1.5.1.13.

2.5 Methods of powering: All system configurations have the ability to accept a continuous power supply via the prescribed special connector conforming to ISO 7638 and, as a back up, an intermittent power supply via the ISO 1185 (24N) or ISO 12098 connector (stop lamp circuit).

2.5.1 Permanent powering: This is the primary power source (see ECE-13 paragraph 5.2.2.17.2 a)) via the connector according to the standards:

<table>
<thead>
<tr>
<th>Connector</th>
<th>Pin Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 7638:1985</td>
<td>5 Pin</td>
</tr>
<tr>
<td>ISO 7638:1997 Part 1 (24 V)</td>
<td>5 Pin</td>
</tr>
<tr>
<td>ISO 7638:1997 Part 1 (24 V)</td>
<td>7 Pin</td>
</tr>
<tr>
<td>ISO 7638:1997 Part 2 (12 V)</td>
<td>5 Pin</td>
</tr>
<tr>
<td>ISO 7638:1997 Part 2 (12 V)</td>
<td>7 Pin</td>
</tr>
</tbody>
</table>

Note: The system is also compatible with connectors produced in accordance with ISO 7638:2003

2.5.2 Intermittent powering: As a safety backup function in the event of a failure of the ISO 7638 electrical power, the Trailer EBS is able to receive electrical power from the ISO 1185 (24N) or ISO 12098 (15 pin) connector (stop lamp circuit). In this case at least the ABS function and load sensing function are retained.

Under normal permanent power operation the backup power has no effect on the operation of the braking system.

In compliance with paragraph 5.2.2.17.2 of ECE-Regulation No. 13:

- It can be confirmed that the Trailer EBS system contains short circuit monitoring in order to protect the backup supply from overload (see also paragraph 3.3.14 below and ID_TEBS, paragraph 2.1.5.1, c2).

- The system manufacturer does not supply any marking or label to indicate that the trailer is equipped with an additional power supply.
- There is no failure warning device for the purposes of providing a warning in the event of a failure within the trailer braking system when the braking system is powered from the additional supply.

- The operation of the braking system from the backup power source may be verified by two means:
  1) With the permanent power supply disconnected, on application of the backup power supply the modulators will cycle (each solenoid one time).
  2) The voltage supply of the backup power source can be also checked by using the WABCO PC-diagnostic program.

See also ID_TEBS, paragraph 2.3.2.1

- Should a failure exist within the electrical supply of energy from the ISO7638 connector the failure warnings as described in paragraph 3.3.12 below are continuously sent.

For more detailed information see paragraph 2.3.4 and Appendix 2 of ID_TEBS

2.6. Identification of approved components:

For more detailed information see section 2.3 of ID_TEBS.

3. Verification of performance

3.0 General:

The tests defined below were used to establish conformity with the provisions for trailers with an electric control line and/or an electric control transmission.

The tests were carried out on a test bench which represented a 3-axle semi-trailer braking system according to Appendix 3 (page 5/10, diagram 841 701 050 0) of ID_TEBS with a 4S/3M configuration and an air reservoir of 60 l and brake cylinders of size 24”.

For the purpose of verification a simulation test rig was used.
3.1 Compliance with ECE-R13

Annex 16: The requirements of Annex 16 apply only to towing vehicles and trailers equipped with an electric control line as defined in paragraph 2.24. of the Regulation.

3.1.1 Prescribed messages transmitted from the towing vehicle to the trailer

Annex 16, paragraph 2.1.1: The following messages are received and processed by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
<th>Regulation No. 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service/secondary brake demand value</td>
<td>EBS11 Byte 3-4</td>
<td>Annex 10, paragraph 3.1.3.2.</td>
</tr>
<tr>
<td>Two electrical circuits brake demand value</td>
<td>EBS12 Byte 3 Bit 1-2</td>
<td>paragraph 5.1.3.2.</td>
</tr>
<tr>
<td>Pneumatic control line</td>
<td>EBS12 Byte 3 Bit 5-6</td>
<td>paragraph 5.1.3.2.</td>
</tr>
</tbody>
</table>

3.1.2 Prescribed messages transmitted from the trailer to the towing vehicle

Annex 16, paragraph 2.1.2: The following messages are transmitted by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
<th>Regulation No. 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDC Active / passive</td>
<td>EBS21 Byte 2 Bit 1-2</td>
<td>Annex 21, paragraph 2.1.6</td>
</tr>
<tr>
<td>Vehicle electrical supply sufficient / insufficient</td>
<td>EBS22 Byte 2 Bit 1-2</td>
<td>paragraph 5.2.2.20.</td>
</tr>
<tr>
<td>Red warning signal request</td>
<td>EBS22 Byte 2 Bit 3-4</td>
<td>paragraphs 5.2.2.15.2.1., 5.2.2.16. and 5.2.2.20.</td>
</tr>
<tr>
<td>Supply line braking request</td>
<td>EBS22 Byte 4 Bit 3-4</td>
<td>paragraph 5.2.2.15.2.</td>
</tr>
<tr>
<td>Stop lamps request</td>
<td>EBS22 Byte 4 Bit 5-6</td>
<td>paragraph 5.2.2.22.1.</td>
</tr>
<tr>
<td>Vehicle pneumatic supply sufficient / insufficient</td>
<td>EBS23 Byte 1 Bit 7-8</td>
<td>paragraph 5.2.2.16.</td>
</tr>
</tbody>
</table>
3.1.3 Prescribed warnings by the motor vehicle (Annex 16, paragraph 2.2):

The following warnings are transmitted by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
<th>Regulation No. 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDC Active / passive</td>
<td>EBS21 Byte 2</td>
<td>Annex 21, paragraph 2.1.6</td>
</tr>
<tr>
<td></td>
<td>Bit 1-2</td>
<td></td>
</tr>
<tr>
<td>Red warning signal request</td>
<td>EBS22 Byte 2 Bit 3-4</td>
<td>paragraph 5.2.1.29.2.1.</td>
</tr>
</tbody>
</table>

3.1.4 Prescribed messages supported by the trailer (Annex 16, paragraph 2.3.2):

The following messages are transmitted by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle service brake active / passive</td>
<td>EBS22 Byte 1, Bit 5-6</td>
</tr>
<tr>
<td>Braking via electric control line supported</td>
<td>EBS22 Byte 4, Bit 7-8</td>
</tr>
<tr>
<td>Geometric data index</td>
<td>EBS24 Byte 1</td>
</tr>
<tr>
<td>Geometric data index content</td>
<td>EBS24 Byte 2</td>
</tr>
</tbody>
</table>

3.1.5 Towing vehicle messages with respect to certain functions/parameters (Annex 16, paragraph 2.4.1):

The following tables shows which messages are received and processed by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
<th>Received Trailer-EBS without TCE</th>
<th>Received Trailer-EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle type</td>
<td>EBS11 Byte 2, Bit 3-4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>VDC (Vehicle Dynamic Control) Active / passive</td>
<td>EBS11 Byte 2, Bit 5-6</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake demand value for front or left side of vehicle</td>
<td>EBS11 Byte 7</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake demand value for rear or right side of vehicle</td>
<td>EBS11 Byte 8</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>ROP (Roll Over Protection) system enabled/disabled</td>
<td>EBS12 Byte 1, Bit 3-4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>YC (Yaw Control) system</td>
<td>EBS12 Byte 1,</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Function / Parameter</td>
<td>ISO 11992-2:2003</td>
<td>Received Trailer-EBS without TCE</td>
<td>Received Trailer-EBS with TCE</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------</td>
<td>---------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>tem enabled/disabled</td>
<td>Bit 5-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enable/disable trailer ROP (Roll Over Protection) system</td>
<td>EBS12 Byte 2, Bit 1-2</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Enable/disable trailer YC (Yaw Control) system</td>
<td>EBS12 Byte 2, Bit 3-4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Traction help request</td>
<td>RGE11 Byte 1, Bit 7-8</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Lift axle 1 - position request</td>
<td>RGE11 Byte 2, Bit 1-2</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Lift axle 2 - position request</td>
<td>RGE11 Byte 2, Bit 3-4</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Steering axle locking request</td>
<td>RGE11 Byte 2, Bit 5-6</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Seconds</td>
<td>TD11 Byte 1</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Minutes</td>
<td>TD11 Byte 2</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Hours</td>
<td>TD11 Byte 3</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Months</td>
<td>TD11 Byte 4</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Day</td>
<td>TD11 Byte 5</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Year</td>
<td>TD11 Byte 6</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Local minute offset</td>
<td>TD11 Byte 7</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Local hour offset</td>
<td>TD11 Byte 8</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
### 3.1.6 Trailer messages with respect to certain functions/parameters

**Annex 16, paragraph 2.4.1:** The following tables show which are transmitted by Trailer EBS E:

<table>
<thead>
<tr>
<th>Function / Parameter</th>
<th>ISO 11992-2:2003</th>
<th>Transmitted Trailer – EBS without TCE</th>
<th>Transmitted Trailer – EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support of side or axles wise brake force distribution</td>
<td>EBS21 Byte 2, Bit 3-4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Wheel based vehicle speed</td>
<td>EBS21 Byte 3-4</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Lateral acceleration</td>
<td>EBS21 Byte 8</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Vehicle ABS active / passive</td>
<td>EBS22 Byte 1, Bit 1-2</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Amber warning signal request</td>
<td>EBS22 Byte 2, Bit 5-6</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Vehicle type</td>
<td>EBS22 Byte 3, Bit 5-6</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Loading ramp approach assistance</td>
<td>EBS22 Byte 4, Bit 1-2</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Axle load sum</td>
<td>EBS22 Byte 5-6</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Tyre pressure sufficient / insufficient</td>
<td>EBS23 Byte 1, Bit 1-2</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Brake lining sufficient / insufficient</td>
<td>EBS23 Byte 1, Bit 3-4</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Brake temperature status</td>
<td>EBS23 Byte 1, Bit 5-6</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Tyre / wheel identification (pressure)</td>
<td>EBS23 Byte 2</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Tyre / wheel identification (lining)</td>
<td>EBS23 Byte 3</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Tyre / wheel identification (temperature)</td>
<td>EBS23 Byte 4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Tyre pressure (actual tyre pressure)</td>
<td>EBS23 Byte 5</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Brake lining</td>
<td>EBS23 Byte 6</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Brake temperature</td>
<td>EBS23 Byte 7</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake cylinder pressure first axle left wheel</td>
<td>EBS25 Byte 1</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Function / Parameter</td>
<td>ISO 11992-2:2003</td>
<td>Transmitted Trailer – EBS without TCE</td>
<td>Transmitted Trailer – EBS with TCE</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------------------</td>
<td>-------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Brake cylinder pressure first axle right wheel</td>
<td>EBS25 Byte 2</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake cylinder pressure second axle left wheel</td>
<td>EBS25 Byte 3</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake cylinder pressure second axle right wheel</td>
<td>EBS25 Byte 4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake cylinder pressure third axle left wheel</td>
<td>EBS25 Byte 5</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brake cylinder pressure third axle right wheel</td>
<td>EBS25 Byte 6</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>ROP (Roll Over Protection) system enabled/disabled/</td>
<td>EBS25 Byte 7, Bit 1-2</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>YC (Yaw Control) system enabled/disabled</td>
<td>EBS25 Byte 7, Bit 3-4</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Traction help</td>
<td>RGE21 Byte 1, Bit 5-6</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Lift axle 1 position</td>
<td>RGE21 Byte 2, Bit 1-2</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Lift axle 2 position</td>
<td>RGE21 Byte 2, Bit 3-4</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Steering axle locking</td>
<td>RGE21 Byte 2, Bit 5-6</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Tyre wheel identification</td>
<td>RGE23 Byte 1</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Tyre temperature</td>
<td>RGE23 Byte 2-3</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Air leakage detection (Tyre)</td>
<td>RGE23 Byte 4-5</td>
<td>yes*</td>
<td>yes*</td>
</tr>
<tr>
<td>Tyre pressure threshold detection</td>
<td>RGE23 Byte 6, Bit 1-3</td>
<td>yes*</td>
<td>yes*</td>
</tr>
</tbody>
</table>

* Only supported, when the corresponding optional equipment has been installed (see also in ID_TEBS the related paragraphs: - 2.1.6.2 IVTM (regarding parameters ‘tyre pressure sufficient / insufficient’, ‘Tyre wheel identification’, ‘Air leakage detection’ and ‘Tyre pressure threshold detection’))
2.1.5.1.1.10 Lining wear sensing (regarding parameter ‘Brake lining sufficient / insufficient’)
2.1.5.1.1.19 Traction help
2.1.5.1.1.8 Lift axle
2.1.5.1.1.20 Steering axle control (regarding parameter ‘Steering axle locking’)

3.1.7 List of supported messages and parameters:
Appendix 4 of ID_TEBS shows which of the ISO 11992 messages and parameters are supported.

3.2 Compliance with ECE-R13
Annex 17:
Annex 17 provides an example of tests to perform the assessment of functional compatibility of towing and towed vehicles equipped with electric control lines by checking that the relevant provisions of ISO 11992:2003 parts 1 and 2 (including Amendment 1:2007) are fulfilled.

Compliance with the relevant provisions was proved by the test report mentioned under paragraph 3.2.1 below and by demonstration of the bus failure conditions 1 to 8 as defined in paragraph 5.4.3.1 of ISO 11992-1 (2003) showing that the specified failure modes were adopted.

3.2.1 Test Report ISO 11992:
The manufacturers provided three test reports:
- 6870 - 620 - 2006 – 0013 (TEBS E)
- 0617 - 142 – 2006 – 0002  (TCE)
- 6171 - 2009 - 0009  (CAN Repeater / Router)

for the controller which demonstrates compliance that the interface, including the physical layer, data link layer and the application layer and the respective position of supported messages and parameters, complies with standard ISO 11992.
3.2.2 Towing vehicle simulator: A towing vehicle simulator was used with an interface according to ISO 7638:1997 (7 pin) which was able to receive all of the messages transmitted by the test trailer and was capable of transmitting all motor vehicle messages defined within ISO 11992-2: 2003.

The simulator was equipped with a failure warning display and an electrical power supply for the trailer.

During verification the parameters and messages were read directly by PC with a PowerPCNetBoard for BCAN protocol from I&ME or by a proprietary CAN analyser (Vector CANalyser) and displayed on a monitor. The devices provided a direct readout of messages with the parameters in the data field shown in the correct order in relation to time.

For measuring the brake system response time in accordance with paragraph 3.5.2. of Annex 6 to ECE-Regulation No. 13 the WABCO CTU measuring device was used.

3.2.3 Towed vehicle simulator: For the trailer simulation a hardware in the loop simulation (“WABCO HIL-Simulation”) was used for all tests.

For the test bench tests, wheels speeds, lateral deceleration and demand pressure from the tractor were simulated.

3.2.4 Functional checks

3.2.4.1 Service brake system: With the towing vehicle simulator connected to the trailer via the ISO 7638 interface and all towing vehicle messages relevant to the interface being transmitted the following checks were carried out (cp. paragraphs 4.2.2.1.1.1 and 4.2.2.1.1.2 of Annex 17 respectively):

The trailer response to the parameters defined in EBS 11 of ISO 11992-2 were in all cases (listed in this paragraph) verified as follows:

- pressure in the supply line at the start of each test was \( \leq 700 \text{ kPa} \)
- laden state of the vehicle simulated
a) Both pneumatic and electric control lines connected:
- both control lines be signalled simultaneously
- the motor vehicle message byte 3, bits 5–6 of EBS12 was set to 01b and transmitted to the trailer to indicate that a pneumatic control line is connected

<table>
<thead>
<tr>
<th>EBS11, byte 3 – 4</th>
<th>pressure at the brake chambers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>prescribed</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33280d</td>
<td>33660d</td>
</tr>
</tbody>
</table>

b) Electric control line only connected:
- The motor vehicle message byte 3, bits 5–6 of EBS12 was set to 00b and transmitted to the trailer to indicate that a pneumatic control line is not available
- Byte 3, bits 1–2 of EBS12 set to 01b to indicate to the trailer that the electric control line signal is generated from two electric circuits.

<table>
<thead>
<tr>
<th>EBS11, byte 3 – 4</th>
<th>pressure at the brake chambers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>prescribed</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33280d</td>
<td>33280d</td>
</tr>
</tbody>
</table>

Trailer equipped with only an electric control line:
The provisions in paragraph 4.2.2.1.2 of Annex 17 are not applicable as the braking system is only designed for trailers utilising connections according to paragraph 5.1.3.1.2 of ECE-Regulation No. 13 (one pneumatic supply line, one pneumatic control line and one electric control line).

Trailer connected with only an electric control line
In the case that a braking performance of at least 30 per cent of the prescribed performance for the service braking system of the trailer can no longer be ensured, paragraph 5.2.2.15.2 of the ECE-Regulation No. 13 and paragraph 4.2.2.1.3 of Annex 17 require that either the "supply line braking request" signal (byte 4, bits 3-4 of EBS22, set to 01b) via the data communication part of the electric
control line is sent or an automatic braking is invoked by the continuous absence of the data communication invoked (see also paragraph 5.2.1.27.10 of ECE-Regulation No. 13). An electrical failure (o/c) was simulated by disconnecting the high side wire (+Uₐ) of an inlet/outlet solenoid of the modulator. This failure caused a complete shut down of the pressure control circuit with the consequence that the prescribed service braking performance could not be met.

The test was carried out under the following conditions:
- Pressure in the supply line at the start of each test was \( \geq 700 \text{ kPa} \)
- The electric control line was connected to the motor vehicle simulator.
- Byte 3, bits 5-6 of EBS12 was set to 00b to indicate to the trailer that a pneumatic control line is not available.
- Byte 3, bits 1-2 of EBS12 was set to 01b to indicate to the trailer that the electric control line signal was generated from two independent circuits.
- With no fault present in the trailer braking system the braking system was communicating with the motor vehicle simulator. This was indicated by setting the signal “Red warning lamp request” (byte 4, bits 3-4) of message EBS22 to 00b.

When the above mentioned failure was introduced under the two speed conditions:
a) vehicle stationary
b) vehicle travelling at a constant speed > 30 km/h
the following observations had been made.

Observations in the cases a) and b)
- Pin 5 of the ISO7638 that indicates the yellow warning lamp status to the towing vehicle, was connected to ground by the ECU.
- The signal “Red warning lamp request” (byte 2, bits 3-4) of message EBS22 was set to 01b.
- The signal “Amber warning lamp request” (byte 2, bits 5-6) of message EBS22 was set to 01b.
- The signal “Supply line braking request” (byte 4, bits 3-4) of message EBS22 was set to 01b.
3.2.4.2 Failure Warning: 
(Annex 17/4.2.2.2)

The following failures as prescribed in ECE-Regulation No. 13 were simulated after which the warning messages and signals were detected at the ISO 7638 interface:

a) Permanent failure within the electric control transmission which precludes the service braking performance being met

**Both pneumatic and electric control lines connected**

A permanent failure (inlet/outlet solenoid) within the electric control transmission was simulated. After recognizing this fault the ECU electrically isolates all solenoids and the system reverts to entirely pneumatic control.

- Observation with semi-trailer and full trailer
  - yellow signal transmitted via Pin 5 of the ISO 7638 connector
  - byte 2, bits 5–6 of EBS22 transmitted by the trailer and set to 01b (amber warning signal request)
  - byte 2, bits 3–4 of EBS22; set to 01b (red warning signal request)

**Note with respect to the red warning signal request**

The red warning signal has to be given when the prescribed service braking performance (required service braking performance attained without wheel-locking; see also Annex 4, paragraph 1.2.7 of ECE-Regulation No. 13 has not been reached.

In the case of semi-trailer the simulated fault does not preclude the service braking system performance from being fulfilled whereas in the case of full trailer the service braking system performance (without locking of the wheels) cannot be guaranteed (due to unknown distribution of braking forces).

In the case of semi-trailer the pneumatic control pressure can always be increased until wheel lock occurs. Since the type O test is carried out on a surface with high adhesion the prescribed service braking performance can always be reached.
However, in the case of full trailers this assumption cannot principally be made. Thus, a permanent failure within the electric control transmission which may preclude the service braking performance (without locking of the wheels) being met, has to be also indicated by the red warning signal.

The above failure indication by the yellow warning signal is to be taken to be the minimum requirement. However, the manufacturer WABCO believes that such a permanent failure may lead to a possible safety risk.

Paragraph 3.4.3 of Annex 18 to ECE-Regulation No. 13 states that “in case of a failure, the driver shall be warned for example by warning signal or message display”.

The safety concept of the manufacturer considers it necessary that the driver is also be warned under certain conditions by the red warning signal. Thus, in conditions that result in the loss of both load sensing and ABS functions also the red warning signal is activated independent whether the prescribed braking performance can be achieved or not.

The “yellow warning signal only” is transmitted when a failure occurs whereby either the ABS or LSF functions is retained.

**Trailer connected with only an electric control line (according to paragraph 5.1.3.1.3 of ECE-Regulation No. 13)**

See test conditions and trailer responses as described in paragraph 3.2.4.1 (“Trailer connected with only an electric control line”) above.

**b) Low voltage warning**

Verification of compliance with the provisions of paragraph 5.2.2.20 of ECE-R13; reduction of the voltage on Pins 1 and 2 of the ISO 7638 connector

Trailer responses:
b1) Reduction of the voltage **below 19 V** (but above 18 V):
- Byte 2, bits 1–2 of EBS22 transmitted by the trailer and set to 01b (vehicle electrical supply sufficient)
- Yellow warning signal transmitted via Pin 5 of the ISO 7638 connector
- Byte 2, bits 5–6 of EBS22 transmitted by the trailer and set to 01b (amber warning signal request)

b2) Reduction of the voltage **below 18 V**:
- Yellow warning signal transmitted via Pin 5 of the ISO 7638 connector
- Byte 2, bits 5–6 of EBS22 transmitted by the trailer and set to 01b (amber warning signal request)
- Byte 2, bits 3–4 of EBS22 transmitted by the trailer and set to 01b (red warning signal request)
- Byte 2, bits 1–2 of EBS22 transmitted by the trailer and set to 00b (vehicle electrical supply insufficient)

b3) Reduction of the voltage **below 16 V**:
- Warnings as in paragraph b2) above
  In addition:
- A software reset was carried out when the supply voltage reached a value of 21 V

c) **Low system supply pressure warning**

Verification of compliance with the provisions of paragraph 5.2.2.16 of ECE-R13:

The pressure in the trailer air reservoir was reduced below the nominated value of 450 kPa.

Trailer responses when the pressure had reached a value of ≤ 450 kPa in the air reservoir:
- Yellow warning signal transmitted via Pin 5 of the ISO 7638 connector
- Byte 2, bits 5–6 of EBS22 transmitted by the trailer and set to 01b (amber warning signal request)
- Byte 2, bits 3–4 of EBS22 transmitted by the trailer and set to 01b (red warning signal request)
- Byte 1, bits 7–8 of EBS23 transmitted by the trailer and set to 00\textsubscript{b} (vehicle pneumatic supply insufficient)

d) Verification of the warning signal indication at system energisation (see also paragraphs 5.2.1.29.5 and 5.2.2.17 of ECE-Regulation No. 13)

When the electrical part of the braking equipment was first energised byte 2, bits 3 - 4 and bits 5 - 6 of EBS 22 was transmitted by the trailer and set to 01\textsubscript{b} (red and amber warning signals). In parallel a yellow warning signal was transmitted via pin 5 of the ISO 7638 connector.

After the braking system had checked that no defects that require identification by the above mentioned warning signals were present these messages were set to 00\textsubscript{b} (no red and amber warning signals) and the signal transmitted via pin 5 was deactivated.

3.2.4.3 Response Time:

The response time $t_R$ (see Annex 6 of ECE-R13) was measured with a normal and a simulated high bus loading of the CAN.

<table>
<thead>
<tr>
<th>$p_{el}$</th>
<th>$p_{pr}$</th>
<th>Test Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>33280\textsubscript{d}</td>
<td>650 kPa</td>
<td>electric control line demand signal</td>
</tr>
<tr>
<td>3328\textsubscript{d}</td>
<td>65 kPa</td>
<td>electric control line demand signal (10 %-value)</td>
</tr>
<tr>
<td>30464\textsubscript{d}</td>
<td>595 kPa</td>
<td>measured asymptotic pressure in the brake chamber with a digital demand signal in the electric control line of 33280\textsubscript{d} bit</td>
</tr>
<tr>
<td>22848\textsubscript{d}</td>
<td>446 kPa</td>
<td>75 % of the measured asymptotic pressure in the brake chamber</td>
</tr>
</tbody>
</table>

$p_{el}$ = digital demand signal in bit

$p_{pr}$ = equivalent pressure in kPa of $p_{el}$
Test Results:

<table>
<thead>
<tr>
<th>response time</th>
<th>bus load 23 %</th>
<th>bus load 96 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_R</td>
<td>280 ms</td>
<td>280 ms</td>
</tr>
</tbody>
</table>

* The response time measurement was carried out under worst case condition with a bus load of 96%. Comparative tests with a bus load of 23% showed the same test results.

The braking system response time requirements of Annex 6 of ECE-Regulation No. 13 are fulfilled for both test conditions of high (96%) and low bus load.

**CAN Repeater:**

In addition to the above tests, response time tests were carried out with the optional CAN Repeater (see Appendix 2 to this report).

**3.2.4.4 Illumination of stop lamps:**

The message requirement "illuminate stop lamps" specified in paragraphs 5.2.2.22.1 and 5.2.2.22.2 of ECE-Regulation No. 13 was verified, see paragraph 3.2.4.5 below; see also paragraph 2.1.5.1.1.14 of “ID_TEPS”

**3.2.4.5 Automatically commanded braking (Annex 17/4.2.2.4):**

The Trailer EBS E incorporates automatically commanded braking which was verified as follows:

The roll-over control function “Roll Stability Support (RSS)” - see ID_TEBS, paragraph 2.1.5.1.1.11- was activated. An unstable driving condition was simulated:

- Different wheel speed signals on both sides of the vehicle were simulated by two motor driven pole wheel generators.

- The ECU with the built in accelerometer was tilted about 30° in a vertical plane to simulate a lateral acceleration of 4.9 m/s² which caused the roll-over control function to initiate an automatically commanded braking event; see also paragraph 3.2.4.7 below.
Irrespective of the deceleration, the Trailer EBS E always transmits the "illuminate stop lamps" request message EBS22 byte 4, bits 5-6 set to 01b in the event of automatically commanded braking (see also paragraph 5.2.2.22.1 of ECE-Regulation No. 13). When there was no automatically commanded braking the data changed to 00b.

In addition, during the automatically commanded braking event the message “VDC Active ” (EBS21 Byte 2, Bit 1-2 set to 01b) was transmitted to the towing vehicle simulator.

### 3.2.4.6 Geometric Data:

In order to verify the geometric data content the CAN data of the message EBS24 was recorded and monitored on the CANalyser. The following data was received which corresponded to the vehicle setup programmed:

<table>
<thead>
<tr>
<th>Parameter (d)</th>
<th>Value (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EBS24 Byte 1</strong></td>
<td><strong>EBS24 Byte 2</strong></td>
</tr>
<tr>
<td>0</td>
<td>0 (semi-trailer)</td>
</tr>
<tr>
<td>1</td>
<td>78 (7.8 m)</td>
</tr>
<tr>
<td>2</td>
<td>195 (1.95 m)</td>
</tr>
<tr>
<td>3</td>
<td>3 (axles)</td>
</tr>
<tr>
<td>4</td>
<td>- (Not draw-bar) [FFh]</td>
</tr>
<tr>
<td>5</td>
<td>1 (lift axles)</td>
</tr>
<tr>
<td>6</td>
<td>1 (lift axle position)</td>
</tr>
<tr>
<td>7</td>
<td>- (lift axle position) [FFh]</td>
</tr>
<tr>
<td>8</td>
<td>- (Not defined) [FFh]</td>
</tr>
<tr>
<td>9</td>
<td>- (Not defined) [FFh]</td>
</tr>
<tr>
<td>10</td>
<td>- (Not defined) [FFh]</td>
</tr>
<tr>
<td>11</td>
<td>14 (1.4 m)</td>
</tr>
<tr>
<td>12</td>
<td>14 (1.4 m)</td>
</tr>
<tr>
<td>13 – 29</td>
<td>- (Not defined) [FFh]</td>
</tr>
</tbody>
</table>
3.2.4.7 Vehicle stability function: The Trailer EBS E includes the roll-over control function “Roll Stability Support (RSS)”. During the test described in paragraph 3.2.4.4 it was verified that during the intervention of the vehicle stability control function the VDC message EBS21 byte 2 bits 1-2 was set to 01b (VDC active) and the parameter 01b changed to 00b (VDC passive) when the vehicle stability function was inactive. See also ID_TEBS, paragraph 2.1.5.1.1.11.

3.2.4.8 Braking via electric control line: The Trailer EBS E supports the electric control line and the message EBS22 byte 4 bits 7-8 are always set to 01b. This was checked by monitoring the CAN data bus with the CANalyser.

3.2.5 Additional messages supported by the trailer: The supported messages listed in the table of paragraph 3.1.6 above were verified at the ISO 11992-interface by monitoring the messages using CANalyzer as follows:

3.2.5.1 Wheel based vehicle speed: Message EBS21 Byte 3-4:
A speed of 50 km/h was simulated and the parameter which was transmitted corresponded to this value.

3.2.5.2 Lateral acceleration: Message EBS21 Byte 8:
The ECU of the TEBS E was tilted at 20° in each direction. The calculated value was monitored at the ISO 11992 Interface.

3.2.5.3 Vehicle ABS active / passive: EBS22 Byte 1, Bit 1-2:
During hardware in the loop simulation (HIL) ABS control loops where simulated. Whilst the ABS was active the data was set to 01b. Approximately 2 s after the end of ABS activity the data was reset to 00b.
3.2.5.4 Amber warning signal request: Message EBS22 Byte 2, Bit 5-6:
A failure (disconnecting of ABS sensor c) which triggers the amber warning signal request was generated. Before generating the fault the parameter was set to 00b, after the fault was introduced the parameter was set to 01b.

Note: The amber warning signal mirrors the ISO 7638 Pin 5 yellow warning signal

3.2.5.5 Vehicle type: Message EBS22 Byte 3, Bit 5-6:
This message is not supported.

3.2.5.6 Loading ramp approach assistance: Message EBS22 Byte 4, Bit 1-2:
This message is not supported.

3.2.5.7 Axle load sum: Message EBS22 Byte 5-6:
Various air bellows pressures, which correspond to the corresponding axle loads were simulated by using a pressure regulator. The transmitted axle load sum was monitored and verified.

3.2.5.8 Brake lining sufficient / insufficient: Message EBS23 Byte 1, Bit 3-4:
The TEBS-E System was equipped with a switch which simulated the lining wear sensor circuit (open or closed) and the parameter “Brake lining sufficient” was set accordingly.

When the switch was closed (lining wear sufficient) the parameter was set to 01b.

When the switch was open (lining wear insufficient) the parameter was set to 00b.
3.2.5.9 Traction help:

Message RGE21 Byte 1, Bit 5-6:
The hardware in the loop simulation (HIL) included also the control for a lift axle.

The parameter for lowering the lift axle where set to an air bellows pressure of 500 kPa and for lifting to a pressure of 300 kPa. The Traction help was activated by the diagnostic tool. The parameters where this function is terminated were set to a pressure limitation of 650 kPa and an ‘exit speed’ of 30 km/h.

The air bellows pressure was simulated by using a pressure regulator.

The value was initially set to 00b to indicate that traction help was inactive.

When the traction help was activated by three times applying the brakes with the vehicle stationary, the “Traction help status” was changed to 01b.

When the air bellows pressure was increased above 650 kPa (> 130% loaded) the “Traction help status” was changed back to 00b and the lift axle control valve was de-activated.

See also ID_TEBS, paragraph 2.1.5.1.19.

3.2.5.10 Lift axle 1 position:

Message RGE21 Byte 2, Bit 1-2:

The hardware in the loop simulation (HIL) included also the control for two lift axles.

The parameter for lowering the lift axle was set to 500 kPa and for lifting was set to 300 kPa for ‘Lift axle 1 position’ and 180 kPa for ‘Lift axle 2 position’.

The air bellows pressure was simulated by using a pressure regulator.

The pressure was increased above 500 kPa and both lift axle control valves were deactivated (de-energised). Both parameters for the lift axle positions were set to 00b (‘Lift axle position down’).

The air bellows pressure was lowered below 300 kPa and the lift axle control valve of lift axle 1 position was activated (energised) and the parameter was set to 01b.

The air bellows pressure was then lowered below 180 kPa and the lift axle control valve of lift axle 2 position was activated (energised) and also this parameter was also changed to 01b (lift axles raised).
3.2.5.11 Steering axle locking:

Message RGE21 Byte 2, Bit 5-6:

The hardware in the loop simulation (HIL) included also the control of one self steering axle.

The WABCO function “Steering axle control” (see ID_TEBS, paragraph 2.1.5.1.1.20) was configured to lock a steering axle via a solenoid at a vehicle speed of 30 km/h and to unlock below 20 km/h.

The vehicle speed was generated by using a wheel speed simulation.

The parameter “Steering axle locking” was set to 00b at standstill. When the vehicle speed was increased to 31 km/h the parameter changed to 01b.

When the speed was reduced to 25 km/h the value remained 01b, but when reduced to 19 km/h the value changed back to 00b.

3.2.5.12 Time and Date:

Messages TD11 Byte 1- 8 (see table in paragraph 3.1.5 of this report above):

It was verified, that the Trailer EBS E used the time and date information sent by the tractor to record the time/date, when a fault occurs. For this the message TD11 was simulated by the CANalyzer and a wheel speed sensor fault was simulated by disconnecting the sensor plug from the ECU. Then the WABCO Trailer EBS E PC Diagnostics was used to check that the time/date information, which is provided with the corresponding failure entry, matched with the simulated time/date information.

3.3 Additional checks:

(Annex 17/4.2.3)

In addition to the verification procedure according to Annex 17 of ECE-R13 (see section 3.2 above) compliance with the following provisions of ECE-Regulation No. 13 were demonstrated:

3.3.1 Failure detection signal:

Not applicable (paragraph 5.1.1.5 of ECE-Regulation No. 13)
3.3.2 Failure of electric control line: In the case of defect in one of the control lines between the towing and towed vehicles according to paragraph 5.1.3.1.2 of ECE-Regulation No. 13 the trailer used the control line not affected by the failure to ensure, automatically, the braking performance prescribed for the trailer according to paragraph 3.1. of Annex 4 of ECE-R13.

With the electric and pneumatic signal present at the coupling head the system uses the electric control signal. In the case of a failure of the electric control line the system switches automatically to the pneumatic control line (paragraph 5.1.3.4.1 of ECE-Regulation No. 13). This was verified by the following tests:

a) Disconnection of the electric control line (ISO7638 Pins 6 & 7):
   The disconnections (pin 6 & 7 alone and together) were carried out during a brake application and were indicated by the yellow warning lamp via Pin 5.
   - With a brake force distribution setting to 1:1 the electric control line was set to a constant brake demand of 300 kPa and the pneumatic control line pressure of 400 kPa. The brake delivery pressure was measured as 300 kPa. When a loss of the CAN signal (electrical brake demand) was simulated by an interruption of pins 6 & 7 of the ISO 7638 connector, the brake delivery pressure increased to 400 kPa taking account of the not failed pneumatic control line pressure.

   When the test was carried out with the vehicle stationary and with a simulated vehicle speed of more than 10 km/h, the loss of the CAN signal (electrical brake demand) was indicated by the yellow warning signal via pin 5 of the ISO 7638 connector.

b) Disconnection of the pneumatic control line:
   The disconnection was carried out during a brake application and was indicated by the yellow warning lamp via Pin 5.
c) Reversion to pneumatic control on failures in electric control line:
- The electric control line was set to a constant brake demand of 400 kPa with a corresponding pneumatic control line pressure of 400 kPa. The brake delivery pressure was measured as 390 kPa. A failure was introduced in the electric control line which caused a yellow warning signal via Pin 5 of the ISO 7638 connector and the brake delivery pressure remained at 390 kPa taking account of the not failed pneumatic control line pressure.

3.3.3 Internal failure of modulator: With a brake force distribution simulating an unladen trailer the electric and the pneumatic control line pressure was set to 300 kPa. Without a failure the brake delivery pressure was measured as 120 kPa. When an internal fault of the modulator (disconnection of cable between ECU and solenoid) was introduced the electronic system was switched off which was indicated by the yellow warning lamp via Pin 5 and the brake delivery pressure was increased to 300 kPa due to the loss of the load sensing function.

By changing to “push through” (laden characteristics) in the case of failure in the load-dependent brake force control (front and rear axle), the prescribed minimum service braking performance requirement of Annex 10, paragraph 6 (braking performance in the case a failure in the braking distribution system) is deemed to be fulfilled.

3.3.4 Recognition of pneumatic control line failure:

Paragraph 5.1.3.4.3 of ECE Regulation 13 requires that the driver is warned when the pneumatic signal is not present.

If a pneumatic signal is not present and the electric control signal exceeds the equivalent of 100 kPa for more than 1 s, the yellow warning signal is transmitted via pin 5 of the ISO 7638 connector. The test was carried out simulating a vehicle speed of 0 km/h and 80 km/h.
3.3.5 Priority of braking functions: Paragraph 5.1.3.6 of ECE-Regulation No. 13 requires that the electric control line shall transfer information exclusively for braking and running gear functions and that the braking functions have priority and shall be maintained in the normal and failed modes.

The “Trailer EBS” software does not process any incoming messages other than EBS 11 and EBS 12 and running gear message RGE 11 and the brake messages are given the highest priority according to requirements of standard ISO 11992.

Priority of electrical control line:

- With a brake demand being generated various auxiliary towing vehicle messages were switched on and off. At no time was a change in the brake delivery pressure observed.

- By loading the CAN bus with additional non braking messages when the brake demand was generated it was demonstrated that the observed delivery pressure did not change.

3.3.6 Distribution of braking: Paragraph 5.2.2.5 of ECE Regulation 13 requires that systems that incorporate functions - such as anti-lock - which may cause deviation from the symmetrical distribution of braking must be declared.

The anti-lock braking function has been assessed in accordance with the procedure defined in Annex XIV to Directive 71/320/EEC and Annex 19 of ECE-Regulation No. 13 respectively – see TÜV NORD Test Report No. EB123.8E.

3.3.6.1 Declared functions: The “Trailer EBS” system includes the following functions which may result in a deviation from the longitudinal braking distribution. In compliance with the requirements above these functions have been taken into consideration during the evaluation of the systems safety concept (see Appendix 1 to this report).

- Anti-lock braking: The manufacturer declared that all variants of the system incorporate an anti-lock braking function that automatically controls wheel slip of the directly controlled wheels to prevent wheel locking; see also ID_TEBS, paragraph 2.1.5.1.1.4.
- Roll-over control (RSS): The manufacturer declared that all variants and ABS configurations of the system incorporate the “Roll Stability Support” function that automatically applies the brakes to one or more sides of the vehicle as part of a detection routine and/or vehicle stabilising function. In compliance with the requirements above this function has been taken into consideration during the evaluation of the systems safety concept (see Appendix 1 to this report) and ID_TEBS, paragraph 2.1.5.1.1.11.

3.3.6.2 Electronic brake distribution: n/a (see paragraph 7.5 of Annex 10 to ECE Regulation 13)

3.3.6.3 Emergency braking function: At high control line pressures the brake actuator pressure is increased in a ramp fashion up to the characteristic of the vehicle in laden condition (see also paragraph 2.1.5.1.1.6 of ID_TEBS).

3.3.7 Compensation for deterioration or defect within the braking system: The provisions defined in item 5.2.2.5.1 of ECE-Regulation No. 13 do not apply as the system does not support these functions.

3.3.8 Suppression of automatic braking: n/a

3.3.9 Failures in the electric control transmission: The “Trailer EBS” does not distinguish between temporary failures with a duration of ≤ 40 ms and continuous failures that affects the function and performance of the braking system.

3.3.9.1 Single temporary failure: Single temporary failure within the electric control transmission (excluding its energy supply) of less than 40 ms have no distinguishable effect on the service braking performance (cp. paragraph 5.2.2.15.1 of ECE-Regulation No. 13).

3.3.9.2 Single continuous failure: In the case of a failure within the electric control transmission (e.g. breakage, disconnection), the required braking performance of at least 30 per cent of the prescribed performance for the service braking system is ensured by the non-failed part of the electrical control transmission (cp. paragraph 5.2.2.15.2 of ECE-Regulation No. 13).
3.3.10 Failure of energy supply available from ISO 7638:

A failure within the energy supply available from the ISO 7638 connector (see paragraph 5.2.2.15.2.1 of ECE-R13) had the following effects:

a) Open circuit failure of Pin 1:

A yellow warning signal via pin 5 of the ISO 7638 connector and an amber and a red warning signal via the data communication part of the electric control line were sent.

b) Open circuit failure of Pin 2 or Pin 3 or Pin 4

A yellow warning signal via pin 5 of the ISO 7638 connector was sent.

Note:

Failure of pin 2 or 4 also results in the loss of the communications part of the electric control transmission. A failure in the power transmission part of the electric control transmission (pins 1, 2 or 4) causes the system to revert to entirely pneumatic control.

In the case of a failure in pin 3 there is no loss of system function, although the yellow warning signal is sent on pin 5 (see also paragraph 3.3.10 b above).

When the optional CAN Repeater / CAN Router is installed, the intermediate power lines 1 to 4 between the Repeater and the EBS have the same failure modes as the pins 1 to 4 on the ISO7638 connection.

3.3.11 Low energy test according to para. 5.2.2.16.1 of ECE-R13:

Starting from a pressure of 450 kPa in the air reservoir (60 l) a trailer (bench which represented a 3-axle semi-trailer braking system, see above paragraph 3.0) the service brake control was applied 5 times \( (p_m = 650 \text{ kPa}) \). At the fifth full-stroke actuations a pressure of 330 kPa in the air reservoir was obtained. Since the pressure of 330 kPa is more than 50% of the pressure \( p_m = 650 \text{ kPa} \), the necessary pressure to obtain at least 50 per cent of the prescribed performance of the service braking system is fulfilled for the tested “bench trailer” (see above paragraph 3.0).

3.3.12 Warning signals:

See paragraph 5.2.2.17 of ECE-Regulation No. 13

General Note:

The amber warning signal request is always transmitted in parallel and mirrors the Pin 5 yellow warning signal of the ISO 7638 connector when ISO 11992 data communication is available (see also paragraph 3.2.4.2 above).
3.3.12.1 Warning signal indication: Failures or defects of the brake system were signalled to the motor vehicle via the ISO 7638 connector by the red and/or yellow (pin 5) warning signal(s); see also paragraph 3.2.4.2 above.

3.3.12.2 Warning signal sequence: All configurations have the option of two discrete warning signal sequences - see para. 2.3.5. of ID_TEBS - both of which fulfil the prescribed requirements of paragraphs 4.1.1 and 4.1.2 (including footnote 3) of Annex X of Directive 71/320/EEC and Annex 13 of ECE-Regulation No. 13 respectively.

On the test bench both optional warning signal sequences (see paragraph 2.3.5. of ID_TEBS) were realised and positively verified.

3.3.12.3 Red warning signal

The red warning signal request is sent to the motor vehicle in the following cases:

- Permanent failure within the electric control transmission which precludes the service braking performance being met (see paragraph 3.2.4.1 b) and 3.2.4.2 a) above)

- Low voltage warning (see paragraph 3.2.4.2 b above)

- Low system supply pressure warning (see paragraph 3.2.4.2 c above)

- A failure within the energy supply available from Pin 1 of ISO 7638 connector (o/c failure - see paragraph 3.3.10 a) above)

In addition, the red warning signal request is sent when there is a failure which results in the simultaneous loss of both load sensing and anti-lock function (and when the data communication according to ISO 11992 is available).

3.3.12.3 Non specified failures: Non-specified failures (e.g. excessive brake lining wear, failure in the control channel of the auxiliary equipment etc.) shall be indicated only by the flashing of the warning signal. However, the warning signal shall be extinguished when the vehicle speed exceeds 10 km/h (paragraph 5.2.1.29.6.3 of ECE-Regulation No. 13).
The following tests were carried out:

a) Introduction of a non-specified fault (simulation of an excessive brake lining wear by an electrical line interruption) at a vehicle speed $\geq 10$ km/h with the following reduction of the vehicle speed to 0 km/h

**System response:** No warning signal was transmitted.

b) After the internal recognition time of the failure according to a) the ignition of the system was switched off and on again.

**System response:** After energising the “Trailer EBS” the flashing of the yellow signal started only after the normal warning signal sequence was completed (see para. 2.3.5 of ID_TEBS)

c) With the failure according to a) still present, the vehicle speed was increased again $\geq 10$ km/h.

**System response:** The flashing yellow warning signal was terminated.

d) The test conditions according to a) and b) were repeated and, in addition, a specified failure (sensor 1A o/c) was introduced.

**System response:** The flashing yellow warning signal was replaced by a non-flashing signal.

### 3.3.13 Failure mode simulation:

With regard to fault detection at the periphery and measures against faults, various failures (in addition to the tests mentioned under paragraph 3.2.4.2 above) were simulated on a bench (which represented a 3-axle semi-trailer braking system, see above paragraph 3.0) with regard to the sensors and modulators and to the related electrical cables.

The failures were detected and indicated as specified in Appendix 2 of ID_TEBS.

### 3.3.14 Protection of braking system:

The braking system is protected from an overload external to the braking system according to paragraph 5.2.2.18 of ECE-Regulation No. 13.

This function was checked by simulating a short circuit of the power supply of the electronically controlled air suspension. After the detection of the short circuit the power supply to the subsystem **ECAS** (electronically controlled air suspension system) was switched off by the trailer modulator. There was no influence in the braking pressure.
Due to the possibility of influencing the brake force distribution, in the case of this fault the yellow warning signal via pin 5 of the ISO 7638 connector was sent. In other cases of a fault within the GIO outputs the system response with a flashing of the yellow warning signal as described under paragraph 3.3.12.3 above.

3.3.15 Dynamic sensor fault:
A dynamic sensor fault was introduced at a vehicle speed of greater than 10 km/h. After reducing the speed to zero and switching the ignition on and off the “permanent” yellow failure warning signal was transmitted via pin 5 of the ISO 7638 connector (see paragraph 5.1.2.29.5 ECE-R13 and paragraph 4.1.2 of Annex 13 to ECE-Regulation No. 13).

3.3.16 Modulator cycling:
When the system is energised each electrically controlled modulator will cycle (each solenoid one time).

3.4 Requirements for Periodic Technical Inspection:
See paragraph 5.1.4.4 of ECE-Regulation No. 13

3.4.1 Static braking forces:
It is possible to generate maximum braking forces under static conditions on a rolling road or roller brake tester see ID_TEBS, section 5.

3.5 Safety assessment:
A safety assessment was carried out. The results are reported in Appendix 1 to this report.
The safety provisions applied are considered satisfactory.

3.6 Electro magnetic compatibility:
see paragraph 3.2.3.1 of Appendix 1 to this report

3.7 Special Functions:
3.7.1 Load-dependent brake force control (LSV):
see ID_TEBS, paragraph 2.1.5.1.1.2

3.7.2 Monitoring of brake air pressure:
see ID_TEBS, paragraph 2.1.5.1.1.7

3.7.3 Lifting axle control:
see ID_TEBS, paragraph 2.1.5.1.1.8

3.7.4 Integrated speed switch:
see ID_TEBS, paragraph 2.1.5.1.1.9

3.7.5 Standstill function:
see ID_TEBS, paragraph 2.1.5.1.1.5

3.7.6 Emergency braking function:
see ID_TEBS, paragraph 2.1.5.1.1.6
3.7.7 Lining wear sensing: see ID_TEBS, paragraph 2.1.5.1.1.10

3.7.8 Roll stability support (RSS): see ID_TEBS, paragraph 2.1.5.1.1.11 and TÜV NORD report EB134.3E

3.7.9 ECAS: see ID_TEBS, paragraph 2.1.5.1.1.12

3.7.10 Road finisher brake: see ID_TEBS, paragraph 2.1.5.1.1.16

The road finisher brake function is regarded as an auxiliary braking function which is only operational at a speed below 10 km/h. This function is not regarded as a braking function in the meaning of ECE R13.

The road finisher brake is used for targeted braking of tippertipper trailers during operation with road finishers. The service braking system of the tipper can also be operated without any braking by the towing vehicle.

Safety features incorporated:

- The function can only be activated when the vehicle speed is below 10 km/h
- The function may be activated either by a switch or SmartBoard (see also ID_TEBS, paragraph 2.1.6.6.1).
- The function will be automatically disabled when the vehicle speed exceeds 10 km/h
- When the power supply from the motor vehicle is interrupted (i.e. ignition off or ISO 7638 connector disconnected) the function is disabled

Note: The maximum pneumatic control pressure can be set by SmartBoard and may be up to 650 kPa

3.7.11 Brake release function see also ID_TEBS, paragraph 2.1.5.1.1.17

The brake release function is regarded as an auxiliary braking function which is only operational at a speed below 2 km/h. This function is not regarded as a braking function in the meaning of ECE R13.

This function can be used, if the trailer brakes have to be released to allow a forward or rearward movement of the vehicle e.g. due to a change in suspension height or to change the length of a telescopic drawbar. For this the brakes of the trailer can be released by the brake release function.
Safety features incorporated:
The brake release function can only be activated if all of the following conditions are met:
- Vehicle is at standstill (no wheel speed detected by the system)
- Demand pressure at the yellow coupling head of the trailer (parking brake in the tractor applied) must be greater than 650 kPa.
- The brake release button has to be pressed. Instead of a separate button it is also possible to activate the brake release function by the SmartBoard
- When the above conditions are fulfilled, the brakes are released by venting the brake chambers by the EBS-modulators as long as the button is pressed.
- When the power supply from the motor vehicle is interrupted (i.e. ignition off or ISO 7638 connector disconnected) the function is disabled

With respect to the conditions when the function is disabled see ID_TEBS, paragraph 2.1.5.1.1.1.

3.7.12 Tension reduction function

see also ID_TEBS, paragraph 2.1.5.1.1.17

The tension reduction function is regarded as an auxiliary braking function enabling a partial release of the wheel brakes for the purpose to position the trailer. It is not a braking function in the meaning of ECE-Regulation No. 13.

Safety features incorporated:
The brake release function can only be activated when no wheel speed of the trailer is detected.

Further safety conditions of this function are described in ID_TEBS, paragraph 2.1.5.1.1.17.
3.7.13 **SmartBoard:** see ID_TEBS, paragraph 2.1.6.6.1

3.7.14 **IVTM:** see ID_TEBS, paragraph 2.1.6.6.2

**4 Functionality label:** An “ISO 7638 label” (as required by paragraph 5.2.2.17 of ECE-R13) is shown in Appendix 7 of ID_TEBS.

**5 Optional Equipment**

5.1 **CAN Repeater:** See ID_TEBS, paragraph 2.3.3.5 and Appendix 2 to this report

5.2 **CAN Router:** See ID_TEBS, paragraph 2.3.3.6 and Appendix 2 to this report

**6 Test documents** (provided confidentially for inspection)
- Supporting documentation in respect of the assessment according to Annex 18
- ISO 11992 Conformity Test Reports:
  - Test Report No. 617 –142 00 - 02 of 07.06.00 (TCE)
  - Test Report No. 6171 - 2009 - 0009 (CAN Repeater / Router)

**7. Date of test:** 11/2006 – 12/2008

**8 Attached Documentation**
- Electronic Safety Assessment Test Report (see Appendix 1 to this report)
- CAN Repeater / Router (see Appendix 2 to this report)
9 Conclusions

The “Trailer EBS, variant E” system described within the manufacturer’s Information Documents has been technically assessed and the results recorded within this report. Based on this assessment it is confirmed that the system conforms to the special requirements for trailers which are equipped with an electric control line and/or an electric control transmission according to ECE Regulation No. 13/11*.

* The assessment of the Trailer EBS, variant E system covers also the technical requirements included within the “Proposal for Supplement 1 to the 11 series of amendments to Regulation No. 13” (see document ECE/TRANS/WP.29/2008/63 of 10 April 2008) which was adopted at the 146th session of WP29 in November 2008 and scheduled to be effective from the 22nd July 2009.

The technical content of this report remains valid for future amendments of ECE-Regulation No. 13 provided that such future amendments do not change the technical requirements and procedures associated with the systems covered by this report.

Essen, 26th May 2009
TDB/Gaupp
Order-No. 08.1027

TÜV NORD Mobilität GmbH & Co. KG
Institute for Vehicle Technology and Mobility (IFM)

Technical Service for Braking Systems

Dipl.-Ing. Winfried Gaupp

Accredited by the accreditation authority of the Kraftfahrt-Bundesamt Bundesrepublik Deutschland - Federal Republic of Germany - DAR-registration-number KBA-P 00004-96
Electronic Safety Assessment Test Report

1. General
This test report has been compiled in accordance with Annex 18 to ECE Regulation 13:
“Special Requirements to be applied to the Safety Aspects of Complex Electronic Vehicle Control Systems”

2. Identification
2.1 Manufacturer: WABCO Vehicle Control Systems
Am Lindener Hafen 21
D - 30453 Hannover

1.2 System name/model: Trailer EBS
1.2.1 System variant: E (see also paragraph 1.3 of ID_TEBS)

Versions:
- with TCE (Trailer Central Electronic)
- with CAN Repeater
- with CAN Router

Note: Regarding the description of the above mentioned different versions see paragraph 2.1.3 of ID_TEBS. These additional equipments are optional.

3. Manufacturer's documentation
3.0 The manufacturer's documentation was made available in two parts as follows.

Part A

Part B
Additional material and analysis data of paragraph 3.4.4 of ECE R13, Annex 18, which was confidentially made available for assessment, but was retained by the manufacturer.

Note: For the sake of simplicity “Trailer Electronic Braking System Information Document” is abbreviated to “ID_TEBS”
The documentation of Part A contains the following:

3.1 Periodic technical inspections
How the current operational status of Trailer EBS can be checked is described in section 5 of ID_TEBS.

3.2 Description of the functions of “The System”
A description of the function of the System is given in section 2.1.5 of ID_TEBS.

3.2.1 List of all input variables with their working ranges
A list of all input and sensed variables and the associated working ranges is included in section 3.1 of ID_TEBS.

3.2.2 List of all output variables with their working ranges
A list of all output variables controlled by the Trailer EBS and the associated working ranges is included in section 3.2 of ID_TEBS.

3.2.3 Boundaries of functional operation within environmental conditions
The limits defining the boundaries of functional operation are included in sections 3 and 7 of ID_TEBS.

The manufacturer demonstrated that, during the system development, adequate provisions had been made to take account of the environmental conditions to which the Trailer EBS will be subjected (Documentation Part B - Product Identification Nos. 480 102 089 0 (Trailer EBS), Doc.-Code No. 535).

3.2.3.1 Electromagnetic compatibility (EMC)
Measures have been taken within the design and corresponding tests have been carried out to show the electromagnetic compatibility with respect to conducted and radiated disturbances.

The system has been tested and verified to conform to the requirements of Directive 72/245/EEC (as last amended by Directive 2006/28/EC)* and have been given the following approval marks:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Approval Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBS Trailer Modulator</td>
<td>e1<em>72/245</em>2006/28<em>4868</em>01</td>
</tr>
<tr>
<td></td>
<td>E1-10R-034868</td>
</tr>
<tr>
<td>TCE*</td>
<td>e1<em>72/245</em>2006/28<em>1665</em>01</td>
</tr>
<tr>
<td>CAN Router/ Repeater</td>
<td>e1<em>72/245</em>2006/28<em>5434</em>00</td>
</tr>
<tr>
<td></td>
<td>E1-10R-35434</td>
</tr>
</tbody>
</table>
See also paragraph 2.4 and Appendix 5a to 5e (copies of the EMC approval reports) of ID_TEBS.

*Note:* This approval does not make reference to ECE-Regulation 10. However, the performance requirements of Directive 72/245/EEC as last amended by Directive 2006/28/EC are more extensive than those of ECE-Regulation 10/02. Since Directive 72/245/EEC contains also all technical requirements of ECE-Regulation 10/02 compliance with ECE-Regulation 10/02 is assured as well.

### 3.3 System layout and schematics

#### 3.3.1 Inventory of components

The inventory of components is included in the component description section 2.3.

#### 3.3.2 Functions of the units

The functions of the units are described in section 2.1.5.1.1 of ID_TEBS.

#### 3.3.3 Interconnections

The interconnections are shown in paragraph 4.1 (pneumatic), paragraph 4.2 (electric) and appendices 4 and 8.

#### 3.3.4 Signal flow and priorities

The signal flow and priorities are depicted in section 4.3 of ID_TEBS.

#### 3.3.5 Identification of units

##### 3.3.5.1 Identification of hardware

The version of the hardware is identified by the corresponding component numbers, see section 2.3 of ID_TEBS.

The modulator of the Trailer EBS is identified by the part number on the component type plate.

The hardware versions of the Trailer EBS E modulator at the date of type approval were Nos 480 102 060 0 (sequential number: 213).

The hardware version of the Trailer Central Electronic (TCE) at the date of type approval was ECU No. 446 122 001 0 (sequential number: 001).

##### 3.3.5.2 Identification of software

The identification of software version is described in sections 2.3.2.1 and 2.3.2.2 of ID_TEBS.

The software version of the Trailer EBS is identified by the name of the software program and its corresponding identification number.
The current software versions of the Trailer EBS variant E mentioned under paragraph 1.2.1 above at the date of type approval were:

a) Trailer EBS without TCE
   - Name of software program: **TE 00 1418**
   - Software identification number: **246 145 000 2**

b) Trailer Central Electronic (TCE)
   - Name of software program: **TCE 00 R0326A01**
   - Software identification number: **446 122 543 4**

c) CAN Repeater / CAN Router
   - Name of software program: **RR 00 0108**
   - Software identification number: **246 122 071 2**

**Note:** The third and fourth characters (numbers) in the case of a), and c) above and the fourth and fifth characters (number) in the case of b) above in the software program name of the Trailer EBS variant E and the Trailer Central Electronic (see above numbers "00") denotes the software version as far as ECE-Regulation No. 13 is concerned.

The last four characters in the name of software program may vary although the functions of the Trailer EBS, TCE and CAN Repeater as far as ECE-Regulation No. 13 is concerned is unchanged (compare ECE-R13, paragraph 3.3.5.1 of Annex 18).

New software versions can only be installed by the WABCO TEBS-E diagnostic software by authorized persons (as described in paragraph 2.1.5.3 of ID_TEBS).

### 3.4 Safety concept of the manufacturer

During the assessment the design provisions built into the Trailer EBS regarding the generation of safe operation under fault conditions were explained by means of safety document No. 400 200 220 0.

The following design provisions to protect against failures in the Trailer EBS are implemented as follows:

- Monitoring functions to recognise faults within the electronic control unit (ECU) and external faults (e.g. of sensors, actuators, cables, etc.) associated with the system.
- In the case of a failure, the driver will be warned by the prescribed warning signal(s).
- Fall-back to partial system operation: the various detected failures and their effects are described in Appendix 2 of ID_TEBS.
3.4.1 **Statement of the manufacturer**

The required statement of the manufacturer which affirms that the strategy chosen to achieve the “The System” objectives under the conditions defined in paragraph 3.4.1 of Annex 18 of ECE-Regulation No. 13 is provided in paragraph 6.1 of ID_TEBS.

3.4.2 **Software of Trailer EBS (outline architecture, software design methods and tools used)**

The software development was carried out according to WABCO Common Development Process (CDP) based on organisation model according to ISO/TS 16949:2002 and ISO 9001:2000.

The outline architecture of software (information flow, data flow) and the software design method and tools according to V-model/ISO 12207 (system specification, software specification, design, software construction, integrations tests, software tests, system tests) were explained.

The manufacturer gave evidence of the means by which he determined realisation of the system logic during the design and the development process, e.g.:

- **Constructive measures**
  - Documentation of development activities
  - Using of templates and checklists
  - Software design in respect of braking and non-braking functions
  - Structured system analysis according to DeMarco method
  - Structured design
  - Software modularization
  - Partially model based software development
  - Usage of C language together with coding rules
  - Configurations management with MKS

- **Validation**
  - Tests after different phases of software development (integration tests, software tests, system test, document inspections)
  - Static tests with PC-Lint
  - Usage of HIL and model based validation
  - Spice assessment (level 3) for development processes
3.4.3 Design provisions built into “The System” so as to generate safe operation under fault conditions

The trailer braking system is controlled by two independent circuits:
- the pneumatic control line,
- the electric control line.

Failure of these control lines will trigger a change to system operation as described in section 6.3 “Failure mode” of ID_TEBS.

a) Fall-back operation
The system incorporates a selective fall-back strategy in order to maintain at least a partial operation of the system under fault condition. In the case of any safety critical fault detected in the electric control line, the system switched automatically over to the pneumatic control line. The system reactions to the various faults of the pneumatic and electric control lines are delineated in section 6.3 “Failure mode” of ID_TEBS.

b) Change over to a separate back-up system
n/a (no separate back-up system available)

c) Removal of a high level function
see below paragraph 3.4.3.3

3.4.3.1 Partial performance mode of operation under certain fault conditions
The partial performance provided under fall-back conditions is described in section 6.4 of ID_TEBS. The Failure-Deactivation Matrix in Appendix 2 of ID_TEBS specifies the specific system reactions to a fault.

3.4.3.2 Second back-up System
n/a

3.4.3.3 Removal of a high level function
As an option the Trailer EBS system provides a trailer roll stability function (RSS).
In the case of a failure in the brake pressure control, wheel speed sensing or lateral accelerometer the trailer roll stability function is suspended.
3.4.4 Safety analysis

The manufacturer carried out a safety analysis which shows, how the Trailer EBS will behave when any faults occur which may influence the vehicle control performance or safety.

The safety analysis was based on the following documents:

<table>
<thead>
<tr>
<th>Trailer EBS (incl. TCE)</th>
<th>Document No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>System-FMEA</td>
<td>400 200 220 0 / Code 458</td>
</tr>
<tr>
<td>Design-FMEA (Premium)</td>
<td>446 145 202 2 / Code 558</td>
</tr>
<tr>
<td>System Safety Requirement Specification</td>
<td>400 200 229 0 / Code 542</td>
</tr>
<tr>
<td>Failure Mode Test Report</td>
<td>TR-6870-540-2006-0033</td>
</tr>
<tr>
<td>Router/ Repeater</td>
<td>446-122-059-0__.058.fme</td>
</tr>
</tbody>
</table>

Based on the evidence supplied in the documentation and the results of subsequent evaluation of possible failures it is evident that the safety concept described is systematic and complete.

3.4.4.1 Parameters being monitored (fault monitoring) and warning signal given to the driver and/or service/technical inspection personal

The parameters being monitored and the fault condition for which a warning signal is given are itemised in section 3 of ID_TEBS.

The failures and their effect on the Trailer EBS with respect to performance and functionality are listed in the Failure-Deactivation Matrix in Appendix 2 of ID_TEBS.

The supported messages from the Trailer EBS according to ISO 11992 are defined in Appendix 4 of ID_TEBS.

For the monitoring of functions to recognise faults within the electronic control unit (ECU) and external faults (e.g. of sensors, actuators, cables, etc.) associated with the system, see section 6.4 of ID_TEBS.

All failures specified by ECE-Regulation No. 13 are indicated to the driver by the prescribed warning signal.

Fall-back to partial system operation: the various failures detected and their effects are described in Appendix 2 of ID_TEBS.

4.0 Verification and Test

4.1 The functional operation of “The System”, as laid out in the documents required in paragraph 3 of Annex 18 of ECE Regulation 13, was tested as follows:
4.1.1 Verification of the function of “The System”

Track and bench tests were carried out to verify the performance of the vehicle system under non-fault conditions. These demonstrated that the system operated in a manner that ensured that the relevant provisions of EC and ECE braking performance requirements would be fulfilled under non-fault conditions.

4.1.2 Verification of the safety concept

The introduction of individual internal and external faults to the system enabled the safety concept of the system to be evaluated, by observing the reaction of the individual system elements and their effect on the braking system as a whole.

The fault codes stored were as referenced in the documentation and the system operated as specified.

The protection measures against environmental influences were evaluated (with respect to the protection measures for electromagnetic compatibility see paragraph 3.2.3.1 above).

The safety concept was verified as specified by the system manufacturer.

Failure mode simulation

With regard to fault detection and measures against faults, various failures were simulated on the test vehicles and on the test bench.

Amongst other things the following failures and signals were simulated and analysed:

- Sensor failures
- Faulty sensor signals (e.g. out-of-range signals)
- Line interruptions / open circuits
- Short circuits
- Valve failures
- Failure of power supply
- Undervoltage/overvoltage in power supply
- Internal ECU failures (hardware and software (e.g. controller communication, illegal operational code, etc.)

4.1.2.1 Comparison of the verification results with the documented summary of the failure analysis

The reaction by the system to the faults (see paragraph 4.1.2. above) introduced were in correspondence with the documented summary of the failure analysis.
5. **Summary**

Based on the documentation presented and examined in combination with the tests carried out it is anticipated that the measures taken by the manufacturer in respect of failure detection and failure management are appropriate to attain the required level of safety.

6. **Place and date of assessment**

**Hanover / Essen / 11/2006 – 12/2008**

Order-No. 08.1027

**Hanover and Essen, 26th May 2009**

TÜV NORD Mobilität GmbH & Co. KG

Institute for Vehicle Technology and Mobility (IFM)

Competence Centre Electronics

Technical Service for Braking Systems

Dipl.-Ing. Uwe Zinn

Dipl.-Ing. Winfried Gaupp

Accredited by the accreditation authority of the Kraftfahrt-Bundesamt Bundesrepublik Deutschland - Federal Republic of Germany - DAR-registration-number KBA-P 00004-96
CAN Repeater / Router

1 Introduction

The CAN Repeater and the CAN Router are additional ECUs (communication gateways) used on long trailers where a direct connection of the electric control line to the TEBS E would not comply with the maximum trailer cable length of 18 m prescribed by ISO11992 or when two Trailer EBS systems are installed (see below Diagram E in paragraph 3.2).

Generally, the function of the CAN Repeater (one in and one output port for the electrical control signal) is to amplify the CAN signal to extend the maximum cable length whereas the function of the CAN Router is to distribute the CAN signal to different ECUs. Thus, the CAN Router has two output ports for the CAN brake control signal:
- Pow. OUT port 1: Vehicle CAN bus
- Pow. OUT port 2: ISO 11992 CAN bus

In addition, see Diagrams C and D, the CAN-Repeater reads in the signal of the demand pressure sensor (installed in the pneumatic control line in the front of the trailer) to improve the response time when braking only via the pneumatic control line. This signal is transmitted via the CAN-Data bus (vehicle specific) to the trailer modulator.

2 Legislative background

According to paragraph “3.5 of ISO 11992 Part 1, a “point-to-point connection” is an electrical connection between two electronic nodes only (that means between two “intelligent electronic devices”). The definition of "point-to-point" (see below) refers to pins 6 and 7. That means also that the electrical lines of pin 6 and 7 (e.g. between motor vehicle ECU and trailer ECU) have no other connections with other nodes.

"Point-to-point" means a topology of a communication network with only two units. Each unit has an integrated termination resistor for the communication line (see ECE-Regulation No. 13, paragraph 2.26).

In ISO 11992 the maximum length of the various individual cables for this “point-to-point connection” is defined as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Notation</th>
<th>max. length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall cable length</td>
<td>$l = l_1 + l_2 + l_3$</td>
<td>40 m</td>
</tr>
<tr>
<td>Cable length in towing vehicle</td>
<td>$l_1$</td>
<td>15 m</td>
</tr>
<tr>
<td>Coiled cable length</td>
<td>$l_2$</td>
<td>7 m</td>
</tr>
<tr>
<td>Cable length in towed vehicle</td>
<td>$l_3$</td>
<td>18 m</td>
</tr>
</tbody>
</table>
The maximum permissible cable length $l_3$ of 18 m is too short for special very long trailers to connect the Trailer EBS with the ISO 7638 connector. To extend this length to about 92 m either a repeater or a router was used in the Diagram B to E (see paragraph 3.2). In these diagrams the electric control line ends after 12 m behind the ISO 7638. The following cable length of 80 m makes up the missing transmission length for the data communication between the CAN-Repeater or CAN Router and the Trailer EBS. This part of the control transmission is a customized vehicle data bus.

3 Assessment

3.1 General

In addition to the Annex 18 safety assessment (see Appendix 1 to this report) response time tests were carried out with a 3-axle semi-trailer to assess the performance of the TEBS system according to the different brake Diagrams A to E.

Comparative ABS tests with and without CAN Repeater / Router have not been carried out since the ABS performance measurements are carried out by applying the brakes via the pneumatic control line (only braking of the trailer), the length of the electric control line does therefore not have any influence on the ABS performance test results. The ABS performance is measured with a constant control line pressure $p_m$, so that the response time of the pneumatic control line has no influence to the results too.

3.2 Diagrams

The following Diagrams A to D show the test conditions for the response time measurements described in paragraph 3.3 below; with respect to the response time measurement Diagram E is equivalent to Diagram D.
B CAN Repeater without pressure sensor: 12 + 80 m cable length for electric brake signal, 75 + 5 m tube length for pneumatic brake signal

C CAN Repeater and pressure sensor connected directly to TEBS E: 12 + 80 m cable length for electric brake signal, 75 + 5 m tube length for pneumatic brake signal

D CAN Repeater and pressure sensor connected directly to CAN Repeater: 12 + 80 m cable length for electric brake signal, 75 + 5 m tube length for pneumatic brake signal
**Legend**

<table>
<thead>
<tr>
<th>Position</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supply line</td>
</tr>
<tr>
<td>2</td>
<td>Pneumatic control line (from coupling head to PREV)</td>
</tr>
<tr>
<td>3</td>
<td>Electric control line (to 1st TEBS modulator)</td>
</tr>
<tr>
<td>4</td>
<td>Park release emergency valve</td>
</tr>
<tr>
<td>5</td>
<td>Reservoir</td>
</tr>
<tr>
<td>6</td>
<td>Pneumatic control line (From PREV to 1st TEBS E)</td>
</tr>
<tr>
<td>7</td>
<td>(1st) Trailer EBS E (TEBS E) modulator</td>
</tr>
<tr>
<td>8</td>
<td>CAN Repeater</td>
</tr>
<tr>
<td>9</td>
<td>CAN control line</td>
</tr>
<tr>
<td>10</td>
<td>External demand pressure sensor</td>
</tr>
<tr>
<td>11</td>
<td>Pressure sensor signal cable to TEBS E</td>
</tr>
<tr>
<td>12</td>
<td>Pressure sensor signal cable to CAN Router/Repeater</td>
</tr>
<tr>
<td>13</td>
<td>CAN Router</td>
</tr>
<tr>
<td>14</td>
<td>Pneumatic control line to 2nd TEBS modulator</td>
</tr>
<tr>
<td>15</td>
<td>2nd Trailer EBS E (TEBS modulator)</td>
</tr>
<tr>
<td>16</td>
<td>Electric control line to 2nd TEBS modulator</td>
</tr>
</tbody>
</table>
### Appendix 2

<table>
<thead>
<tr>
<th>Three-axle semi-trailer with 80 litres air reservoir – 2S/2M</th>
<th>Diagram A</th>
<th>Diagram B</th>
<th>Diagram C</th>
<th>Diagram D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAN Repeater</strong></td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Pressure sensor</strong></td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Cable length for electric brake signal</strong></td>
<td>12 m</td>
<td>12 + 80 m</td>
<td>12 + 80 m</td>
<td>12 + 80 m</td>
</tr>
<tr>
<td><strong>Tube length for pneumatic brake signal</strong></td>
<td>12 + 5 m</td>
<td>75 + 5 m</td>
<td>75 + 5 m</td>
<td>75 + 5 m</td>
</tr>
</tbody>
</table>

**Response time measurement with pneumatic control line**

<table>
<thead>
<tr>
<th></th>
<th>Diagram A</th>
<th>Diagram B</th>
<th>Diagram C</th>
<th>Diagram D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial reservoir pressure</strong></td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
</tr>
<tr>
<td><strong>Control line demand signal</strong></td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
</tr>
<tr>
<td><strong>Control line demand signal (10 % value)</strong></td>
<td>65 kPa</td>
<td>65 kPa</td>
<td>65 kPa</td>
<td>65 kPa</td>
</tr>
<tr>
<td><strong>Measured asymptotic pressure in the brake chamber with a pneumatic demand signal in the control line 650 kPa</strong></td>
<td>590 kPa</td>
<td>590 kPa</td>
<td>590 kPa</td>
<td>590 kPa</td>
</tr>
<tr>
<td><strong>75 % of the measured asymptotic pressure in the brake chamber</strong></td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
</tr>
<tr>
<td><strong>Measured response time (average of 3 measurements)</strong></td>
<td>0,38 s</td>
<td>1,473 s</td>
<td>0,35 s</td>
<td>0,35 s</td>
</tr>
</tbody>
</table>

**Response time measurement with electric control line**

<table>
<thead>
<tr>
<th></th>
<th>Diagram A</th>
<th>Diagram B</th>
<th>Diagram C</th>
<th>Diagram D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial reservoir pressure</strong></td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
<td>650 kPa</td>
</tr>
<tr>
<td><strong>Control line demand signal</strong></td>
<td>33280 d</td>
<td>33280 d</td>
<td>33280 d</td>
<td>33280 d</td>
</tr>
<tr>
<td><strong>Control line demand signal (10 % value)</strong></td>
<td>3328 d</td>
<td>3328 d</td>
<td>3328 d</td>
<td>3328 d</td>
</tr>
<tr>
<td><strong>Measured asymptotic pressure in the brake chamber with a pneumatic demand signal in the control line 650 kPa</strong></td>
<td>590 kPa</td>
<td>590 kPa</td>
<td>590 kPa</td>
<td>590 kPa</td>
</tr>
<tr>
<td><strong>75 % of the measured asymptotic pressure in the brake chamber</strong></td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
<td>442,5 kPa</td>
</tr>
<tr>
<td><strong>Measured response time (average of 3 measurements)</strong></td>
<td>0,277 s</td>
<td>0,273 s</td>
<td>0,27 s</td>
<td>0,273 s</td>
</tr>
</tbody>
</table>
The response time results show:

a. In the conventional system A without either CAN Repeater or control line pressure sensor, the electric control line gives faster response than the pneumatic control, as expected;

b. In the system B with 92 m cable length for the electric brake signal and 80 m tube length for the pneumatic brake signal (without pressure sensor) the requirements for the response time according to ECE Regulation 13, Annex 6, is met for the electrical signal but not, as expected, for the pneumatic signal

c. In the system C with the CAN Repeater and pressure sensor connected directly to TEBS E, with 92 m cable length for the electric brake signal and 80 m tube length for the pneumatic brake signal the requirements for the response time according to ECE Regulation 13, Annex 6, are met for the electrical signal and as well for the pneumatic signal

d. In the system D with the CAN Repeater and pressure sensor connected directly to the CAN Repeater, with 92 m cable length for the electric brake signal and 80 m tube length for the pneumatic brake signal the requirements for the response time according to ECE Regulation 13, Annex 6, are met for the electrical signal and as well for the pneumatic signal

With respect to the connection of the pressure sensor to the CAN Repeater / Router or connection directly to the TEBS modulator, there is no significant difference in the response time measurements for the systems B to E.

With the exception of the measurement of the pneumatic control signal of system B (see also paragraph b. above) the response time measurements for the systems B to D with the very long cables and tubes were comparable with the response time measurements for the conventional system A.
Trailer Electronic Braking System
Information Document
ID_EB124_5E

Trailer EBS E

Trailer EBS E with TCE

Trailer EBS E with CAN-Repeater

Trailer EBS E with CAN-Router

2S/2M - 4S/3M
# 1. Introduction

<table>
<thead>
<tr>
<th>Excerpt</th>
<th>(Annex 18 of ECE R13 to the 10 series of amendments)</th>
</tr>
</thead>
</table>

## Documentation

### 3.1

The manufacturer shall provide a documentation package which gives access to the basic design of “The System” and the means by which it is linked to other vehicle systems or by which it directly controls output variables.

The function(s) of “The System” and the safety concept, as laid down by the manufacturer, shall be explained.

Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

For periodic technical inspections, the documentation shall describe how the current operational status of “The System” can be checked.

### 3.1.1. Documentation shall be made available in two parts:

- **a)** The formal documentation package for the approval, containing the material listed in paragraph 3 (with the exception of that of paragraph 3.4.4.) which shall be supplied to the technical service at the time of submission of the type approval application. This will be taken as the basic reference for the verification process set out in paragraph 4. of this annex.

- **b)** Additional material and analysis data of paragraph 3.4.4., which shall be retained by the manufacturer, but made open for inspection at the time of type approval.

### 3.2

**Description of the Functions of ‘The System’**

A description shall be provided which gives a simple explanation of all the control functions of “The System” and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

### 3.2.1

A list of all input and sensed variables shall be provided and the working range of these defined.
### 3.2.2. A list of all output variables which are controlled by “The System” shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph 2.7.) exercised on each such variable shall be defined.

### 3.2.3 Limits defining the boundaries of functional operation (paragraph 2.8.) shall be stated where appropriate to system performance.

### 3.3. System layout and schematics

#### 3.3.1. Inventory of components

A list shall be provided, collating all the units of “The System” and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination shall be provided with both the equipment distribution and the interconnections made clear.

#### 3.3.2. Functions of the units

The function of each unit of “The System” shall be outlined and the signals linking it with other units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

#### 3.3.3. Interconnections

Interconnections within “The System” shall be shown by a circuit diagram for the electric transmission links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages.

#### 3.3.4. Signal flow and priorities

There shall be a clear correspondence between these transmission links and the signals carried between Units.

Priorities of signals on multiplexed data paths shall be stated, wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.
### 3.3.5. Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used.

The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

### 3.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the Unit as far as this Regulation is concerned, this identification shall also be changed.

### 3.4. Safety concept of the manufacturer

#### 3.4.1. The manufacturer shall provide a statement which affirms that the strategy chosen to achieve “The System” objectives will not, under non-fault conditions, prejudice the safe operation of systems which are subject to the prescriptions of this Regulation.

#### 3.4.2. In respect of software employed in “The System”, the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall be prepared, if required, to show some evidence of the means by which they determined the realisation of the system logic, during the design and development process.

#### 3.4.3. The Manufacturer shall provide the technical authorities with an explanation of the design provisions built into “The System” so as to generate safe operation under fault conditions. Possible design provisions for failure in ‘The System’ are for example:

- a) Fall-back to operation using a partial system.
- b) Change-over to a separate back-up system.
- c) Removal of the high level functions.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, eg. by turning the ignition (run) switch to “off”, or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.
3.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.  

3.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built-in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.  

3.4.3.3. If the chosen provision selects the removal of the Higher Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.  

3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on vehicle control performance or safety.  

This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.  

The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the technical service at the time of the type approval.  

3.4.4.1. This documentation shall itemise the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4. above, the warning signal to be given to the driver and/or to service/technical inspection personnel.  

<table>
<thead>
<tr>
<th>3.4.3.1.</th>
<th>If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4.3.2.</td>
<td>If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built-in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.</td>
</tr>
<tr>
<td>3.4.3.3.</td>
<td>If the chosen provision selects the removal of the Higher Level Function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.</td>
</tr>
<tr>
<td>3.4.4.</td>
<td>The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on vehicle control performance or safety. This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations. The chosen analytical approach(es) shall be established and maintained by the Manufacturer and shall be made open for inspection by the technical service at the time of the type approval.</td>
</tr>
<tr>
<td>3.4.4.1.</td>
<td>This documentation shall itemise the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4. above, the warning signal to be given to the driver and/or to service/technical inspection personnel.</td>
</tr>
</tbody>
</table>

FMEA (not public)
2. Information document for Trailer EBS

This information document is produced in accordance with ECE R13 as last amended by the 11 series of amendments.

2.1 General

The information contained in this document is used for the type approval of the prescribed braking system.

2.1.1 Name of manufacturer

WABCO GmbH
Vehicle Control Systems
An American Standard Company

WABCO Fahrzeugbremsen
Am Lindener Hafen 21
D-30453 Hannover

2.1.2 System name/model: Trailer EBS

2.1.3 System variant: E

Versions: with TCE (TCE: Trailer Central Electronic)
with CAN Repeater
with CAN Router

2.1.4 System configurations

2S/2M, 2 sensors and one trailer modulator for 1- to 3-axle semi- and centre-axle trailer with air suspension.

2S/2M+SLV, 2 sensors, one trailer modulator and one select low valve for 2- to 3-axle semi- and centre-axle trailer with air suspension and one self-steering axle.

4S/2M, 4 sensors and one trailer modulator for 2- and 3-axle semi-and centre-axle trailer with air suspension.

4S/2M + 1M, 4 sensors, one trailer modulator and one ABS-relay valve for 3- to 4-axle semi-trailers and 3-axle centre-axle trailers with air suspension.

4S/3M, 4 sensors, one trailer modulator and one EBS-relay valve for 2- to 3-axle full trailers and 2- to 3-axle semi-trailer and 2- and 3-axle centre-axle trailer with air suspension.
2.1.5 **Explanation of the basic functions and philosophy of the system**


**2.1.5.1 System structure**

The standard EBS system for a three-axle semi-trailer is shown in the following figure. It controls the brake pressures electronically on each side. The system is made up of a dual-circuit trailer modulator with digital data interface according to ISO 11992 to the EBS towing vehicle, an EBS relay emergency valve or Park Release Emergency Valve (PREV), and the ABS sensors.

When used in full trailers or semi-trailers, with a steering axle, a system with an additional EBS relay valve is used.
Trailers with this brake system are compatible with conventional and EBS-braked towing vehicles. They can be braked with pneumatic redundancy in the case of an EBS failure on the trailer. This results in three possible modes of operation:

a) **Operation behind towing vehicles with EBS and extended (7 pin) ISO 7638 plug-type connection with CAN interface according to ISO 11992.**

   All EBS functions can be utilised. The driver’s braking demand (set value) is transmitted via the data interface to the trailer vehicle.

b) **Operation behind conventional towing vehicles with ISO 7638 plug-type connection, without CAN interface**

   All EBS functions can be used except for transmission of the demand value via the CAN interface. The demand value is specified by the pressure sensor in the relay emergency valve. This pressure sensor measures the trailer control line pressure.

c) **Redundancy operation**

   1. **without ISO 1185 or ISO 12098-powering**

      If the electrical power supply fails or is not plugged in the braking is controlled pneumatically, although **without load-dependent brake force control** and **without ABS function**.

   2. **with ISO 1185 or ISO 12098-powering as a safety function**

      It is not allowed to use the trailer without the ISO 7638 connector. If the electrical power supply via ISO 7638 fails and the system is fitted by an ISO 1185 or ISO 12098-cable (optional feature), the system can be supplied by this optional connection (stoplight-powering). In this case only ABS and the load-dependent brake force control (not TCE) are in function with reduced performance. The Trailer EBS system contains short circuit monitoring in order to protect the backup supply from overload.
2.1.5.1.1 Description of the EBS-functional blocks

The Trailer EBS mode of functioning can be described in terms of various sub-functions.

2.1.5.1.1.1 Selection of demand value

The demand value is the driver's braking request. When operated behind an EBS towing vehicle the trailer modulator obtains the demand value via the trailer interface from the EBS towing vehicle. If no demand value is available via the trailer interface, e.g. when operating the trailer behind a conventionally braked towing vehicle or if the trailer interface in the case of EBS combination is interrupted, a demand value is generated by measuring the control pressure. As a matter of priority, control is always the demand value via CAN.

The electric demand value can optionally be sent via the Trailer Central Electronic or the CAN-Repeater/ CAN Router to the trailer modulator.
2.1.5.1.1.2  LSV- function

The Trailer EBS contains the **load-dependent brake force control**, a distinction being drawn between semi-trailers or centre-axle trailers and full trailers.

The current loading state is determined by sensing the air-suspension bellows pressure.

In case of semi-trailers, as at present, a static linear control function is used. The transmission function of brake pressure \(p_{\text{Cyl}}\) to coupling head pressure \(p_m\) is broken down into two ranges:

- **Application range**
- **Stability range**

In the example the brake cylinder pressure in the application range \(p_m = 0\) bar to \(p_m = 0.7\) bar) rises from 0 to 0.4 bar. At \(p_m = 0.7\) bar the threshold pressure of the wheel brake is reached, and the vehicle can start to generate brake force. The parameters for this point, in other words the response pressure of the whole trailer brake, can be set within the framework of the EEC bands.

Subsequently the brake pressure with laden vehicle follows the straight line which passes through the calculated value at \(p_m = 6.5\) bar. With the unloaded vehicle the response pressure is also modulated from \(p_m = 0.7\) bar, and the brake pressure reduced in accordance with the load.

With a full trailer the brake force distribution, achieved on a software basis, replaces the two LSV valves, the adaptor valve on the front axle and the pressure limiting valve on the rear axle which are commonly used at present.

Here the transmission function is broken down into three ranges:

- **Application range**
- **Wear range**
- **Stability range**

At the end of the application range, the response pressures of the brakes are adjusted again, and these pressures may of course differ from axe to axe.
This ensures uniform loading of all wheel brakes more precisely than can be achieved with the adaptor valve currently used.

In the stability range, the pressures corresponding to equal utilisation of adhesion are adjusted as a function of the axle load.

The rear axle load is determined from the air-suspension bellows pressure. The front axle load is determined, without an axle load sensor, from the slip difference between the speed-sensed wheels.

The parameters are calculated using the WABCO brake calculation program. The parameters are stored in the trailer modulator with the corresponding brake calculation number. The system checks the proper function of the axle load sensor.

2.1.5.1.1.3 Pressure control

The pressure control circuits convert the set pressure specified by the LSV function into cylinder pressures.

The control unit compares the actual pressures measured at the output of the relay valves with the set pressure specified. If a deviation arises, this is corrected by actuating the supply or exhaust solenoids.

2.1.5.1.1.4 Anti-lock function (ABS)

The control logic recognises, from the speed behaviour of the wheels, whether one or more wheels display a "locking tendency" and decides if the related brake pressure is to be lowered, maintained or raised.

For the ABS control logic the wheel speed sensors c, d, e and f are used. At a 2S/2M configuration one wheel speed signal and one TEBS modulator side are connected to one control channel. All other wheels are indirect controlled. The brake forces are controlled according to Individual Control (IR). Every vehicle side gets the brake pressure according to the surface adhesion conditions.

A variant for trailers with self-steering axles is the 2S/2M +SLV (Select Low valve) system. In this configuration the steering axle gets the lowest pressure from both modulator sides, so that the axle is also at µ-split conditions stable.

By 4S/2M configurations there are two wheel speed sensors at each vehicle side. Also in this configuration the brake pressures are controlled sidewise. The both sensed wheels at each side are controlled according to Modified Side Control (MSR). The wheel which locks first determines the ABS control. Both sides of the vehicle are controlled individually. This system is not valid for trailers with tag axles.

The 4S/3M configuration is used for full trailers and semi-trailers with self-steering axles. The steering axle of a semi-trailer has to be equipped with the speed sensors e and f and is controlled by an EBS relay valve. The wheel, which locks first is the reference for the ABS control according to Modified Axle Control (MAR). The other axle(s) are controlled by the TEBS modulator sidewise according to Individual Control (IR). With full trailers the steering axle may be either controlled by the EBS relay valve (MAR) or by the TEBS modulator (IR).

The 4S/2M + 1M configuration can be used for semi-trailers with self-steering axles as a cost optimized variant. The steering axle is controlled by an ABS relay valve which gets the brake pressure from the modulator via a select-high valve. The axle is controlled by a Modified Axle Control (MAR) logic.
All direct controlled wheels can be linked to indirect controlled wheels. However, these wheels are not sensed and therefore may lock.

2.1.5.1.1.5 Standstill function

With the vehicle at a standstill (v \( \leq 1.8 \) km/h) and when the control pressure (pneumatic and electric) is constant for 3 s, there is a switch from electro-pneumatic to pneumatic pressure adjustment. This function serves to prevent unnecessary power consumption when the vehicle is stands still e.g., at a traffic light or if the handbrake is applied and ignition is on. This function is deactivated when the vehicle moves.

2.1.5.1.1.6 Emergency braking function

In order to apply the maximum possible brake force there is an emergency braking function. If the driver's braking command corresponds to more than 90% of the pressure available on the trailer, in other words panic braking is applied, the brake pressures are increased in a ramp fashion up to the characteristic of the vehicle in laden condition. This function is also effective if the bellows of the air suspension system bursts.

2.1.5.1.1.7 Monitoring of brake air pressure

The supply pressure in the trailer vehicle is monitored by the EBS. If the supply pressure falls below 4.5 bar the driver is warned by a warning light which illuminates. When the braking system is filling the warning light only goes out when the supply pressure in the trailer vehicle rises above 4.5 bar. This function is also effective if the bellows of the air suspension system bursts.

2.1.5.1.1.8 Lifting axle control

In conjunction with the WABCO lift axle control valve the T EBS controls one or two lifting axles automatically as a function of the current axle load.

The following messages are transmitted and received:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Message</th>
<th>Byte</th>
<th>Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift axle 1 position request</td>
<td>RGE11</td>
<td>2</td>
<td>1-2</td>
</tr>
<tr>
<td>Lift axle 2 position request</td>
<td>RGE11</td>
<td>2</td>
<td>3-4</td>
</tr>
<tr>
<td>Lift axle 1 position</td>
<td>RGE21</td>
<td>2</td>
<td>1-2</td>
</tr>
<tr>
<td>Lift axle 2 position</td>
<td>RGE21</td>
<td>2</td>
<td>3-4</td>
</tr>
</tbody>
</table>

2.1.5.1.1.9 Integrated speed switch

This output can be used, for example, to activate the RTR function at a speed, set by parameter.
2.1.5.1.1.10 Lining wear sensing

The system can read in max. 6 lining wear sensors or wear indicators. The driver will be warned (stationary, cp. paragraph 5.2.1.29.6 of ECE-Regulation No. 13) when the wear limit is reached.

The following messages are transmitted and received:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Message</th>
<th>Byte</th>
<th>Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>lining wear sufficient</td>
<td>EBS 23</td>
<td>1</td>
<td>3-4</td>
</tr>
<tr>
<td>Tyre wheel identification</td>
<td>EBS 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air leakage detection</td>
<td>RGE23</td>
<td>4-5</td>
<td>1-8</td>
</tr>
<tr>
<td>Tyre pressure threshold detection</td>
<td>RGE23</td>
<td>6</td>
<td>1-3</td>
</tr>
</tbody>
</table>

2.1.5.1.1.11 Roll Stability support (RSS)

The system is equipped with a system to prevent roll over of the trailer when exceeding the possible lateral acceleration.

If the lateral acceleration of the vehicle is above a calculated limit an automatic braking is generated to reduce the speed of the combination with the effect, that the lateral acceleration is also increasing to a safe limit. If a danger of tilting is detected, braking action at high pressure is initiated in the trailer vehicle at least on the individually controlled (IR) outside wheels in order to reduce the vehicle speed, lateral acceleration, and therefore the danger of tilting or to prevent overturning. When the actual lateral acceleration has been reduced under the critical value the automatic braking is removed.

The Trailer EBS utilises automatic commanded braking as a function of the roll stability support system (RSS)

2.1.5.1.1.12 Electronically controlled air suspension

As an option the system can control the air suspension of a trailer by an integrated control algorithm.

2.1.5.1.1.13 Parameter Setting

Variable parameters: The following parameters must be set in the production by the trailer manufacturer.

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>semi-trailer or full trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of axles</td>
<td>for semi-trailers are allowed a max. of 3 axles and for full trailers 3 axles</td>
</tr>
<tr>
<td>ABS-system</td>
<td>installed ABS-system and position of sensors</td>
</tr>
<tr>
<td>Lift axle control</td>
<td>1 or 2 lift axles controlled</td>
</tr>
<tr>
<td>Integrated speed switch</td>
<td>to control self-steering axles or air suspension</td>
</tr>
<tr>
<td>Roll stability support (RSS)</td>
<td>for semi-trailers and centre-axle trailers</td>
</tr>
<tr>
<td>Lining wear sensors</td>
<td>to choose the type of wear sensors</td>
</tr>
<tr>
<td>Warning lamp sequence</td>
<td>on, after 2 s off or on – off - on- at 7 km/h off</td>
</tr>
<tr>
<td><strong>Tyre diameter and pole wheel teeth number</strong></td>
<td>to calibrate the wheel speeds for ABS and odometer</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td><strong>Service interval</strong></td>
<td>The driver will be informed after a specified distance</td>
</tr>
<tr>
<td><strong>Axles load unladen and laden</strong></td>
<td>to adjust the load sensing function</td>
</tr>
<tr>
<td><strong>Air bellow pressure unladen and laden</strong></td>
<td>to adjust the load sensing function</td>
</tr>
<tr>
<td><strong>Brake pressure unladen and laden</strong></td>
<td>to adjust the load sensing function</td>
</tr>
<tr>
<td><strong>Special functions</strong></td>
<td>special functions like traction help or telematic support can be chosen</td>
</tr>
<tr>
<td><strong>Electronically controlled air suspension</strong></td>
<td>to control the level in trailers with air suspension</td>
</tr>
<tr>
<td><strong>GIO- functions</strong></td>
<td>special functions like lift axle control, speed switch, traction help or telematic support can be chosen</td>
</tr>
</tbody>
</table>

2.1.5.1.1.14  **Illuminating stop lamps**

The message requirement "Illuminate stop lamps" of paragraph 5.2.2.22.1 of ECE-Regulation No. 13 (see also its footnote ***) is always transmitted when a automatic commanded braking is applied.

2.1.5.1.1.15  

  --

2.1.5.1.1.16  **Road finisher brake**

The road finisher brake is used for targeted braking of tipper trailers during operation with road finishers. The asphalt-loading tipper and the trailer are pushed ahead by the road finisher. To prevent rolling on a slope, TEBS brakes the tipper independently and in accordance with the load. Mechanical switches can be used for activation in operation (finisher operation ON/OFF) and an end switch for the position of the tipper (roller sensor or proximity switch). The automatic shut-off for this function occurs at speed V > 10 km/h. When using ECAS valves, tipping of the tipper body can be detected via the unloading level switch. The unloading level switch can be activated or deactivated based on the customer’s wishes. An optional switch can be provided for this or a parameter in the diagnostics or a shut-off on the Smart-Board. The braking pressure can be changed via the SmartBoard. The maximum brake pressure is 6.5 bar.

2.1.5.1.1.17  **Brake release function**

This function can be used, if the trailer brakes have to be released e.g. to change the length of a telescopic drawbar. For this the brakes of the trailer can be released by the brake release function.

The brake release function can only be activated if all of the following conditions are met:

- Vehicle is at standstill (no wheel speed detected by the system)
• Parking brake in the tractor applied (without application of the service brake the measured pressure at the yellow coupling head must be higher than 6,5 bar)
• The brake release button has to be pressed. Instead of a separate button it is also possible to activate the brake release function by the SmartBoard; See below paragraph 4.

When these conditions are fulfilled, the brakes are released by venting the brake chambers by the EBS-modulators as long as the button is pressed.

The function will be disabled when:

• The power supply from the tractor is interrupted (ie. ignition off or ISO 7638 connector disconnected)
• When the pressure at the yellow coupling head falls below 6,5 bar
• When at least one wheel speed signal is detected.

To activate the function again the button has to be released and pushed again.

2.1.5.1.1.18 Tension reduction function

The system can support the tension reduction function. When a truck-trailer combination is parked (e.g. at a ramp) and the parking brake in the tractor is applied the following effect can occur: During loading or unloading the trailer or changing the suspension level manually the trailing arms rotate round the pivot to adjust the effective wheel base between tractor and trailer with respect to the loading condition (suspension height). Because the brakes are applied this is not possible. If under these conditions the parking brake would be released, the trailer would make a jerk to release the high tension forces within the suspension. This may cause a damage at the trailer or may hurt a person.

The tension reduction function can only be activated if all of the following conditions are met:

• Supply pressure must be greater than 4.5 bar
• Demand pressure (control line pressure pm) of the trailer must be greater than 3.5 bar
• Detected wheel speed of unbraked wheels must be less than 2.5 km/h
• The tension reduction button has to be pressed to initiate this function. Instead of a separate button it is also possible to activate the tension reduction function by the SmartBoard; See below paragraph 4.

The tension reduction function will run in the following sequences:

• Semitrailer 2S/2M or 4S/2M: The brakes will be released independently side by side. If the wheels of one side are released the wheels of the other side are braked. This sequence will run three times. At the end of these sequences all brakes will be applied and the function is terminated.
• Semitrailer 4S/2M + 1M or 4S/3M: The brakes controlled by the third modulator (ABS relay valve or EBS relay valve; axle controlled) are released when this function is activated. The brakes controlled by the trailer modulator will be released independently side by side. If the wheels of one side are released the wheels of the other side are braked. This sequence will run three times. At the end of these sequences all brakes will be applied and the function is terminated.
• Full Trailer 4S/3M: The brakes will be released independently axle by axle. If one axle is released the other axle is braked. This sequence will run three times. At the end of these sequences all brakes will be applied and the function is terminated.
2.1.5.1.19 Traction help
If the trailer is equipped with lifting axle it can be lifted as a traction help. If the permitted pressure is exceeded when traction help is active, the traction help is cancelled and the lifting axle will be lowered. The traction help can be activated by a switch when the vehicle speed is below 25 km/h or 3 brake applications when the trailer stands still.

The following message are transmitted and received:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Message</th>
<th>Byte</th>
<th>Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>traction help request</td>
<td>RGE 11</td>
<td>1</td>
<td>7-8</td>
</tr>
<tr>
<td>traction help</td>
<td>RGE 21</td>
<td>1</td>
<td>5-6</td>
</tr>
</tbody>
</table>

2.1.5.1.20 Steering axle control
To lock a self steering axle the TEBS-E can control a solenoid dependent on an actuated reverse gear. The signal, with active reverse lights, is read in the TEBS E1 modulator and at a defined speed, the steering axle will be locked. When driving forwards thereafter to pull the tractor-trailer combination straight, the steering axle remains locked up to a defined speed so that the lock can engage.

The following message are transmitted and received:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Message</th>
<th>Byte</th>
<th>Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>steering axle locking request</td>
<td>RGE11</td>
<td>2</td>
<td>5-6</td>
</tr>
<tr>
<td>Steering axle locking</td>
<td>RGE 21</td>
<td>2</td>
<td>5-6</td>
</tr>
</tbody>
</table>
2.1.6 Subsystems

The System has the possibility to connect several intelligent components via the 5V- CAN-data bus.

2.1.6.1 SmartBoard

The SmartBoard monitors trailer relevant data on a display like mileage, failure memory, axle load, tyre pressure etc. It can be used also to control ECAS-functions like lifting/lowering.

2.1.6.2 IVTM

The Integrated vehicle tyre monitoring system (IVTM) can be connected via the 5V CAN-data bus to the trailer modulator. The IVTM sends information regarding tyre pressure leakage etc. to the modulator and from there via the ISO 11992, to the tractor.

The following messages are transmitted:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Message</th>
<th>Byte</th>
<th>Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyre pressure sufficient</td>
<td>EBS 23</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td>Tyre wheel identification</td>
<td>EBS 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air leakage detection</td>
<td>RGE23</td>
<td>4-5</td>
<td>1-8</td>
</tr>
<tr>
<td>Tyre pressure threshold detection</td>
<td>RGE23</td>
<td>6</td>
<td>1-3</td>
</tr>
</tbody>
</table>

This Information will be also monitored at the SmartBoard.

2.1.6.3 Telematic

A telematic system, which sends trailer relevant data via GSM to a provider, can be connected also via the 5V CAN-data bus to the modulator. This data can be:

- Position (by an integrated GPS-System)
- load
- speed
- tyre pressure
- failure status
2.2. Applications

2.2.1 List of trailer types and ABS configurations

Single or multi-axle semi-trailer, centre-axle trailers or drawbar trailers of categories O3 and O4 according to Directive 98/12/EC, with air suspension, disc or drum brakes.

<table>
<thead>
<tr>
<th>Number of axles ⇒ ABS configuration</th>
<th>Semi trailer</th>
<th>Centre-axle trailer</th>
<th>Full trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2S/2M</td>
<td>x</td>
<td>x x x</td>
<td>x x x x</td>
</tr>
<tr>
<td>2S/2M+SLV</td>
<td>x</td>
<td>x x</td>
<td>x x</td>
</tr>
<tr>
<td>4S/2M</td>
<td>x</td>
<td>x x</td>
<td>x x</td>
</tr>
<tr>
<td>4S/2M + 1 M</td>
<td>x</td>
<td>x x</td>
<td>x x</td>
</tr>
<tr>
<td>4S/3M</td>
<td>x</td>
<td>x x</td>
<td>x x x x x x</td>
</tr>
</tbody>
</table>

For sample diagrams see 2.3.5.

2.2.2 Schematic diagrams of the system configurations

Appendix 1 shows possible configurations of sensors and modulators for the different trailers defined in item 2.2.1.
For possible length and diameters of tube/pipe length see 2.3.5.

2.2.3 Additional information to the application of the anti-lock braking system

When the vehicle is first put into service the parameters must be set and the system checked in accordance with the vehicle equipment using the WABCO Trailer- EBS PC diagnostic program. If this sign-off procedure is not followed, the warning light will not go out during operation, even if the system is fault-free. The parameters for the load-dependent brake pressure control and tyre circumference are determined by means of the WABCO brake calculation.
2.3 Component description

2.3.1 Sensors and exciters

2.3.1.1 Wheel speed sensors

The sensors transmit the information from the rotating toothed wheels to the trailer modulator. Based on this information the ECU calculates the wheel and vehicle speeds. Special care must be taken to ensure accurate speed information.

Identification:

Wheel speed sensors: WABCO part number 441 032 ... 0
441 035 ... 0

Sensors are mounted in clamp bushings, WABCO part number 899 760 510 4, 899 759 815 4 or 899 759 882 4

2.3.1.2 Exciters

Exciters according WABCO specification 895 905 000 4

2.3.1.3 Pressure sensor

The sensor can be used optional as an external driver demand sensor in long vehicles or as an external axle load sensor.

Identification:

Pressure sensor: WABCO No. 441 040 007 0 to 441 040 015 0
441 044 007 0 and 441 044 002 0

2.3.1.4 Levelling sensor

The sensor can be used in systems with integrated electronically controlled air suspension (Premium variant) and in trailers with mechanical suspension to measure the axle load.

Identification:

levelling sensor WABCO No. 441 050 100 0

2.3.2 Controllers

2.3.2.1 Trailer modulator

The trailer modulator (TM) serves to control and monitor the electro-pneumatic braking system. The TM is installed in the braking system between the reservoir, yellow coupling head and the brake cylinders. It controls the brake cylinder pressure on both sides of one, two or three axles.

The TM communicates directly or via TCE (Trailer Central Electronic see 2.3.2.2) using the extended ISO 7638 connector with the motor vehicle via the electric trailer interface according ISO 11992. The TM has two pneumatically independent pressure control circuits, each with a supply and exhaust valve, redundancy valve, pressure sensor and common control electronics. The required deceleration of the vehicle is determined from the pressure signal received from the integrated demand sensor and - if there is a trailer interface present - from the CAN set value. The TM has an integrated axle load sensor. If necessary an external
demand sensor and axle load sensor can be connected. The TM has also a connector for lining wear sensor(s). The brake force is modified as a function of the vehicle load (brake force distribution function). In addition the wheel speeds are registered and analysed via up to four rotary speed sensors. If there is a locking tendency the braking pressure specified for the brake cylinder is controlled by the ABS control circuit. The TM has an electrical connection for the EBS relay valve. With this connection, it is possible to control the brake pressure of an axle separately. In the TM the reservoir pressure is sensed so that the driver can be warned if there is any pressure loss.

There two variants available. The Standard variant covers only 2S/2M applications, whereas the Premium variant covers all applications and in addition includes the electronically controlled air suspension.

Identification:

Trailer modulator: WABCO No. Standard variant: 480 102 030 0 – 480 102 058 0
Premium variant: 480 102 060 0 – 480 102 088 0

Name of software program (code):

TE 00 1418

Version–number for changing’s which do not concern ECE R13

Version–number for changing’s concerning ECE R13

Failure modes:
The TM monitors itself. In the event of a fault, any parts found to be defective (ECU, sensors, modulator(s)) are selectively switched off, and the warning system is actuated. Even in the event of the whole system being switched off the back-up braking function is maintained but without load-dependent brake force control and without ABS function. In the case of stoplight-powering only ABS and the load-dependent brake force control are in function with reduced performance.

Correct electrical/electronic function of the EBS is indicated by warning device in the driver’s cab of towing vehicle according to the provisions of the ECE R13 Section 5.2.1.29.

The operation of the braking system from the backup power source may be verified in the following two ways:

- with the permanent power supply disconnected, on application of the backup power supply the modulators will cycle.
- The voltage supply of the backup power source can be also checked by using the WABCO PC-diagnostic program
Additional features:
- integrated speed switch
- diagnostic interface according to ISO 14230 (KWP 2000)
- automatic lift-axle control
- integrated load proportioning function
- Roll stability control
- Lining wear sensing
- Integrated electronically air levelling control for air suspension

2.3.2.2 Trailer Central Electronic

The Trailer Central Electronic (TCE) integrates a communication gateway and power distribution facilities for brake and running gear equipment as well as for equipment other than brake and running.

Electronically controlled power supply for brake and running gear equipment is provided via the connector according to ISO 7638 with the highest priority given to the power supply of the TM. For equipment other than brake and running gear power supply is provided via the connector according to ISO 12098.

For brake and running gear equipment the tractor-trailer CAN data link in the connector according to ISO 7638 is used. For equipment other than brake and running the tractor-trailer CAN data link in the connector according to ISO 12098 is used.

The TM and other trailer systems are connected to the TCE via a trailer CAN high speed data bus according to ISO 11898 with separate physical CAN links. One CAN link is specially assigned for the connection of the TM. In case of a physical CAN link failure the respective link can be switched of individually to maintain communication via the other physical CAN links.

Identification:

Trailer Central Electronic:
- WABCO No 446 122 00. 0
- Software No TCE00....-....

Failure detection and handling

The TCE is a self-monitoring system. In case of a malfunction, the power supplies and CAN data links of externally connected systems and components can be individually switched off. Detected failures are stored in a non-volatile memory and can be read out by a diagnostic tool via the central diagnostic connector.
Additional features:
- Levelling control and lift axle control
- Brake lining wear sensing
- Vehicle lights control

2.3.3 Modulators

2.3.3.1 ABS Relay Valve (4S/2M+1M)
The ABS relay valve serves the purpose of holding or venting the pressure in the brake chambers, this is being done independently of the pressure that is transmitted by the brake valve of the trailer.

Electrically controlled relay valve with two solenoids to hold and vent the brake pressure during ABS-braking of one axle in 4S/2M+1M systems. Only relay valves without check valve between port 4 and the control chamber of the relay valve are permissible

Identification:

ABS Relay Valve WABCO part numbers: & 472 195 037 0

2.3.3.2 EBS Relay Valve (4S/3M)
Electrically controlled relay valve with pressure sensor and redundancy valve (secondary safety circuit) to control the brake pressure during normal braking and ABS-braking of one axle in 4S/3M systems.

Identification:

EBS relay valve: WABCO No. & 480 207 ... 0

2.3.3.3. Park Relay Emergency Valve (PREV)
Trailer brake valve with emergency brake function and integrated release and park valve.

Identification:

Park Release Emergency Valve WABCO part numbers: & 971 002 9.. 0

2.3.3.4. Select Low Valve (SLV)
Double Cut Off Valve or Relay valve to control self-steering axles in 2S/2M+SLV systems.

Identification:

Select Low Valve WABCO part numbers: & 434 500 00. 0
Relay valve WABCO part numbers: & 973 001 ... 0
973 011 ... 0
2.3.3.5. CAN Repeater

The CAN Router is a CAN-communication gateway for long trailers with allow to extend the length of the CAN communication between ISO 7638 connector in the trailer and the EBS modulator up to 80 m: 18 m between ISO 7638 connector and CAN-Repeater and 80 m between CAN-Repeater and EBS-Modulator. The CAN-Repeater can read in a signal of a demand pressure sensor which is installed in the front of the trailer to improve the response time when braking only via the pneumatic control line. The measured value is transmitted via a proprietary Data communication to the Trailer modulator.

Identification:

CAN Repeater: 446 122 051 0
446 122 053 0

Software N RR00......

Version—number for changing’s which do not concern ECE R13

Version—number for changing’s concerning ECE R13

2.3.3.6. CAN Router

The CAN Router is a CAN-communication gateway and power distribution facility for two EBS systems in one trailer and communicates via the ISO 11992 data communication with

- the tractor unit (connector Power-In)
- the second EBS system in the trailer (connector Power-OUT 2)

via a proprietary data communication with

- the first EBS system in the trailer (connector Power-OUT 1)

It supplies also the power for both EBS systems

Identification:

CAN Router: 446 122 050 0
446 122 052 0

Software N RR00......

Version—number for changing’s which do not concern ECE R13

Version—number for changing’s concerning ECE R13
2.3.4. Electrical equipment

The circuit diagrams in appendix 3 show the connection of all external components (power supply, sensors and modulators). All components are connected via external connectors, which are moulded and coded to avoid mismatching.

Powering methods

Permanent power supply via the connector according to ISO 7638-2003 (7-pin) part 1 or part 2 (24 V) or to ISO 7638-1985 (5-pin) (24 V).

In the event of ISO 7638 power supply failure to maintain trailer stability during braking: Intermittent power supply via the connector according to ISO 1185 or ISO 12098. In this case only ABS and the load-dependent brake force control are in function with reduced performance.

Warning lamp sequence

The system can output two different warning lamp sequences. The sequences are according to the provisions of the ECE regulation No. 13/09 Section 5.2.1.29 and can be changed by parameter setting.

1. Option

When vehicle is stationary:
- Warning light comes on when ignition is switched on.
- Warning light goes off after approx. 2 s if no fault is detected.
- If a fault has been detected e.g. sensor fault, the warning light will stay on.
- If a sensor fault was recorded during the previous journey but is no longer current, the warning light will go off at \( v \geq 7 \) km/h.

When vehicle is travelling at \( v \geq 7 \) km/h:
- Warning light comes on, or stays on, if a current error is detected.

2. Option

- Warning light comes on when ignition is switched on
- If no current defect has been detected, warning light goes out after about 2 s, lights up again after a further 2 s, and goes out at \( v \geq 7 \) km/h.
- If a current defect is detected, e.g. sensor broken off, the warning light stays on.

ISO 1185 (ISO 12098) powering failure warning:

The provision of powering the trailer braking system from the ISO1185 or ISO 12098 connector is to provide a backup in the event of failure of the power supplied via the ISO 7638 connector and therefore there is no failure warning requirement.
Non-specified faults
Non-specified faults are monitored by a flashing warning lamp. After energising the Trailer EBS the flashing of the yellow signal starts after the normal warning signal sequence was completed. When the vehicle speed increases over 10 km/h the flashing warning signal is terminated.

When a specified failure is present the flashing warning lamp signal is replaced by a non-flashing warning lamp signal.
2.3.5 Pneumatic circuits

Sample brake diagrams for different trailers with standard air brakes are represented in Appendix 3 (page 1 to 10):
- Page 1: semi-trailer with 2S/2M and 4S/2M
- Page 2: semi-trailer with 2S/2M and 4S/2M
- Page 3: semi-trailer with 2S/2M +SLV
- Page 4: semi-trailer with 4S/2M+1M
- Page 5: semi-trailer with 4S/3M
- Page 6: full trailers with 4S/3M
- Page 7: example for a semi-trailer with 2S/2M and 4S/2M and TCE
- Page 8: example for a semi-trailer with 4S/2M+1M and mechanical suspension
- Page 9: example for a semi-trailer with 2S/2M and 4S/2M and CAN- Repeater
- Page 10: example for a semi-trailer with 4S/3M and CAN- Router

2.4 Electromagnetic Compatibility (EMC)

In order to fulfill the legal requirements regarding EMC, the electronics are certified according to the EU Directive 72/245/EEC in the version 2006/28/EC and have been given the following approval marks:

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBS Trailer Modulator</td>
<td>e1<em>72/245</em>2006/28<em>4868</em>01</td>
</tr>
<tr>
<td></td>
<td>E1-10R-034868</td>
</tr>
<tr>
<td>TCE*</td>
<td>e1<em>72/245</em>2006/28<em>1665</em>01</td>
</tr>
<tr>
<td>CAN Router/ Repeater</td>
<td>e1<em>72/245</em>2006/28<em>5434</em>00</td>
</tr>
<tr>
<td></td>
<td>E1-10R-35434</td>
</tr>
</tbody>
</table>

A copy of the EMC type approval certificates are attached as Appendix 5a to 5e (15 pages).
3 System variables

3.1 List of system-input and sensed variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nominal range</th>
<th>Maximum value</th>
<th>Unit</th>
<th>Monitored</th>
<th>Warning*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input variables of the brake functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage power supply</td>
<td>18 – 30</td>
<td>36</td>
<td>Volt</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Wheel speed sensors</td>
<td>0 – 1000</td>
<td>1345</td>
<td>Hz</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Demand pressure</td>
<td>0 – 8,5</td>
<td>10,0</td>
<td>Bar</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Axle load pressure</td>
<td>0 – 8,5</td>
<td>10,0</td>
<td>Bar</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Reservoir pressure</td>
<td>0 – 8,5</td>
<td>9,5</td>
<td>Bar</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ISO 11992 (CAN)</td>
<td>- see appendix 4</td>
<td>n. a.</td>
<td></td>
<td>n. a.</td>
<td></td>
</tr>
</tbody>
</table>

| **Input variables of optional functions** (see 2.1.5 and 2.1.6) |               |               |      |           |          |
| Analog Inputs                  |               |               |      |           |          |
| X9-Pin3                        |               |               |      |           |          |
| X10-Pin3                       |               |               |      |           |          |
| X11-Pin3                       |               |               |      |           |          |
| X1-Pin6                        |               |               |      |           |          |
| X10-Pin4                       |               |               |      |           |          |
| X11-Pin4                       |               |               |      |           |          |
| X12-Pin1                       |               |               |      |           |          |
| X13-Pin1                       |               |               |      |           |          |
| Inductive Inputs (for levelling Sensor) |               |               |      |           |          |
| X9-Pin2,4                      |               |               |      |           |          |
| X12-Pin2,4                     |               |               |      |           |          |
| Digital Inputs (GIO 1-7)       |               |               |      |           |          |
| X5-Pin1                        |               |               |      |           |          |
| X8-Pin1                        |               |               |      |           |          |
| X9-Pin1                        |               |               |      |           |          |
| X10-pin1                       |               |               |      |           |          |
| X10-Pin4                       |               |               |      |           |          |
| X11-Pin1                       |               |               |      |           |          |
| X11-Pin4                       |               |               |      |           |          |
| X12-Pin1                       |               |               |      |           |          |
| X13-Pin1                       |               |               |      |           |          |
| Lateral acceleration           | -1 ... + 1     | -2...+ 2       | g    | Yes       | Yes      |

* see also appendix 2
# 3.2 List of System-Output and Sensed Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nominal range</th>
<th>Maximum value</th>
<th>Unit</th>
<th>Monitored</th>
<th>Warning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output variables of the brake functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake pressures (2 or 3)</td>
<td>0 – 8,5</td>
<td>10,0</td>
<td>Bar</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ISO 11992 (CAN)</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS/EBS-relay valve</td>
<td>18 – 30</td>
<td>36</td>
<td>Volt</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Output Variables of optional functions (see 2.1.5 and 2.1.6)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power stages (GIO functions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X5-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X8-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X9-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X10-pin1</td>
<td>18 – 30</td>
<td>36</td>
<td>Volt</td>
<td>Yes</td>
<td>Yes*</td>
</tr>
<tr>
<td>X10-Pin4</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X11-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X12-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X13-Pin1</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd CAN-Bus 5 V</td>
<td>n. a.</td>
<td>n. a.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* However, no warning in all cases, e.g. SmartBoard power supply shortcut to +Ub
4  System Interconnections

4.1  Pneumatic Connections trailer modulator

<table>
<thead>
<tr>
<th>Port</th>
<th>Thread</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 x M22 x 1,5</td>
<td>supply pressure</td>
</tr>
<tr>
<td>2.1</td>
<td>3 x M22 x 1,5</td>
<td>brake chambers</td>
</tr>
<tr>
<td>2.1</td>
<td>1 x M16 x 1,5</td>
<td>anti compound valve</td>
</tr>
<tr>
<td>2.2</td>
<td>3 x M22 x 1,5</td>
<td>brake chambers</td>
</tr>
<tr>
<td>4</td>
<td>1 x M16 x 1,5</td>
<td>control pressure</td>
</tr>
<tr>
<td>5</td>
<td>1 x M16 x 1,5</td>
<td>air bellow pressure</td>
</tr>
</tbody>
</table>
4.2 Electrical Connections

General electrical connections. TCE-Version: Connection ISO7638 via TCE
4.3 Signal flow and priorities
4.3.1 Signal Flow
4.3.1.1 Trailer EBS E

Trailer EBS E
- Context Diagram -
4.3.1.2 Trailer EBS E with CAN Repeater

![Diagram of Trailer EBS E with CAN Repeater]

- Context Diagram -

WABCO Vehicle Control Systems
An American Standard Company

32/78
4.1.1.3 Trailer EBS E with CAN Router

- Context Diagram -

Trailer EBS #1

- ISO 7638
- CAN Messages
- Warning Device
- Plus Electrovalve
- Control Line
- Control Pressure

Trailer EBS #2

- CAN Messages
- Warning Device
- Plus Electrovalve
- Control Line
- Control Pressure

Trailer Modulator 1

- Supply Line
- Control Pressure
- Supply Pressure
- Air Locker Pressure
- Lateral Acceleration Sensor
- Actual Brake Pressure
- Lateral Roller Sensor
- Wheels
- Traction Control

Trailer Modulator 2

- Supply Line
- Control Pressure
- Supply Pressure
- Air Locker Pressure
- Lateral Acceleration Sensor
- Actual Brake Pressure
- Lateral Roller Sensor
- Wheels
- Traction Control

Auxiliary CAN
- Auxiliary Functions
- Auxiliary Functions Data
- Trailer EBS Information Document
4.3.2 Input and Output data relevant to the modulator

**Trailer EBS E**

- Trailer Modulator Diagram -
4.3.2 Priorities

The data communication between tractor and trailer (acc. to ISO 11992) is controlled by a priority algorithm. The EBS 11 message, which includes the demand value, has the highest priority. So it is ensured, that the demand value is transmitted before the other messages. The same procedure is also implemented in the CAN Router and CAN Repeater.

5 Periodical Technical Inspection

The operation status of the system can be checked in the following way:

- The correct operation of the system can be checked by watching the warning lamp sequence of the red and yellow warning lamp. The warning lamp sequences are described in 2.3.4 of this document.

- 3 s after powering of the system the pneumatic modulators must start cycling.

- When applying the service brake the clicking of the solenoid valves in the modulators must be heard.

- When the system is energised the load proportioning function can be tested by simulating the air bellow pressure (e.g. by ventilating or exhausting the air bellows of the air suspension) and braking via the pneumatic or electric control line.

- alternatively by checking the system with a WABCO diagnostic tool

The max. brake forces can be simulated by

- switching of the power supply. The system is in the back-up mode and controls the brakes purely pneumatically.

- Simulating an air bellow pressure of 0 bar or pressure of the laden vehicle.

6. Safety Concept

6.1 Statement of the manufacturer

The system is designed to fulfil all of the service brake and anti-lock brake system requirements. The automatic and parking brake are fully pneumatic controlled and have no electrical connection to the EBS, so that these functions are not subject of this description.

The strategy of the development process which has been chosen to achieve, that the objectives of the system will not, under non-fault conditions, prejudice the safe operation of systems, which are subject to the prescriptions of ECE-Regulation No. 13.

The technical measures, which ensures a safe operation of the Trailer EBS, are described in the Safety Concept. The Safety Concept is divided into the Base Safety Concept and the description of supervision functions.
Base Safety Concept

The Trailer EBS is a two circuit controlled brake system. The first circuit is electro-pneumatic controlled and the second circuit is pneumatic controlled. On loss of the electro-pneumatic controlled circuit the remaining pneumatic circuit is activated. The antilock function works even in case of a pure pneumatic controlled system, i.e. as long as no failure exists which affects this function.

The system is designed to detect internal and external failures and reverts to the above described safe operation state. Important features are:

- A double controller concept with mutual supervision
- A ground switch for the redundant cut of the current path in case of an external short circuit

Supervision Functions

The supervision functions of the Trailer EBS are active during the entire operation. They are activated in or after the initialisation phase of the system. The time between the occurrence and detection of a failure is short enough to ensure that the system will not go into a dangerous state. The measures contain the supervision of:

- The sensor signals
- Actuator control
- Electronics and Controller:
  - a continuous supervision with a self check to detect hardware failures (RAM, ROM, CPU)
  - a supervision of the program cycle with an internal watchdog and the safety controller
  - a mutual supervision of the controller activity
  - a supervision of the serial communication between the main and safety controller.
  - the data transfer is encoded with a checksum to detect a communication failure.
  - EEPROM (Checksum)
  - redundant deactivation of the output stage by the safety controller
- The CAN communication
- The power supply
- Cyclic plausibility checks

6.2 Strategy statement

Software requirements are based on the underlying Safety Concept and the Product Development Specification. Further analysis and design of software was done using the ‘de Marco’ methodology of structured analysis. To ensure that corresponding quality demands are met the software development process and activities follow the development rules of WABCO.
### 6.3 Failure mode

The Trailer brake is controlled by the tractor by two independent circuits:
- pneumatic control line
- electric control line

Failures in this control lines will change to the system operation like follows:

<table>
<thead>
<tr>
<th>Pneumatic control line</th>
<th>Electric Control line</th>
<th>Failure mode</th>
<th>Reaction of the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>present</td>
<td>not connected</td>
<td>failure of the electrical power supply</td>
<td>with ISO 1185 powering: ABS and the load-dependent brake force control are in function with reduced performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>without ISO 1185 powering: braking via the pneumatic back-up circuit without ABS and LSV</td>
</tr>
<tr>
<td>present</td>
<td>present</td>
<td>failure of the electrical power supply</td>
<td>with ISO 1185 powering: ABS and the load-dependent brake force control are in function with reduced performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>without ISO 1185 powering: braking via the pneumatic back-up circuit without ABS and LSV</td>
</tr>
<tr>
<td>broken (leakage)</td>
<td>present</td>
<td>failure of the electrical power supply or data communication</td>
<td>Trailer brakes by exhausting the supply line by the towing vehicle. (See Regulation 13 Paragraph 5.2.1.18.3)</td>
</tr>
</tbody>
</table>

### 6.4 Failure monitoring

The Trailer-EBS monitors itself. In the event of a fault, any parts found to be defective (ECU, sensors, modulator(s)) are selectively switched off, and the warning system is actuated.

Correct electrical/electronic function of the EBS is indicated by warning device in the driver’s cab of towing vehicle according to the provisions of the ECE R13, Section 5.2.1.29.

**Appendix 2** shows the list of possible failures and their effect.
7. **Limits of functional operating**

7.1 **Environmental media**

Atmosphere mixed with water, steam, salts, paints, fuels and lubricants, cold cleansers, brake fluid.

7.2 **Thermal range of application**

7.1.1. **Operating temperature range**

-40 °C to +65 °C.

(Maintain) a distance of 50 mm from parts that affect the air circulation. Minimum air velocity 0.2 m/sec.

If this requirement cannot be met, alternatively, a maximum housing surface temperature of +65 °C applies.

7.1.2. **Short-term exposure of components (1 h)**

95 °C (no function).

7.2. **Pneumatic data**

7.2.1. **Medium / pressure**

<table>
<thead>
<tr>
<th>Operating medium:</th>
<th>Compressed air (containing water, motor oil and alcohol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating pressure:</td>
<td>8,5 bar</td>
</tr>
<tr>
<td>Maximum permissible supply pressure:</td>
<td>9,5 bar</td>
</tr>
</tbody>
</table>

7.3. **Degree of protection**

Specifying the degree of protection assumes the presence of electrical connectors with the coupling or protective cap installed.

IP 69K according to DIN 40050 part 9, or equivalent according to IEC 529, subject to acceptance of this protection class into the standards (protection against entering of dust and water under high pressure/steam jet cleaning).

IP 67 according to IEC 529/ JED-370 with closed or foldable ventilation.
7.3.1. Physical exposure

7.3.1.1. Vibrating

For more details refer to the product specifications of the system components.

7.3.1.2. Shocking

For more details refer to the product specifications of the system components.

7.3.1.3. Free falling

For more details refer to the product specifications of the system components.

7.3.1.4. Surface strength, scratch and abrasive exposures

For more details refer to the product specifications of the system components.

7.3.1.5. Impact exposure

For more details refer to the product specifications of the system components.
ABS-Configurations for Semitrailer, Centre Axle Trailer and Drawbar Trailer

Lift axles

System 2S/2M: Lift axles shall not be sensed.

All other systems: Lift axles can be sensed with ABS-sensors e and f.

Steering axles

Positively steered axles have to be handled like rigid axles.

WABCO recommends that trailers with self steering axles shall be used with 4S/3M, 4S/2M+1M or 2S/2M+SLV configuration.

If 2S/2M or 4S/2M EBS-Systems are used, checks should be carried at the time of type approval of a trailer to ensure that no undue vibration or course deviation is observed. It is not possible to evaluate the reaction of all available steering axles in the case of anti-lock braking control.

In the case of requirement to provide additional stability to a self-steering axle during anti-lock operation the output-signal of the ISS may be connected to a solenoid valve which locks the self steering function at higher speed.

LEGEND: Mounting Instructions for axle boogie types:

- = driving direction

= trailer modulator

= two way valve (SHV)

= select low valve (SLV)

= EBS-relay valve

= ABS-relay valve
### System Configurations

#### Semi-trailer and Centre-axle Trailer

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>2S / 1M</th>
<th>2S / 2M</th>
<th>4S / 2M</th>
<th>4S / 3M</th>
<th>4S / 2M+1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre axle trailer + Semitrailer</td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>Centre axle trailer + Semitrailer</td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>Centre axle trailer + Semitrailer</td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
</tbody>
</table>
### System Configurations

**Full Trailer**

<table>
<thead>
<tr>
<th>VEHICLE TYPE</th>
<th>2S / 2M</th>
<th>4S / 2M</th>
<th>4S / 3M</th>
<th>4S / 2M + 1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawbar Trailer</td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Note: Diagrams show the configurations for different vehicle types and coupling scenarios.
## Appendix 2 (page 1/2)  Failure-Deactivation Matrix

### Failure Deactivation Matrix

<table>
<thead>
<tr>
<th>A.1</th>
<th>Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1.1</td>
<td>Wheel speed sensors</td>
</tr>
<tr>
<td>A.1.1.1</td>
<td>failure of wheel speed sensor c, d, e or f</td>
</tr>
<tr>
<td>A.1.1.2</td>
<td>failure of wheel speed sensor a or b</td>
</tr>
<tr>
<td>A.1.3</td>
<td>Chattering of wheel c, d, e or f</td>
</tr>
<tr>
<td>A.1.4</td>
<td>Memory bit wheel c, d, e or f</td>
</tr>
<tr>
<td>A.2</td>
<td>Brake pressure sensors</td>
</tr>
<tr>
<td>A.2.1</td>
<td>failure of a pressure sensor in the EBS relay-valve</td>
</tr>
<tr>
<td>A.2.2</td>
<td>failure of a brake pressure sensor side d, f in the trailer-modulator</td>
</tr>
<tr>
<td>A.2.3</td>
<td>failure of a brake pressure sensor side c, d in the trailer-modulator</td>
</tr>
<tr>
<td>A.2.4</td>
<td>failure of a both brake pressure sensors in the trailer-modulator</td>
</tr>
<tr>
<td>A.3</td>
<td>Driver demand</td>
</tr>
<tr>
<td>A.3.1</td>
<td>failure of the driver demand sensor</td>
</tr>
<tr>
<td>A.3.2</td>
<td>Signal of demand sensor too low</td>
</tr>
<tr>
<td>A.3.3</td>
<td>failure of the driver demand sensor and CAN-communication</td>
</tr>
<tr>
<td>A.4</td>
<td>Axle load sensor</td>
</tr>
<tr>
<td>A.4.1</td>
<td>failure of the axle load sensor</td>
</tr>
<tr>
<td>A.4.5</td>
<td>Supply pressure sensor</td>
</tr>
<tr>
<td>A.4.5.1</td>
<td>failure of the supply pressure sensor</td>
</tr>
<tr>
<td>A.5</td>
<td>Solenoid valves</td>
</tr>
<tr>
<td>A.5.1</td>
<td>EBS/ABS- relay valve</td>
</tr>
<tr>
<td>A.5.1.1</td>
<td>failure of solenoid valves in the EBS(ABS) relay-valve</td>
</tr>
<tr>
<td>A.5.2</td>
<td>Trailer modulator</td>
</tr>
<tr>
<td>A.5.2.1</td>
<td>failure of solenoid valves in the trailer-modulator side e, f</td>
</tr>
<tr>
<td>A.5.2.2</td>
<td>failure of solenoid valves in the trailer-modulator side c, e</td>
</tr>
<tr>
<td>A.5.2.3</td>
<td>failure of solenoid valves in the trailer-modulator side c, e and e, f</td>
</tr>
<tr>
<td>A.6</td>
<td>Back-up valve</td>
</tr>
<tr>
<td>A.6.1</td>
<td>back-up valve failure EBS relay-valve</td>
</tr>
<tr>
<td>A.6.2</td>
<td>back-up valve failure trailer-modulator</td>
</tr>
<tr>
<td>A.7</td>
<td>ECU</td>
</tr>
<tr>
<td>A.7.1</td>
<td>internal failure</td>
</tr>
<tr>
<td>A.7.2</td>
<td>CPU-failure</td>
</tr>
</tbody>
</table>
# Appendix 2 (page 2/2) Failure-Deactivation Matrix

## Failure Deactivation Matrix

<table>
<thead>
<tr>
<th>Failure</th>
<th>Meaning of failure status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>yellow warning lamp during the failure (ECE R13 para. 5.2.1.29.1.1)</td>
</tr>
<tr>
<td>1</td>
<td>yellow warning lamp until reset (ECE R13 para. 5.2.1.29.1.2)</td>
</tr>
<tr>
<td>2</td>
<td>yellow warning lamp flashing after ignition &quot;ON&quot; (ECE R13 para. 5.2.1.29.6)</td>
</tr>
<tr>
<td>3</td>
<td>no warning lamp</td>
</tr>
</tbody>
</table>

### A_3_1_3 EEPROM failure
- [ ] Semitrailer 4S/3M
- [ ] Semitrailer 4S/2M
- [ ] Trailing 4S/3M with one axle load sensor
- [ ] EBS pressure control deactivation
- [ ] Solenoid valve ABS/EBS relay-valve currentless
- [ ] RSS Deactivation
- [ ] Waning lamp status

### A_3_1_4 Wrong parameter setting
- [ ] Semitrailer 4S/3M
- [ ] Semitrailer 4S/2M
- [ ] Trailing 4S/3M with one axle load sensor
- [ ] EBS pressure control deactivation
- [ ] Solenoid valve ABS/EBS relay-valve currentless
- [ ] RSS Deactivation
- [ ] Waning lamp status

### A_3_1_5 GIO Mian- Powerstage defect
- [ ] Semitrailer 4S/3M
- [ ] Semitrailer 4S/2M
- [ ] Trailing 4S/3M with one axle load sensor
- [ ] EBS pressure control deactivation
- [ ] Solenoid valve ABS/EBS relay-valve currentless
- [ ] RSS Deactivation
- [ ] Waning lamp status

### A_3_1_7 EOL test at customer not passed
- [ ] Semitrailer 4S/3M
- [ ] Semitrailer 4S/2M
- [ ] Trailing 4S/3M with one axle load sensor
- [ ] EBS pressure control deactivation
- [ ] Solenoid valve ABS/EBS relay-valve currentless
- [ ] RSS Deactivation
- [ ] Waning lamp status

### A_4 CAN-Communication
- [ ] partial failure of CAN-Communication/one-wire-operation
- [ ] failure of CAN-communication

### A_5 Voltage Supply
- [ ] high voltage at Kl. 30 or Kl. 15
- [ ] low voltage
- [ ] small undervoltage Kl. 30
- [ ] massproblem (Kl. 15)
- [ ] Warning undervoltage Kl. 30
- [ ] failure in ECAS-communication

### A_6 Pneumatic
- [ ] service line not connected (only with ISO 7638 extended)
- [ ] supply pressure low
- [ ] supply line not connected

### A_7 Miscellaneous
- [ ] failure in GIO-output
- [ ] failure in internal ECAS function
- [ ] failure of liftaxle or ISS
- [ ] failure of lining wear sensor

### Remarks:
- (1) ABS selective deactivated
- (2) braking with pneumatic service line
- X = Function deactivated
Appendix 3 (page 1/10) Braking schematic 2S/2M and 4S/2M for Semi-trailer

- TRIP STOP BRAKE ACTUATORS Optionally on 2 AXLES
- WHEN USING AS 2S/2M TWO SENSORS AND TWO SENSOR EXTENSION CABLES CAN BE DROPPED
- SENSING OF THE AXLES IS OPTION
  # NOT APPLICABLE FOR DISC-BRAKE
  ## SUPPLY PIPE: 1x 18x2 OR 2x 15x1.5, MAX LENGTH: 3m
  ### PIping WITHOUT THREADED PIPE ANGLE
  #### OPTIONALLY (ONLY POSSIBLE FOR PREMIUM EQU)
Appendix 3 (page 2/10) Braking schematic 2S/2M and 4S/2M for Semi-trailer with PREV

- Tristop brake actuators optionally on 2 axles
- When using as 2S/2M two sensors and two sensor extension cables can be dropped
- Sensing of the axles is option

* Not applicable for disc-brake
** Supply pipe: 1x 18x2 or 2x 15x1.5, max. length: 3m piping without threaded pipe angle
*** Optionally

---

Diagram showing the braking schematic for a semi-trailer with PREV.
Appendix 3 (page 3/10) Braking schematic 2S/2M+SLV for Semi-trailer with steering axle
Appendix 3 (page 4/10) Braking schematic 4S/2M + 1M for Semi-trailer
Appendix 3  (page 5/10)  Braking schematic  4S/3M for Semi-trailer
Appendix 3 (page 6/10) Braking schematics 4S/3M for Drawbar-Trailer

![Braking schematic diagram for Drawbar-Trailer](image)
Appendix 3 (page 7/10) Braking schematics 2S/2M and 4S/2M for Semi-trailer with TCE
Appendix 3 (page 8/10) Braking schematics 4S/2M+1M for Semi-trailer with mechanical suspension
Appendix 3 (page 10/10) Braking schematics 4S/3M for Semi-trailer with CAN-Router

#### Message EBS 11 (tractor – trailer) (10 ms, ID 0C02C820)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit Description</th>
<th>ISO 11992-2</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>ABS active</td>
<td>6.4.2.2.17</td>
<td>No</td>
</tr>
<tr>
<td>3 – 4</td>
<td>Vehicle retarder control active</td>
<td>6.4.2.2.14</td>
<td>No</td>
</tr>
<tr>
<td>5 – 6</td>
<td>ASR brake control active</td>
<td>6.4.2.2.23</td>
<td>No</td>
</tr>
<tr>
<td>7 – 8</td>
<td>ASR engine control active</td>
<td>6.4.2.2.24</td>
<td>No</td>
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</tbody>
</table>

#### Message EBS 12 (tractor – trailer) (100 ms, ID 18FEC920)

<table>
<thead>
<tr>
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<th>Bit Description</th>
<th>ISO 11992-2</th>
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</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>Vehicle retarder control active</td>
<td>6.4.2.2.14</td>
<td>No</td>
</tr>
<tr>
<td>3 – 4</td>
<td>ROP system enabled/disabled</td>
<td>6.4.2.2.57</td>
<td>No</td>
</tr>
<tr>
<td>5 – 6</td>
<td>YC system enabled/disabled</td>
<td>6.4.2.2.58</td>
<td>No</td>
</tr>
<tr>
<td>7 – 8</td>
<td>Not defined</td>
<td></td>
<td>-</td>
</tr>
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</table>

#### Message EBS 21 (tractor – trailer) (10 ms, ID 0C0320C8)

<table>
<thead>
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<th>Byte(s)</th>
<th>Bit Description</th>
<th>ISO 11992-2</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>Vehicle ABS active</td>
<td>6.4.2.2.17</td>
<td>Yes</td>
</tr>
<tr>
<td>3 – 4</td>
<td>Vehicle retarder control active</td>
<td>6.4.2.2.14</td>
<td>No</td>
</tr>
<tr>
<td>5 – 6</td>
<td>Vehicle service brake active</td>
<td>6.4.2.2.15</td>
<td>Yes</td>
</tr>
<tr>
<td>7 – 8</td>
<td>Automat. towed vehicle brake active</td>
<td>6.4.2.2.16</td>
<td>No</td>
</tr>
</tbody>
</table>

#### Message EBS 22 (tractor - tractor) (100 ms, ID 18FEC4C8)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit Description</th>
<th>ISO 11992-2</th>
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<tbody>
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<td>1 – 2</td>
<td>Vehicle ABS active</td>
<td>6.4.2.2.17</td>
<td>Yes</td>
</tr>
<tr>
<td>3 – 4</td>
<td>Vehicle retarder control active</td>
<td>6.4.2.2.14</td>
<td>No</td>
</tr>
<tr>
<td>5 – 6</td>
<td>Vehicle service brake active</td>
<td>6.4.2.2.15</td>
<td>Yes</td>
</tr>
<tr>
<td>7 – 8</td>
<td>Automat. towed vehicle brake active</td>
<td>6.4.2.2.16</td>
<td>No</td>
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</tbody>
</table>

#### WABCO Trailer EBS Information Document

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**Message EBS 23** (trailer – tractor) (100 ms, ID 18FEC6C8)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit</th>
<th>Description</th>
<th>ISO 11992-2</th>
<th>Trailer-EBS</th>
<th>Trailer-EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td></td>
<td>Tyre pressure sufficient</td>
<td>6.4.2.2.27</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3 – 4</td>
<td></td>
<td>Brake lining sufficient</td>
<td>6.4.2.2.28</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5 – 6</td>
<td></td>
<td>Brake temperature status</td>
<td>6.4.2.2.29</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7 – 8</td>
<td></td>
<td>Vehicle pneumatic supply sufficient</td>
<td>6.4.2.2.19</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>1 – 2</td>
<td></td>
<td>Tyre/ wheel identification (pressure)</td>
<td>6.4.2.2.10</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3 – 8</td>
<td></td>
<td>Not defined</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 – 2</td>
<td></td>
<td>Tyre/ wheel identification (temperature)</td>
<td>6.4.2.2.10</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3 – 4</td>
<td></td>
<td>Brake temperature</td>
<td>6.4.2.2.12</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5 – 6</td>
<td></td>
<td>Pneumatic supply pressure</td>
<td>6.4.2.2.9</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Message EBS 24** (trailer – tractor) (1000 ms, ID 18FD9AC8)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit</th>
<th>Description</th>
<th>ISO 11992-2</th>
<th>Trailer-EBS</th>
<th>Trailer-EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td></td>
<td>Geometric data index</td>
<td>6.4.2.2.47</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3 – 8</td>
<td></td>
<td>Geometric data index content</td>
<td>6.4.2.2.48</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3 – 8</td>
<td></td>
<td>Not defined</td>
<td>-</td>
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</table>

**Message EBS 25** (trailer – tractor) (50 ms, ID 18F020C8)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit</th>
<th>Description</th>
<th>ISO 11992-2</th>
<th>Trailer-EBS</th>
<th>Trailer-EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Brake cylinder pressure first axle, left wheel</td>
<td>6.4.2.2.49</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Brake cylinder pressure first axle, right wheel</td>
<td>6.4.2.2.50</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Brake cylinder pressure second axle, left wheel</td>
<td>6.4.2.2.51</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Brake cylinder pressure second axle, right wheel</td>
<td>6.4.2.2.52</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Brake cylinder pressure third axle, left wheel</td>
<td>6.4.2.2.53</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Brake cylinder pressure third axle, right wheel</td>
<td>6.4.2.2.54</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7 – 8</td>
<td></td>
<td>Not defined</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>7 – 8</td>
<td></td>
<td>Not defined</td>
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</table>

**Message EBS 26** (trailer – tractor) (10 ms, ID 0CF01FC8)

<table>
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<tr>
<th>Byte(s)</th>
<th>Bit</th>
<th>Description</th>
<th>ISO 11992-2</th>
<th>Trailer-EBS</th>
<th>Trailer-EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td></td>
<td>Wheel speed first axle, left wheel</td>
<td>6.4.2.2.55</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3 – 4</td>
<td></td>
<td>Wheel speed first axle, left wheel</td>
<td>6.4.2.2.56</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5 – 8</td>
<td></td>
<td>Not defined</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Message RGE 11** (tractor - trailer) (100 ms, ID 18E4C820)
### Byte(s) Bit Description ISO 11992-2

| 1 | 1 – 2 | Ride height request | 6.4.2.3.21 | Yes | Yes |
|   | 3 – 4 | Level change request, front axle | 6.4.2.3.9 | Yes | Yes |
|   | 5 – 6 | Level change request, rear axle | 6.4.2.3.10 | Yes | Yes |
|   | 7 – 8 | Traction help request | 6.4.2.2.19 | Yes | Yes |

| 2 | 1 – 2 | Lift axle 1 position request | 6.4.2.3.13 | Yes | Yes |
|   | 3 – 4 | Lift axle 2 position request | 6.4.2.3.14 | Yes | Yes |
|   | 5 – 6 | Steering axle locking request | 6.4.2.3.17 | Yes | Yes |
|   | 7 – 8 | Ramp level request | 6.4.2.3.24 | Yes | Yes |

| 3 | 1 – 2 | Level control request | 6.4.2.3.7 | Yes | Yes |
|   | 3 – 4 | Ramp level storage request | 6.4.2.3.27 | Yes | Yes |
|   | 5 – 6 | Stop level change request | 6.4.2.3.29 | Yes | Yes |
|   | 7 – 8 | Not defined | - | - | - |

| 4 – 5 | Driven axle load | 6.4.2.3.2 | No | No |
| 6 | Parking and trailer air pressure | 6.4.2.3.31 | No | No |
| 7 | Auxiliary equipment supply pressure | 6.4.2.3.32 | No | No |
| 8 | Not defined | - | - | - |

### Message RGE 21 (trailer - tractor) (100 ms, ID 18E520C8)

<table>
<thead>
<tr>
<th>Byte(s)</th>
<th>Bit Description ISO 11992-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 – 2 Leveling control system, ride height level</td>
</tr>
<tr>
<td></td>
<td>3 – 4 Level control</td>
</tr>
<tr>
<td></td>
<td>5 – 6 Traction help</td>
</tr>
<tr>
<td></td>
<td>7 – 8 Ramp level position</td>
</tr>
</tbody>
</table>

| 2       | 1 – 2 Lift axle 1 position | 6.4.2.3.15 | Yes | Yes |
|         | 3 – 4 Lift axle 2 position | 6.4.2.3.16 | Yes | Yes |
|         | 5 – 6 Steering axle locking | 6.4.2.3.18 | Yes | Yes |
|         | 7 – 8 Not defined | - | - | - |

| 3       | 1 – 2 Not defined | - | - | - |
|         | 3 – 4 Ramp level storage | 6.4.2.3.28 | Yes | Yes |
|         | 5 – 6 Level change, front axle | 6.4.2.3.11 | Yes | Yes |
|         | 7 – 8 Level change, rear axle | 6.4.2.3.12 | Yes | Yes |

| 4       | 1 – 2 Stop level change acknowledge | 6.4.2.3.30 | Yes | Yes |
|         | 3 – 4 Normal level | 6.4.2.3.23 | Yes | Yes |
|         | 5 – 6 Ramp level | 6.4.2.3.25 | Yes | Yes |
|         | 7 – 8 Not defined | - | - | - |

| 5 - 6   | Nominal vehicle body level, front axle | 6.4.2.3.3 | No | No |
| 7 - 8   | Nominal vehicle body level, front axle | 6.4.2.3.4 | No | No |

#### Message RGE 22 (trailer - tractor) (100 ms, ID 18FE5CC8)

<table>
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<tr>
<th>Byte(s)</th>
<th>Bit</th>
<th>Description</th>
<th>ISO 11992-2</th>
<th>Trailer- EBS</th>
<th>Trailer- EBS with TCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td></td>
<td>Relative vehicle body level, front axle</td>
<td>6.4.2.3.5</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3 – 4</td>
<td></td>
<td>Relative vehicle body level, front axle</td>
<td>6.4.2.3.6</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Tyre/Wheel identification</td>
<td>6.4.2.2.10</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>6 – 7</td>
<td></td>
<td>Axle load</td>
<td>6.4.2.3.37</td>
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<td>No</td>
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<tr>
<td>8</td>
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#### Message RGE 23 (trailer - tractor) (1000 ms, ID 18FE5EC8)

<table>
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<th>Byte(s)</th>
<th>Bit</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
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<td>Tyre/ wheel identification</td>
<td>6.4.2.2.10</td>
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<tr>
<td>2 – 3</td>
<td></td>
<td>Tyre temperature</td>
<td>6.4.2.3.35</td>
</tr>
<tr>
<td>4 – 5</td>
<td></td>
<td>Air leakage detection</td>
<td>6.4.2.3.34</td>
</tr>
<tr>
<td>6</td>
<td>1 – 3</td>
<td>Tyre pressure threshold detection</td>
<td>6.4.2.3.33</td>
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<td>6 – 8</td>
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#### Message Time/ Date (tractor-trailer) (1000 ms, ID 18FEE620) (1)

<table>
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<tr>
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<tr>
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<td>Hours</td>
<td>6.4.2.3.39</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Month</td>
<td>6.4.2.3.41</td>
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<tr>
<td>5</td>
<td></td>
<td>Day</td>
<td>6.4.2.3.40</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Year</td>
<td>6.4.2.3.42</td>
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<td>7</td>
<td></td>
<td>Local Minute Offset</td>
<td>6.4.2.3.43</td>
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<tr>
<td>8</td>
<td></td>
<td>Local Hour Offset</td>
<td>6.4.2.3.43</td>
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</table>

Subject to the provisions of ISO 11992-2. Current Document Stage for message Time/Date: Preparatory. Future changes in standardisation have to be considered.
EG-TYPGENEHMIGUNGSBOGEN
EC TYPE-APPROVAL CERTIFICATE

Benachrichtigung über
- die Erweiterung der Typgenehmigung

eines Bauteiltyps gemäß der Richtlinie 72/245/EWG, zuletzt geändert durch die
Richtlinie 2006/28/EG

Communication concerning the
- extension of type-approval

of a type of component with regard to Directive 72/245/EEC, as last amended by
Directive 2006/28/EC

Typgenehmigungsnummer: e1*72/245*2006/28*4868*01
Type-approval No.:

Grund für die Erweiterung:
Reason for extension:
Erweiterung des Nummernkreises zur Typidentifizierung
extension of numbers for identification of type

An der EUB anzubringendes EG-Typgenehmigungszeichen:
EC type-approval mark to be affixed on ESA:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>e1</td>
<td>03 4868</td>
</tr>
</tbody>
</table>

ABSCHNITT I
SECTION I

0.1. Fabrikmarke (Firmenname des Herstellers):
Make (trade name of manufacturer):
WABCO

0.2. Typ:
Type:
EBS Trailer Modulator
Nummer der Genehmigung: e1*72/245*2006/20*4868*01
Approval No.:

0.3. Merkmale zur Typidentifizierung, sofern am Bauteil vorhanden:
Means of identification of type, if marked on the component:
480 102 030 0 bis up to 480 102 058 0
480 102 060 0 bis up to 480 102 088 0

0.3.1. Anbringungsstelle dieser Merkmale:
Location of that marking:
auf dem Gehäuse
on the housing

0.5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
WABCO GmbH
DE-30453 Hannover

0.7. Bei Bauteilen und selbständigen technischen Einheiten, Lage und Anbringungsart des
EG-Genehmigungszeichens:
In the case of components and separate technical units, location and method of affixing
of the EC approval-mark:
Erhebung auf dem Gehäuse
cast relief on the housing

0.8. Anschrift(en) der Fertigungsstätte(n):
Address(es) of assembly plant(s):
WABCO GmbH
DE-30453 Hannover

WABCO Polska Sp.z.o.o.
PL-53-238 Wroclaw

ABSCHRITT II
SECTION II

1. Zusätzliche Angaben (erforderlichenfalls):
Additional information (where applicable):
siehe Anlage
see appendix

2. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
WABCO EMV-Prüflabor
DE-30432 Hannover
Nummer der Genehmigung: e1*72/245*2006/28*4868*01  
Approval No.:  
Datum des Prüfprotokolls:  
Date of test report:  
*entfällt*  
*not applicable*  
Nummer des Prüfprotokolls:  
Number of test report:  
*entfällt*  
*not applicable*  
Gegebenenfalls Bemerkungen:  
Remarks (if any):  
siehe Anlage  
see appendix  
Ort:  
Place:  
DE-24932 Flensburg  
Datum:  
Date:  
11.01.2007  
Unterschrift:  
Signature:  
Im Auftrag  

Detlef Hansen
MITTEILUNG
ausgestellt von:
Kraftfahrt-Bundesamt
über die Genehmigung
eines Typs eines elektrisch/elektronischen Bauteiles nach der
Regelung Nr. 10

COMMUNICATION
issued by:
Kraftfahrt-Bundesamt

concerning approval granted
of a type of electrical/electronic sub-assembly with regard to
Regulation No. 10

Nummer der Genehmigung: 034868
Erweiterung Nr.: --
Approval No.: Erweiterung Nr.: --

1. Fabrikmarke (Handelsname des Herstellers):
   Make (trade name of manufacturer):
   WABCO

2. Typ:
   Type:
   EBS Trailer Modulator

   Handelsbezeichnung(en):
   General commercial description(s):
   entfällt
   not applicable

3. Merkmale zur Typidentifizierung, sofern am Bauteil vorhanden:
   Means of identification of type, if marked on the component:
   480 102 030 0 bis / to 480 102 058 0
   480 102 060 0 bis / to 480 102 088 0
Nummer der Genehmigung: 034668
Approval No.: □

3.1 Anbringungsstelle dieser Merkmale:
Location of that marking:
Typschild auf dem Gehäuse
type label on the housing

4. Klasse der Fahrzeuge:
Category of vehicle:
entfällt
not applicable

5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
WABCO GmbH
DE-30453 Hannover

6. Bei Bauteilen und selbständigen technischen Einheiten, Lage und Anbringungsart des
ECE-Genehmigungszeichens:
In the case of components and separate technical units, location and method of affixing
of the ECE approval-mark:
Erhebung auf dem Gehäuse
cast relief on the housing

7. Anschrift(en) der Fertigungsstätte(n):
Address(es) of assembly plant(s):
WABCO GmbH
DE-30453 Hannover
WABCO Polska Sp.z.o.o.
PL-53-238 Wroclaw

8. Zusätzliche Angaben (erforderlichenfalls):
Additional information (where applicable):
siehe Anlage
see appendix

9. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
TÜV Nord Mobilität GmbH & Co.KG
Institut für Fahrzeugtechnik und Mobilität,
DE-45307 Essen

10. Datum des Prüfprotokolls:
Date of test report:
17.03.2009
Nummer der Genehmigung: 034888
Approval No.:

11. Nummer des Prüfprotokolls:
Number of test report:
1565/09a

12. Gegebenenfalls Bemerkungen:
Remarks (if any):
siehe Anlage
see appendix

13. Ort: DE-24932 Flensburg
Place: 

Date: 

15. Unterschrift: Im Auftrag
Signature: 

Dettlef Hansen

16. Das Inhaltsverzeichnis der bei den zuständigen Behörden hinterlegten Typenehmi-
gungsunterlagen, die auf Antrag erhältlich sind, liegt bei.
The index to the information package lodged with the approval authority, which may be
obtained on request is attached.

1. Anlage zur ECE-Typenehmungs-Mitteilung
Appendix to the ECE type-approval communication

2. Inhaltsverzeichnis zu den Beschreibungsunterlagen
Index to the information package

3. Beschreibungsunterlagen
Information package

WABCO Trailer EBS Information Document
64/78
EG - TYPGENEHMIGUNGSBOGEN
EC TYPE-APPROVAL CERTIFICATE

Benachrichtigung über

- die Typenehmigung

eines Bauteils gemäß der Richtlinie 72/245/EWG, zuletzt geändert durch die Richtlinie 2006/28/EG

Communication concerning the

- type-approval

of a type of component with regard to Directive 72/245/EEC, as last amended by Directive 2006/28/EC

Typenehmigungsnummer: e1*72/245*2006/28*5434*00
Type-approval No.:

Grund für die Erweiterung:
Reason for extension:
entfällt
not applicable

An der EUB anzubringendes EG-Typenehmigungszeichen:
EC type-approval mark to be affixed on ESA:

\[\text{e1} \quad 03 \text{ 5434}\]

ABSCHNITT I
SECTION I

0.1. Fabrikmarke (Firmenname des Herstellers):
Make (trade name of manufacturer):
WABCO

0.2. Typ:
Type:
Router / Repeater RR-AK
Appendix 5c (page 2/3)  EEC type- approval certificate for Router/ Repeater

Kraftfahrt-Bundesamt
DE-24932 Flensburg

2

Nummer der Genehmigung: e1*72/245*2000/28*5434*00
Approval No.:

0.3. Markmale zur Typidentifizierung, sofern am Bauteil vorhanden:
Means of identification of type, if marked on the component:
446 122 05? 0

0.3.1. Anbringungsstelle dieser Merkmale:
Location of that marking:
auf dem Gehäuse
on the housing

0.5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
WABCO GmbH
DE-30453 Hannover

0.7. Bei Bauteilen und selbständigen technischen Einheiten, Lage und Anbringungsart des
EG-Genehmigungszeichens:
In the case of components and separate technical units, location and method of affixing
of the EC approval-mark:
auf dem Typschild aufgedruckt
imprinted on the type label

0.8. Anschrift(en) der Fertigungsstätte(n):
Address(es) of assembly plant(s):
WABCO GmbH
DE-30453 Hannover
Tonfunk GmbH
DE-06463 Ermsleben

ABSCHNITT II
SECTION II

1. Zusätzliche Angaben (erforderlichenfalls):
Additional information (where applicable):
siehe Anlage
see appendix

2. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
WABCO EMV-Prüflabor
DE-30432 Hannover

3. Datum des Prüfprotokolls:
Date of test report:
20.11.2008

WABCO Trailer EBS Information Document
66/78
Nummer der Genehmigung: e1*72/246*2006/28*5434*00
Approval No.: 

4. Nummer des Prüfprotokolls:
   Number of test report: 
   73_00

5. Gegebenenfalls Bemerkungen:
   Remarks (if any): 
   siehe Anlage
   see appendix

6. Ort: DE-24932 Flensburg
   Place: 

   Date: 

8. Unterschrift: Im Auftrag
   Signature: 

(Koark)
MITTEILUNG

ausgestellt von:
Kraftfahrt-Bundesamt

über die Genehmigung
eines Typs eines elektrischen/elektronischen Bauteiles nach der
Regelung Nr. 10

COMMUNICATION

issued by:
Kraftfahrt-Bundesamt

concerning approval granted
of a type of electrical/electronic sub-assembly with regard to
Regulation No. 10

Nummer der Genehmigung: 035434                      Erweiterung Nr.: --
Approval No.:                                          Extension No.:

1. Fabrikmarke (Handelsname des Herstellers):
   Make (trade name of manufacturer):
   WABCO

2. Typ:
   Type:
   Router / Repeater RR-AK

   Handelsbezeichnung(en):
   General commercial description(s):
   entfällt
   not applicable

3. Merkmale zur Typidentifizierung, sofern am Bauteil vorhanden:
   Means of identification of type, if marked on the component:
   446 122 057 8

2. Fassung
2nd issue

Dietrich Hermen
24. 05. 2002
Nummer der Genehmigung: 035434
Approval No.:

3.1 Anbringungsstelle dieser Merkmale:
Location of that marking:
*auf dem Gehäuse*
on the housing

4. Klasse der Fahrzeuge:
Category of vehicle:
*entfällt*
not applicable

5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
WABCO GmbH
DE-30453 Hannover

6. Bei Bauteilen und selbständigen technischen Einheiten, Lage und Anbringungsart des
ECE-Genehmigungszeichens:
In the case of components and separate technical units, location and method of affixing
of the ECE approval-mark:
*Typschild auf dem Gehäusedeckel*
type label on the cover of the housing

7. Anschrift(en) der Fertigungsstätte(n):
Address(es) of assembly plant(s):
WABCO GmbH
DE-30453 Hannover
Tonfunk GmbH
DE-06463 Ermsleben

8. Zusätzliche Angaben (erforderlichenfalls):
Additional information (where applicable):
*siehe Anlage*
see appendix

9. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
TÜV Nord Mobility GmbH & Co.KG
Institut für Fahrzeugtechnik und Mobilität,
DE-45307 Essen

10. Datum des Prüfprotokolls:
Date of test report:
17.03.2009
Nummer der Genehmigung: 035434
Approval No.: 

11. Nummer des Prüfprotokolls:
Number of test report:
1565/09b

12. Gegebenenfalls Bemerkungen:
Remarks (if any):
siehe Anlage
see appendix

13. Ort: DE-24932 Flensburg
Place: 

Date: 

15. Unterschrift: Im Auftrag
Signature: 

Detlef Hansen

16. Das Inhaltsverzeichnis der bei den zuständigen Behörden hinterlegten Typgenehmigungsunterlagen, die auf Antrag erhältlich sind, liegt bei.
The index to the information package lodged with the approval authority, which may be obtained on request is attached.

1. Anlage zur ECE-Typgenehmigungs-Mitteilung
Appendix to the ECE type-approval communication

2. Inhaltsverzeichnis zu den Beschreibungsunterlagen
Index to the information package

3. Beschreibungsunterlagen
Information package
EG-TYPENEHMIGUNGSBOGEN
EC TYPE-APPROVAL CERTIFICATE

Benachrichtigung über
- die Erweiterung der Typenehmigung

eines Bauteiltyps gemäß der Richtlinie 72/245/EWG, zuletzt geändert durch die
Richtlinie 2006/28/EG

Communication concerning the
- extension of type-approval

of a type of component with regard to Directive 72/245/EEC, as last amended by
Directive 2006/28/EC

Typenehmigungsnummer: e1*72/245*2006/28*1665*01
Type-approval No.:

Grund für die Erweiterung:
Reason for extension:
Anpassung an die Fassung 2006/28/EG der Richtlinie
adaptation to the version 2006/28/EC of the directive
technische Änderungen
technical modification

An der EUB anzubringendes EG-Typenehmigungszeichen:
EC type-approval mark to be affixed on ESA:

\[ e1 \]
03 1665

ABSCHNITT I
SECTION I

0.1. Fabrikmarke (Firmenname des Herstellers):
Make (trade name of manufacturer):
WABCO
Nummer der Genehmigung: e172/245*2006/28*1665*01
Approval No.:

0.2. Typ:
Type:
Trailer Central Electronik (TCE)

0.3. Merkmale zur Typidentifizierung, sofern am Bauteil vorhanden:
Means of identification of type, if marked on the component:
446 122 000 0 bis / up to 446 122 015 0

0.3.1. Anbringungsstelle dieser Merkmale:
Location of that marking:
auf dem Typenschild auf dem Gehäuse
on the type label on the housing

0.5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
WABCO GmbH & Co.OHG
DE-30453 Hannover

0.7. Bei Bauteilen und selbständigen technischen Einheiten, Lage und Anbringungsart des
EG-Genehmigungszeichens:
In the case of components and separate technical units, location and method of affixing
of the EC approval-mark:
Typenschild auf dem Gehäuse oder
als metallisiertes Klebeschild auf dem Elektronikgehäuse geklebt
type label on the housing or
metalized label on the housing of the electronic

0.8. Anschrift(en) der Fertigungstät(en):
Address(es) of assembly plant(s):
WABCO GmbH & Co.OHG
DE-30453 Hannover

ABSCHNITT II
SECTION II

1. Zusätzliche Angaben (erforderlicherfalls):
Additional information (where applicable):
siehe Anlage
see appendix

2. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
WABCO EMV-Prüflabor
DE-30432 Hannover
Appendix 5e (page 3/3) EEC type-approval certificate for TCE

Kraftfahrt-Bundesamt
DE-24932 Flensburg

3

Nummer der Genehmigung: e1*72/245*2006/28*1865*01
Approval No.: 

3. Datum des Prüfprotokolls:
   Date of test report:
   15.09.2006

4. Nummer des Prüfprotokolls:
   Number of test report:
   29_01

5. Gegebenenfalls Bemerkungen:
   Remarks (if any):
   siehe Anlage
   see appendix

6. Ort:
   Place:
   DE-24932 Flensburg

7. Datum:
   Date:
   26.09.2006

8. Unterschrift:
   Signature:
   Im Auftrag

[Signature]
Detlef Hansen

WABCO Trailer EBS Information Document
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# Appendix 6 (page 1/1) EBS System plate

## Trailer EBS-E

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### Subsystems

- **IVTM**
- **SmartBoard**

### Specifications

**Product Number:** 480 102 030 0

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### Pressure and Load Chart

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### Diagram

![Diagram of EBS System plate](image)
Appendix 8 (page 1/2) Wiring diagram modulator with ECAS/IVTM/SmartBoard
Appendix 8 (page 1/2) Wiring diagram TCE
This side is for technical reasons free