Kraftfahrt-Bundesamt

DE-24932 Flensburg

E 1

MITTEILUNG

ausgestellt von:
Kraftfahrt-Bundesamt

eines Prüfprotokolls gemäß Anhang 19 Teil 1 Punkt 6.6. der ECE Regelung Nr. 13 für eine Fahrzeugstabilisierungsfunktion (Überschlagregelung)

COMMUNICATION

issued by:
Kraftfahrt-Bundesamt

of a Test Report regarding Annex 19 part 1 item 6.6. of ECE Regulation No. 13 for a vehicle stability function (roll-over control)

R13 190534

Nummer der Bestätigung**: 190534**
Confirmation No.:

1. Fabrikmarke (Handelsname des Herstellers):
Make (trade name of manufacturer):
Haldex Brake Products Ltd

2. Typ:
Type:
EB+; EB165.2E

3. Name und Anschrift des Herstellers:
Name and address of manufacturer:
Haldex Brake Products Ltd Warwickshire CV13 6DE
United Kingdom

4. Gegebenenfalls Name und Anschrift des Vertreters des Herstellers:
If any, name and address of manufacturer's representative:
Entfällt
Not applicable

5. 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

Nummer der Bestätigung**: 190534**
Confirmation No.:

6. Datum des Prüfprotokolls:
Date of test report:
23.03.2020

7. Nummer des Prüfprotokolls:
Number of test report:
EB165.2E

8. Die Bestätigung wird **erteilt**
Confirmation is **granted**

9. Bemerkungen (gegebenenfalls):
Remarks (if any):
***)**

***) Siehe Anlage**
See enclosure

10. Ort: **DE-24932 Flensburg**
Place:

11. Datum: **15.05.2020**
Date:

12. Unterschrift: **Im Auftrag**
Signature:

M. Kasischke

M.Kasischke

KRAFTFAHRT-BUNDESAMT 512

13. Anlagen:
Enclosures:
Gemäß Inhaltsverzeichnis
According to index

Kraftfahrt-Bundesamt

DE-24932 Flensburg

Zu: **190534**
To:

Erklärung über die Einhaltung der Anforderungen hinsichtlich der Übereinstimmung der Produktion gemäß dem Übereinkommen von 1958
Statement of compliance with the conformity of the production requirements of the 1958 Agreement

1. Name des Herstellers:
   Manufacturer's name:
   Haldex Brake Products Ltd Warwickshire CV13 6DE
   United Kingdom

2. Datum der Anfangsbewertung:
   Date of the initial assessment:
   31.01.2013

3. Datum aller durchgeführten Überwachungstätigkeiten:
   Date of any surveillance activities:

Aktenzeichen Register number	Datum der Begehung Date of inspection	Genehmigungsnummer Approval number

   CoP-Q:
   Entfällt
   Not applicable

   CoP-P:
   Entfällt
   Not applicable

Kraftfahrt-Bundesamt

DE-24932 Flensburg

Zu: **190534**
To:

Inhaltsverzeichnis zu den Beschreibungsunterlagen
Index to the information package

Ausgabedatum: Date of issue:	**15.05.2020**	Letztes Änderungsdatum: Last date of amendment:	**--**

Nebenbestimmungen und Rechtsbehelfsbelehrung
Collateral clauses and instruction on right to appeal

Prüfbericht(e) Nr.: Test report(s) No.: **EB165.2E**	Datum: Date: **23.03.2020**
Beschreibungsbogen Nr.: Information document No.: **GS0471**	Datum: Date: **29.01.2020**
Liste der Änderungen: List of modifications: **Entfällt** **Not applicable**	Datum: Date:

Kraftfahrt-Bundesamt

DE-24932 Flensburg

Nummer der Bestätigung**: 190534**
Confirmation No.:

- Anlage -

Rechtsbehelfsbelehrung

Gegen diese Bestätigung kann innerhalb eines Monats nach Bekanntgabe Widerspruch erhoben werden. Der Widerspruch ist beim **Kraftfahrt-Bundesamt, Fördestraße 16, DE-24944 Flensburg,** schriftlich oder zur Niederschrift einzulegen.

- Attachment -

Instruction on right to appeal

This Confirmation can be appealed within one month after notification. The appeal is to be filed in writing or as a transcript at the **Kraftfahrt-Bundesamt, Fördestraße 16, DE-24944 Flensburg.**

EBS-System : **EB+**
Manufacturer : **Haldex**

Approval Report
No: EB165.2E

with respect to a

Vehicle (Trailer) Stability Function

according to

UN-Regulation No. 13 - Annex 19 - Appendix 8

as last amended by

supplement 16 to the 11 series of amendments

Content

EBS-System : **EB+**
Manufacturer : **Haldex**

EBS-System : **EB+**
Manufacturer : **Haldex**

0. General

This Test Report is issued to demonstrate the functionality of the stability control function for the purposes of vehicle type approval.

With respect to the previous TÜV NORD Report EB165.1E this report covers the following amendments:

- Inloader configurations added (see 2.1.3)
- Optional CAN-Hub (Router/Repeater) added (see 2.6.1)
- Permissible tyre-to-exciter tolerances
- Replacing of Annexes 2, 3 and 4 by a confirmation of a vehicle stability simulation tool
- Deletion of the variant BPW ECO Tronic
- Editorial amendments

For the sake of simplicity the Manufacturer's Vehicle Stability Function Information Document of the Trailer **E B +** system is abbreviated in this report to **"I D _ G S 0 4 7 1"**.

In this document 'EB+' refers to all variants unless specifically stated otherwise.

0.1 Statement of equivalence:

With respect to the assessed roll-over stability function the comparative tests provided evidence that EB+ Gen 3 can be considered to be equivalent to previous versions of the system (see annex 9, paragraph 1.5).

The control logic of the roll-over control function between EB+ Gen 2 and Gen 3 is unchanged. This was verified by a comparison of the relevant source code with a source version control system. Modifications are limited to editorial amendments according to MISRA guidelines and a modified low voltage warning for the accelerator sensor due to the extended supply voltage range.

EBS-System : **EB+**
Manufacturer : **Haldex**

1. Identification

1.1	Manufacturer:	**Haldex Brake Products Ltd** Redditch, Worcestershire B98 9HA United Kingdom
1.2	System name/model:	**EB+**
1.3	System variants:	**EB+ Gen 1:** This is a modular EBS package consisting of one or two modulators and a removable ECU, with optional anti-compounding valve. **EB+ Gen 2** **EB+ Gen 3:** These are integrated EBS packages consisting of a non-removable ECU and a twin modulator
1.3.1	System option with:	EB+ Stability (see paragraph 2.3)
1.3.1.1	Control function:	Roll-over control (RoC) A vehicle stability function that reacts to an impending roll-over in order to stabilise the trailer during dynamic manoeuvres within the physical limits of the vehicle. For further information see ID_GS0471, paragraph 2.4).

2. System and installation

2.1	ABS - Configurations:	2S/2M* - 2S/2M_SL* - 2S/2M DAR - 2S/2M_Relay**- 4S/2M* - 4S/2M_Relay** - 4S/3M * These configurations have integrated and non-integrated versions with EB+ Gen 1 variant ** Inloader configuration See also paragraph 1.5 and Appendix 1 of ID_GS0471
2.2	Range of application:	The ABS **configurations** as defined in 2.1 above may be used with the following **vehicle types**: - Semi-trailers - Centre-axle trailers - Full trailers having up to 3 axles. For **specific applications** refer to paragraph 2.1 of ID_GS0471.

EBS-System : **EB+**
Manufacturer : **Haldex**

2.3 System Identification:

If the vehicle stability function is enabled this is indicated on the trailer EB$^+$ system plate (load plate) by the wording: "Stability" in addition to the installed ABS configuration (see also paragraph 1.6 of ID_GS0471).

Software code:		
EB+ Gen 1		**C497**
	or	**C498**
EB+ Gen 2		**D523**
EB+ Gen 3		**E642**

(see TÜV NORD report EB132.11E, Appendix 1, paragraph 3.3.5.2)

2.4 "End-of-line" programming:

A list of the parameters is defined in ID_GS0471, paragraph 2.4.6.

2.5 Functional description:

When the system detects an imminent possibility of trailer roll-over it acts to reduce the vehicle speed using the trailer brakes until the possibility of trailer roll-over is sufficiently reduced. For further information see paragraph 2.4 of ID_GS0471.

2.6 Components:

The only additional component to the EB+system without the roll-over control function is the **lateral accelerometer**, see paragraphs 3.1 and 3.2.1 of ID_GS0471.

2.7 RoC-Interventions:

Interventions of the vehicle stability function (but not test pulses during the learning process) cause the 'VDC Active' indication to be sent via the data communications part of the electric control line (EBS21, byte 2, bits 1-2; set to 01_b). With respect to the illumination of stop lamps in case of "automatically commanded braking" see paragraph 2.9 below.

2.8 Failure Warning:

Vehicle stability function failures or defects are detected and indicated to the driver by

- the 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)

2.9 Illumination of stop lamps:

In accordance with paragraph 5.2.2.22.1 of ECE-Regulation No. 13, a signal to illuminate the stop lamps in case of "automatically commanded braking" is transmitted via the electric control line (EBS 22, Byte 4, bits 5-6, set to 01b).
See also ID_GS0471, paragraph 2.4.7.

EBS-System : **EB+**
Manufacturer : **Haldex**

3 Assessed vehicle variables

3.1 General:

The following variables which may have an impact on EB+ Stability performance were taken into account during vehicle testing. Based on the results of these tests in the following paragraphs it is determined whether any limiting factors (see paragraph 4 below) regarding the scope of application should be applied.

3.2 Braking system type:

Test were carried out on different vehicles equipped with pneumatic transmission braking systems. From these tests it is concluded that these braking systems may be installed on any trailer defined in paragraph 2.2 above.

3.3 Brake type:

Test were carried out on vehicles equipped with drum brakes. From these tests it is concluded that these brake type may be installed on any of the configurations defined in paragraph 2.2 above.

The EB+ Stability system uses the brake threshold pressure as an input parameter, and uses this as one term in the equation for test pulse pressure calculation; see also ID_GS0471, paragraph 2.4.6. This means that variations in brake thresholds and hysteresis, due to any of the mechanical components, will not have a significant effect on the RoC performance. For this reason it is further concluded that any pneumatic brake type may be installed on any of the configurations defined in paragraph 2.2 above.

3.4 Centre of gravity:

Simulations were carried out with different centre of gravity heights to assess that the system is able to react to variations in this value, see Annex 9, paragraph 1.3.

3.5 Installation configuration:

Annex 5 (Test Vehicle Data) shows the various installations and vehicle configurations used for the purpose of demonstrating the vehicle stability control function. Based on the number of variants tested it is concluded that the range of system configurations defined in paragraph 2.1 of ID_GS0471 is adequately covered by these tests; see also paragraphs 2.1 and 2.2 above.

3.6 Lateral Accelerometer Position:

Tests were conducted to confirm that system still functioned correctly with the accelerometer at the lateral and longitudinal limiting positions defined in ID_GS0471, Appendix 5; for test results see paragraph 1.3 of Annex 9.

For Inloader configuration an extended range for installation of accelerometer is permitted. Additional tests verified the function of the system with the extreme position of the sensor.

EBS-System : **EB+**
Manufacturer : **Haldex**

3.7 Lift axles:

Tests were carried out on vehicles with one, two and three axles. Some of these vehicle configurations consisted of lifted axles without any special programming of the ECU (wheel base is not an input parameter of the RoC).

From the test it is concluded that vehicles equipped with lift axle(s) are compatible with RoC functionality.

However, in all cases the recommendations specified in paragraph 2.2.1 of ID_GS0471 shall be adhered to.

3.8 Suspension:

Tests were conducted on vehicles with air suspensions. Simulations were carried out with a variation of suspension stiffness of ±20 % from the nominal value in order to assess the sensitivity of the system to differences in this parameter and hence suitability for use with other suspension types. It was observed that suspension stiffness has little influence with the roll-over control strategy employed.

Although the actual roll angles are distinctively different (4 ° at +20% stiffness versus 6 ° at -20% stiffness) the physical limits for roll-over are reached at comparable lateral accelerations of about -4.9 m/s² (see Annex 9, paragraph 1.3). Thus, the suspension type is not a programmable parameter for EoL.

Therefore, vehicles equipped with different suspension types may be fitted with RoC as long as they are in compliance with the relevant ABS requirements regarding suspension type (see e.g. ECE-Regulation No. 13, paragraph 5.3.1.1).

For further information see paragraph 2.3 of ID_GS0471.

3.9 Track width:

See Annex 5 of this report with respect to the vehicles actually tested.

For roll stability the relationship of the height of the centre of mass (h) to lateral distance of the centre of mass from the tyre contact patch is important. Increasing the centre of gravity height will increase the destabilising torque, and reducing the track width (or introducing a lateral offset to the location of the centre of mass) will reduce the stabilising torque and so has the same effect on roll stability. Since tests were carried out with different centre of gravity heights it can be concluded that the system can also accommodate different track widths (and lateral offsets).

The track width is not a programmable parameter for EoL

For further information see paragraph 2.4.2 of ID_GS0471.

3.10	Tube sizes:	The ABS requirements with respect to the response and hysteresis behaviour are by no means less stringent than those for the RoC. Therefore, provided the trailer fulfils the performance requirements associated with anti-lock braking no additional requirements are necessary to ensure RoC performance. Extended tube length in conjunction with extended sensor position for Inloader configurations were tested and simulated.
3.11	Tyre type:	In contrast to directional control the influence of the tyre type is not a deciding factor. Thus the manufacturer does not limit the system to any specific tyre type/configuration.
3.12	Vehicle type:	The tests covered vehicle types as referenced in paragraph 2.2 above.
3.13	Wheel base:	The wheel base may have an influence on vehicle roll-over characteristics. Therefore, tests were carried out on semi-trailers/centre-axle trailers with different wheel bases from 4830 mm (C11, C13) to 8005 mm (S12) and in the case of full trailers from 3855 mm (F13) to 4530 mm (F12) – see Annex 5 of this report. In addition, simulations were carried out with 2-axle full trailers (F22 & F32) with different wheel bases (from 3,0 m to 5,5 m) to assess that the system is able to react to variations in this value. From these ranges of tested wheel bases and simulations it is concluded that also different wheel bases may be installed on the trailers defined in paragraph 2.2 above.
3.14	Wheel type:	The wheel type may be either a single or twin wheel. The manufacturer considers that the influence of the type of wheel is not significant for its control function. This is because the function automatically learns the roll behaviour of the vehicle and does not use e.g. track width as an input parameter. Thus the manufacturer does not limit the system to any specific wheel configuration.

4 Limitations of installation

4.1	Suspension type:	See paragraph 3.8 above.
4.2	Brake type:	The scope of this report is limited to vehicles equipped with disc and drum brakes which are pneumatically operated (see also paragraph 3.3 above).

EBS-System : **EB+**
Manufacturer : **Haldex**

4.3	Brake system type:	The scope of this report is limited to braking systems with pneumatic energy transmission where the energy transmission is directly or indirectly controlled by the electric control transmission of the EB+ system.
4.4	Location of components on the trailer	
4.4.1	Location of lateral acceleration sensor:	The ECU/accelerometer must be installed in accordance with the specifications of Appendix 5 of ID_GS0471. As the lateral acceleration sensor is integrated into the EB+ master modulator the position of the sensor is normally controlled by the location of this modulator on the trailer. A separate accelerometer is however allowed as an option. The scope of this report limits the position of the EB+ module (or separate accelerometer) to the envelope defined in Appendix 5 of ID_GS0471 (see also paragraph 3.6 above). However, the permissible maximum tube length shall not be exceeded (see Appendix 2 of ID_GS0441 of Test Report EB128.10E or ID_GS0443 of Test Report EB159.3E according to variant).
4.4.2	Location of 3rd modulator:	The position of the 3rd modulator (slave) is only limited in the scope of this report when the permissible maximum tube lengths are not exceeded (see Appendix 2 of ID_GS0441 of Test Report EB128.10E or ID_GS0443 of Test Report EB159.3E according to variant).
4.5	ABS Configurations	Anti-lock braking configurations are limited to those defined within paragraph 2.1 of this report.
4.6	Other recommendations / limi - tations:	
4.6.1	Lift axles	See paragraph 3.7 of this report and paragraph 2.2 of ID_GS0471
4.6.2	Steering axles:	This report does not cover an assessment of the reaction of the available steering systems with “EB+ Stability”. See paragraph 2.2 of ID_GS0471 for recommendations by the system manufacturer.
4.6.3	Tube sizes:	See paragraph 3.10 above.

EBS-System : **EB+**
Manufacturer : **Haldex**

5 Test Conditions and Test Procedures

5.1 Test surface information: All the tests were carried out on a high friction surface (dry asphalt)

5.2 Measurement data acquisition: The following measured variables, among others, were recorded to evaluate and document the tests:

- Brake actuator pressures
- Control line pressure p_{m_pneum} (CAN signal p_{m_el} disabled or not present on motor vehicle)

  Note: Since there is no braking from the towing vehicle during the various manoeuvres the control line signals are of no relevance.
- Driver demand (throttle position)
- Vehicle speed
- Wheel speeds
- Steering wheel angle
- Yaw rate
- Lateral acceleration
- Longitudinal acceleration
- Body slip angle
- Roll angle
- Angle of articulation
- Steering-wheel angle
- Suspension height
- Suspension pressure (bellows)
- Heading of each vehicle body
- Outrigger wheel touchdown (indicated by monitoring the outrigger wheel speeds)

  The **reference figure** was the clearance height between the outside edge of the tyre tread of the outrigger wheels and the surface:

  - Semi-trailer: around 325 mm
  - Centre-axle trailer: around 358 mm
  - Full trailer: around 380 mm

  See also paragraph 2.2 of Annex 5

5.3 Test Codes: See Annex 6

5.4 Overview Vehicle Tests and Simulation: See Annex 7

5.5 Description of Test Procedures: See Annex 8

EBS-System : **EB+**
Manufacturer : **Haldex**

6 Test Data and Results

6.1	Test Vehicle Data:	See Annex 5
6.2	Increasing Curvature Test:	See Annex 9
6.3	Circle Test (constant Radius):	See Annex 10
6.4	Double Lane Change Test:	See Annex 11
6.5	Additional Assessment with respect to Dolly Application:	See Annex 12
6.6	Annex 18 Safety assessment:	See TÜV NORD Report EB132.11E, Annex 1

7 Attachments

7.1 Annexes to this report

1: List of Abbreviations
2: Vehicle Stability Function Simulation Tool Test Report
3: Vehicle parameters and Values used in the Simulation
4: Simulation Verification
5: Test Vehicle Data
6: Test Codes
7: Overview "Vehicle Tests and Simulation"
8: Description of Test Procedures
9: Increasing Curvature Test "IC"
10: Circle Test (constant Radius) "CR"
11: Double Lane Change Test "DLC"
12: Additional Assessment with respect to Dolly Application

7.2 Manufacturer's Information Document GS0471 Issue 3 - of 29th January 2020

8. Date of test: 2009 – 2012 - 2018

EBS-System : **EB+**
Manufacturer : **Haldex**

9. Concluding certification

This test has been carried out and the results reported in accordance with paragraph 6 of Annex 19 to ECE Regulation No. 13 as last amended by supplement 16 to the 11 series of amendments.

In addition it is further confirmed that the requirements of paragraphs 2.2.1. and 2.2.2 of Annex 21 to ECE Regulation 13 with respect to the following functionality of the RoC has been verified:

- The ability to automatically control the wheel speeds on at least two wheels of each axle or axle group by selective braking or automatically commanded braking based on the evaluation of actual trailer behaviour that may lead to roll-over
- The ability to determine actual trailer behaviour by directly measuring the lateral acceleration and wheel speeds.
- Only on-board generated information is used (see paragraph 3.1.2 of ID_GS0471)

10. Approval Authority

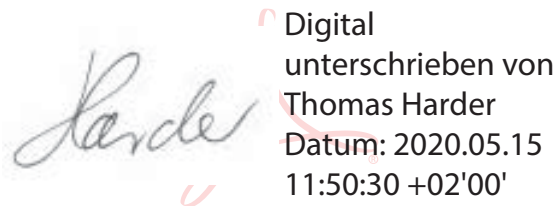
See cover sheet to this report

PRÜFLABORATORIUM / *TEST LABORATORY*

TÜV NORD Mobilität GmbH & Co. KG
IFM - Institut für Fahrzeugtechnik und Mobilität
Schönscheidtstr. 28, 45307 Essen

DIN EN ISO/IEC 17025, 17020
Benannt als Technischer Dienst / *Designated as Technical service*
vom Kraftfahrt Bundesamt / *by Kraftfahrt-Bundesamt*: KBA – P 00004-96

Branch office Hanover, 23.03.2020



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EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 1: List of Abbreviations

General	
.2	Distinguishing symbol to denote the additional tests carried out for the Approval Report EB165.2E
.1	Distinguishing symbol to denote the additional tests carried out for the Approval Report EB165.1E
AL	Anti-lock braking system
Ay	Lateral acceleration
AYS	Lateral acceleration sensor
CoG	Centre of gravity (height)
E	Wheel base
E1	In the case of motor vehicle: Distance from front axle to 1st rear axle
E2	In the case of motor vehicle: Distance from 1st rear axle to 2nd rear axle
E_R	Distance between king-pin and centre of axle or axles of semi-trailer or distance between drawbar coupling and centre of axle(s)
DLC	Double Lane Change
DM	Drive Manager (module in TruckMaker to create the driver activity)
GUI	Graphical user interface
HIL	Hardware in the loop
h_R	Height of centre of gravity of trailer
ID_GS0471	Function Information Document of the Trailer EB+ system
IMU	Inertial measurement unit
KP	Distance from king pin
KP_RA	In the case of semi-trailer tractor: Distance from king pin to last rear axle (negative if king pin is located behind last rear axle) In the case of trucks: Distance from hitch pin to last rear axle
OR	Outrigger
OR_h	Clearance **h**eight between the outside edge of the tyre tread of the outrigger wheels and the surface (see Annex 5)
OR_d	**D**istance (offset) between the centres of tyre contact of the left or right outrigger wheel and the adjacent tyre of rear axle (see Annex 5) **OR_d = (W – T) / 2;** where “W” is the “track width” of the outriggers and “T” is the track of the trailer
PP	Distance from pivot pin of A-Frame
RoC	Roll-over Control

EBS-System : **EB+**
Manufacturer : **Haldex**

SIM	Simulation
TE	Distance from towing eye
Unlad	Unladen
v_E	Speed at end of defined test manoeuvre
v_{In}	Speed when brake intervention occurred
v_{In_S}	Speed at start of brake intervention
v_{In_E}	Speed at end of brake intervention
v_0	Initial speed (test entrance speed)
$v_{0\ ON}$	Entrance test speed with system ON – see test identifier N1 and N2
$v_{0\ OFF}$	Entrance test speed with system OFF – see test identifier F1 and F2
v_{TD}	Speed when touchdown occurred
YR	Yaw rate ($d\Psi/dt$)
YRS	Yaw rate sensor
Test identifier	
F1	Test with the system OF**F** without a touchdown
F2	Test with the system OF**F** with a touchdown
N1	Test with the system O**N** without a touchdown
N2	Test with the system O**N** with a touchdown
Test procedure codes	
I	Increasing Curvature - IC
D	Double Lane Change – DLC (according to Haldex specification)
R	Circle Test – constant radius – CR (clockwise)
S	Circle Test – constant radius – CR (anti-clockwise)
Z	Double Lane Change – DLC (according to ISO standard 3888-1:2002)
Vehicle codes	
L	Lorry / Truck
T	Semi-trailer tractor
C	Centre-axle trailer
F	Full trailer
S	Semi-trailer

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 2: Vehicle Stability Function Simulation Tool Test Report

See E1*210215 of 27.04.2015 / EB183.0

Confirmation of a Test Report regarding Annex 21 Appendix 3 of UN Regulation No. 13 for a vehicle stability simulation tool

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 3: Vehicle Parameters and Values used in the Simulation

See E1*210215 of 27.04.2015 / EB183.0

Confirmation of a Test Report regarding Annex 21 Appendix 3 of UN Regulation No. 13 for a vehicle stability simulation tool

Annex 4: Simulation Verification

See E1*210215 of 27.04.2015 / EB183.0

Confirmation of a Test Report regarding Annex 21 Appendix 3 of UN Regulation No. 13 for a vehicle stability simulation tool

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 5: Test Vehicle Data

1. Test Vehicle Data

1.1 General Data – Motor Vehicle

The towing vehicles used, shown in the table below, did not have any operative vehicle stability functions.

Test vehicle	Make	Model	Veh.-Conf.	ABS-Conf.	Susp.	brake	Track [mm] front rear	E [mm] E1 E2	KP_RA [mm]
Test vehicles „.2“									
T1	Volvo	FH480	4x2*	4S/4M	Steel/Air	Disc	2040 1850	4100	730
Test vehicles „.0“									
T1	Volvo	FH12	4x2	4S/4M	Steel/Air	Disc	2030 1830	3700	450
L1	Volvo	F12	6x2	4S/4M	Air/Air	Drum	2007 1840 2007	3200 1380	1000

* 6x2 vehicle with centre (pusher) axle lifted and wheels removed

EBS-System : **EB+**
Manufacturer : **Haldex**

1.2 General Data – Trailer

1.2.1 Real Test Vehicles

Test vehicle	Make	Type	No. of axles	Susp.	ABS-Conf.	Brake	Track [mm]	E / E_R [mm]	OR_h OR_d [mm]
Test vehicles „.2“									
S12	Fruehauf	Semi-trailer	2	Air	**		2020	8005	325 1560
S13			3				2020	7330	
Test vehicles „.0“									
S11	Fruehauf	Semi-trailer	1	Air	**	Drum	2020	7330	325 1560
S12			2				2020	8005	
S13			3				2020	7330	
C11	Dennison	Centre-axle trailer	1	Air	**	Drum	2100	4830	358 1730
C12			2				2100	5490	
C13			3				2100	4830	
F12	Abel	Full trailer	2	Air	**	Drum	2050	4530 18N	380 1765
F13			3				2050	3855	

** **See Annex 7, Table „Test Overview”**

EBS-System : **EB+**
Manufacturer : **Haldex**

1.2.2 Virtual Test Vehicles

The following virtual test vehicles were use for simulation purpose to assess the impact of Gen 3 modifications vs. Gen 2 on RoC. Masses and dimensions of these test vehicles are unchanged to data of the real test vehicle (S13, C13, F13) of the previous test report.

Test vehicle	Make	Type	No. of axles	Susp.	ABS-Conf.**	Brake	Track [mm]	E / E_R [mm]	OR_h OR_d [mm]
S13.1	Fruehauf	Semi-trailer	3	Air	2 C _	Drum	2020	7330	325 1560
C13.1	Dennison	Centre-axle trailer	3	Air	4 C R	Drum	2100	4830	358 1730
F13.1	Abel	Full trailer	3	Air	3 F C	Drum	2050	3855	380 1765

** See Annex 6, Table „ABS Configuration-Code”

The following virtual test vehicles represent actual used test trailers with the exception that for simulation purposes individual parameters have been varied to assess the impact on the RoC.

Test vehicle	Make	Type	No. of axles	Susp.	Variation	Brake	Track [mm]	E / E_R [mm]	OR_h OR_d [mm]
S23	Fruehauf	Semi-trailer	3	Air	High CoG 2200mm see 2.3 below	Drum	2020	7330	325 1560
S33					Low CoG 1500mm see 2.3 below				
S43					Roll stiffness +20%				
S53					Roll stiffness -20%				
S63					Reference vehicle for simulation with CoG 1920mm				
F22	Abel	Full trailer	2	Air	Short wheel base (E_R)	Drum	2050	3000	380 1765
F32					Long wheel base (E_R)		2050	5500	

EBS-System : **EB+**
Manufacturer : **Haldex**

1.3 Weights and CoG of Vehicle Combination

Test vehicles ".2"

	Test Weights (coupled)			
	Motor vehicle		Trailer	CoG [mm]
Trailer	Vehicle	Weight [kg]	PR [kg]	
S12.2_laden	T1.2	12120	16760	1940
S12.2_unladen		12480	12500	1625
S13.2_laden		14180	25140	2190
S13.2_unladen		11400	13820	1560

EBS-System : **EB+**
Manufacturer : **Haldex**

Test vehicles ".0"

	Test Weights (coupled)			
	Motor vehicle		Trailer	CoG [mm]
Trailer	Vehicle	Weight [kg]	PR [kg]	
S11_laden	T1	9150	9380	1427
S11_unladen		9050	7880	1155
S12_laden		11970	16000	1694
S12_unladen		12160	11910	1528
S13_laden S43_laden* S53_laden*		14710	23660	1997
S23_laden*				2200
S33_laden*				1500
S63_laden*				1920
S13_unladen		10910	13050	1480
C11_laden	L1	21070	8470	1342
C11_unladen		20880	6190	729
C12_laden		21310	15770	1691
C12_unladen		21680	9270	1036
C13_laden		21650	23710	1908
C13_unladen		21120	11980	1240
F12_laden F22_laden * F32_laden *	L1	21180	16040	1868
F12_unladen			12460	1508
F13_laden			24560	1890
F13_unladen			12720	1490

* Virtual vehicles, see paragraph 1.2.2 above

EBS-System : **EB+**
Manufacturer : **Haldex**

1.4 Instrumentation Sensor Positions

Test vehicles „.2“

Three IMU’s (YRS & AYS)

- Centre of tractor unit chassis
- Centre of trailer landing legs
- Centre of trailer centre axle

Test vehicles „.0“

Trailer	IMU (YRS & AYS) KP / TE / PP [mm]	IMU (YRS & AYS) Distance from left side of trailer	IMU (YRS & AYS) Height [mm]	Body Slip Sensor
S11	KP = 7255	1375	1200	KP = 7330
S12				
S13 S23* S33* S43* S53* S63*				
C11	TE = 5370	1250	925	TE = 4830
C12				
C13				
F12	PP = 650 and PP = 4340	1120 and 1250	980 and 1100	PP = 1270 in front and PP = 4680 behind
F13 F22* F32*				

* Virtual vehicles, see paragraph 1.2.2 above

KP = Distance from king pin
TE = Distance from towing eye
PP = Distance from pivot pin of A-Frame

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 6: Test Codes

1 File Name

Examples of file names

Note: All vehicles numbered '1', i.e. S**1**, **C1**, F**1**, were real test vehicles, other numbers, e.g. S**2**, denote '**virtual vehicles**' used for simulation.

1 to 4	5 to 8	9 &10	11 &12	13	14 & 15
Vehicle	**Configuration**	**Load condition**	**Test procedure**	**ON / OFF status**	**Running test No.**
S 1 1 _	**2F__**	**L_**	**D_**	**F**	**01**
S 1 3 _	**2C__**	**U_**	**I_**	**N**	**02**

Table „ABS Configuration-Code"

F = front axle C = centre axle R = rear axle S = SLV	Main Identifier	1 axle-trailer	2 axle-trailer	3 axle-trailer
2S/2M with SLV valve	1		1FS ⇐ SLV on R	1SC ⇐ SLV on F 1CS ⇐ SLV on R
2S/2M	2	2F_	2F_ 2R_	2C_
2S/2M 'DAR' (Dolly)	2	-	2FD 2RD	-
4S/2M	4		4FR	4CR
4S/3M with slave valve on front axle	3		3FR	3FC 3FR
4S/3M with slave valve on rear axle	6		6FR	6CR 6FR

EBS-System : **EB+**
Manufacturer : **Haldex**

2 Test Procedures

The following table shows the test procedure codes used throughout this document, included in the file names / test references described in paragraph 1 above.

I	**Increasing Curvature Test** (Tightening curve) **(truck R ∞ ⇒ 50 m)**
R	**Constant Radius (truck 21.25m) clockwise**
S	**Constant Radius (truck 21.25m) anti-clockwise**
Z	**Double Lane Change Test (ISO)**
D	**Double Lane Change Test (7m)**

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 7: Overview Vehicle Tests and Simulation

The following table shows an overview of the different tests carried out with the defined real vehicles below. In addition a number of simulations were carried out with virtual test vehicles with modified parameters for the purpose of assessing the sensitivity of the RoC to those parameters (see Annex 9).

Table „Test Overview Inloader" – Test Vehicles „2"							
Test No.	Test vehicle	Configuration See Annex 6	I	R	S	D	Z
1_L	S13	2C_	V	V	V	--	--
1_U	S13	2C_	V	V	V	--	--
2_L remote	S13	2C_	V	V	V	--	--
2_U remote	S13	2C_	V	V	V	--	--
1_L	S12	2F_	V	V	V	--	--
1_U	S12	2F_	V	V	V	--	--
1_L	S12	4FR_	V	V	V	--	--
1_U	S12	4FR_	V	V	V	--	--

Table „Test Overview" – Test Vehicles „0"							
Test No.	Test vehicle	Configuration See Annex 6	I	R	S	D	Z
1_L	S13	2C_	VS	VS	VS	VS	VS
1_U	S13	2C_	VS	VS	VS	-	-
2	S12	2F_	V	V	V	V	V
2_D	S12	2F_	S	-	-	-	-
3_L	S12	2R_	VS	VS	VS	-	-
3_D	S12	2R_	S	-	-	-	-

EBS-System : **EB+**
Manufacturer : **Haldex**

Table „Test Overview" – Test Vehicles „0"							
Test No.	Test vehicle	Configuration See Annex 6	I	R	S	D	Z
3_U	S12	2R_	VS	VS	VS	-	-
4_L	S11	2F_	VS	VS	VS	-	-
5	S13	1CS	V	V	V	-	-
6	S13	1SC	V	V	V	-	-
7	S12	1FS	V	V	V	-	-
8	S13	4CR	V	V	V	-	-
9	S12	4FR	V	V	V	-	-
10	S13	3FC	V	V	V	-	-
11	S13	3FR	V	V	V	-	-
12	S13	6FR	V	V	V	-	-
13	S13	6CR	V	V	V	-	-
14	S12	3FR	V	V	V	-	-
15	S12	6FR	V	V	V	-	-
16_L	C13	2C_	VS	V	V	-	-
17	C12	2F_	VS	-	-	-	-
17_D	C12	2F_	S	-	-	-	-
18	C12	2R_	VS	-	-	-	-
18_D	C12	2R_	S	-	-	-	-
19_L	C11	2F_	VS	-	-	-	-
20	C13	1CS	V	-	-	-	-
21	C13	1SC	V	-	-	-	-
22	C12	1FS	V	-	-	-	-
23_L	C13	4CR	VS	-	-	-	-

EBS-System : **EB+**
Manufacturer : **Haldex**

Table „Test Overview" – Test Vehicles „0"							
Test No.	Test vehicle	Configuration See Annex 6	I	R	S	D	Z
23_U	C13	4CR	VS	-	-	-	-
24_L	C12	4FR	V	-	-	-	-
24_U	C12	4FR	V	-	-	-	-
25	C13	3FC	V	-	-	-	-
26	C13	3FR	V	-	-	-	-
27	C13	6FR	V	-	-	-	-
28	C13	6CR	V	-	-	-	-
29	C12	3FR	V	-	-	-	-
30	C12	6FR	V	-	-	-	-
31_L	F13	3FC	VS	VS	VS	V	V
31_U	F13	3FC	VS	VS	VS	-	-
32_L	F13	3FR	V	V	V	-	-
33_L	F12	3FR	VS	VS	VS	V	V
33_U	F12	3FR	VS	VS	VS	-	-

The meaning of the symbols in the above table are as follows:	
I, R, S, D, Z	see Annex 1 "Abbreviations"
D	Dolly application, see Annex 12
L	Laden
U	Unladen
V	Vehicle test only
VS	Vehicle test + Simulation

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 8: Description of Test Procedures

The following tests were used for the purpose of evaluating the roll-over control function within the EB+ Stability.

The vehicle tests were conducted at the IDIADA proving ground in dry summer weather conditions (temperature ≥ 25 °C).

1. Circle Test (Constant Radius) "CR"

1.1 Test condition / procedure

The vehicle navigates a constant radius circle at gradually increasing speed until either the vehicle rolls onto its outrigger wheels ('touch-down') or the roll-over control makes a trailer brake intervention to retard the combination. The test is performed with system on and off. The motor vehicle navigates the outside of a 20 m radius, giving a radius to the centre of the cab of approximately 21.25 m. The effective radius followed by the centre of the trailer bogie depends on vehicle type, dimensions and speed.

Note: Although the effective radius followed in the vehicle tests was consistent between tests in the same direction, there was a small difference in effective radius between clockwise and anti-clockwise tests. This was due to slightly different driver/vehicle positioning in relation to the marked circle.

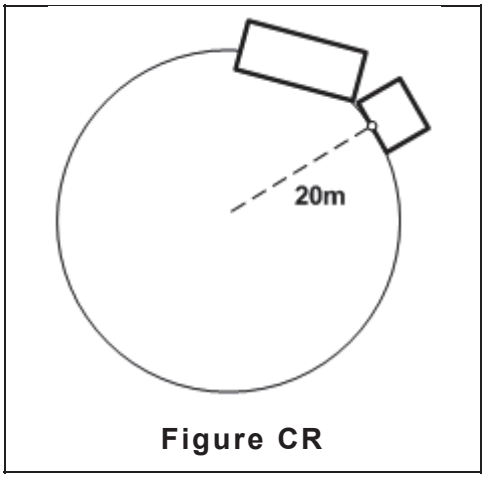


Figure CR

1.2 Acceptance criteria

The test is deemed to have passed when, with the system on, the roll-over control makes a brake intervention at a lower speed than the speed at which a touch-down occurs with the system off. Since the radius is relatively small, the lateral acceleration increases rapidly with speed. The speed difference between brake intervention and touch-down can therefore also be small in this case.

EBS-System : **EB+**
Manufacturer : **Haldex**

2. Increasing Curvature Test "IC"

2.1 Test condition / procedure

Although the drive test procedure "Increasing Curvature Test" (IC) is not a defined ISO test procedure, it is widely used and accepted for evaluation of high dynamic lateral vehicle reactions, especially for the testing of roll-over.

The increasing curvature manoeuvre is a form of 'J' turn. The vehicle enters the manoeuvre in a straight line and then traverses a marked roadway that tightens progressively to a 50 m radius. The vehicle heading at the exit of the manoeuvre is 180 degrees from the start heading.

The increasing curve / reducing radius is defined by a set of co-ordinates, see Table IC below.

This test is representative of a typical motorway exit. The manoeuvre can be entered safely at high speed, but the roll risk increases as the radius reduces. The test is performed with the system on and off in order to demonstrate that the roll-over control can detect the increasing risk and makes a trailer brake intervention to retard the combination.

The **system off tests** are performed by entering the manoeuvre at a set speed (entrance speed) and then attempting as far as possible to maintain that speed until either the end of the marked roadway or touch-down of an outrigger wheel. This may, for instance, be achieved by use of the cruise control.

The **system on tests** are performed by entering the manoeuvre at the entrance speed and then attempting as far as possible to maintain that speed until either the end of the marked roadway or the first application of the brakes by the roll-over control.

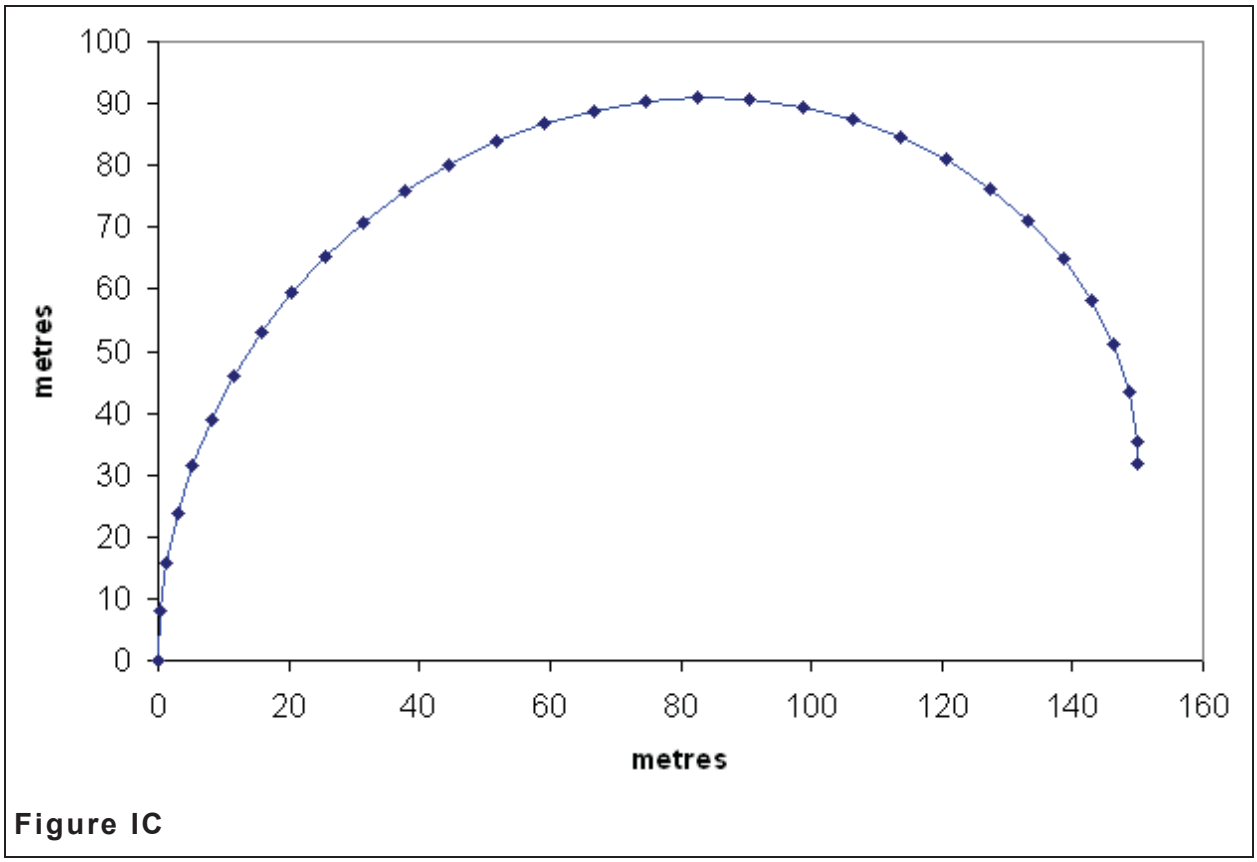


Figure IC

EBS-System : **EB+**
Manufacturer : **Haldex**

X-Y co-ordinates [m] of the increasing curvature manoeuvre

	X	Y		X	Y
1	0	0	**16**	66.8	88.9
2	0.3	8	**17**	74.7	90.3
3	1.3	15.9	**18**	82.6	90.9
4	2.9	23.8	**19**	90.6	90.6
5	5.2	31.4	**20**	98.6	89.5
6	8.1	38.9	**21**	106.3	87.5
7	11.6	46.1	**22**	113.7	84.6
8	15.7	52.9	**23**	120.8	80.9
9	20.5	59.4	**24**	127.4	76.3
10	25.7	65.4	**25**	133.3	71
11	31.5	70.9	**26**	138.6	64.9
12	37.8	75.8	**27**	142.9	58.2
13	44.6	80.1	**28**	146.3	51
14	51.7	83.8	**29**	148.7	43.3
15	59.1	86.7	**30**	149.9	35.4
			31	150	31.8

Table IC

EBS-System : **EB+**
Manufacturer : **Haldex**

2.2 Acceptance criteria

The test is deemed to have passed when the roll-over control detects impending roll-over and makes a trailer brake intervention, slowing the combination to a speed below the lowest touch-down speed that was recorded with the system off.

Although vehicle tests were conducted with the driver maintaining throttle or speed until the end of the manoeuvre (sometimes causing more than one brake intervention), this becomes difficult to simulate in a repeatable manner and so for clarity of results the test was deemed over at the end of the first brake intervention as described above.

The highest entrance speed, v_0, without a touch-down is recorded for system on and off and it is demonstrated that $v_{0\ ON} > v_{0\ OFF}$.*

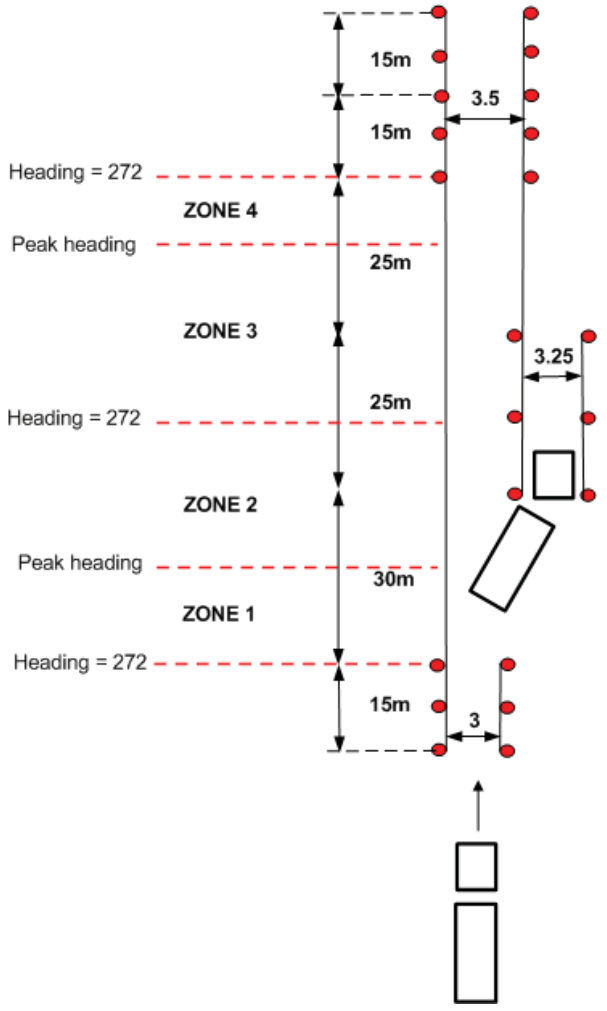
* **Note**: Actually, the above criteria was verified by the more stringent test condition by comparing the entrance speed $v_{0\ ON}$ of the “System ON Test” **N1** with the entrance speed $v_{0\ OFF}$ of the “System OFF Test” **F2** which produced a touchdown.

3. Double Lane Change Test “DLC”

3.1 Test condition / procedure

The double lane change tests assess the reactivity of the roll-over control to a higher frequency steering input. A sudden steering input is made first to steer into an adjacent lane, then to straighten up, then to steer back into the original lane.
Two different lane change manoeuvres are performed. Although **DLC_A** is based on ISO standard 3888-1:2002 (defined for passenger cars) it is widely accepted also in the commercial vehicle world; **DLC_B** is a Haldex defined manoeuvre.

EBS-System : **EB+**
Manufacturer : **Haldex**



Width of first lane	1.1*b + 0.25 = 3.00
Width of second lane	1.2*b + 0.25 = 3.25
Width of third lane	1.3*b + 0.25 = 3.00

b represents the overall width of a commercial vehicle at approximately 2.5m

Figure DLC_A

EBS-System : **EB+**
Manufacturer : **Haldex**

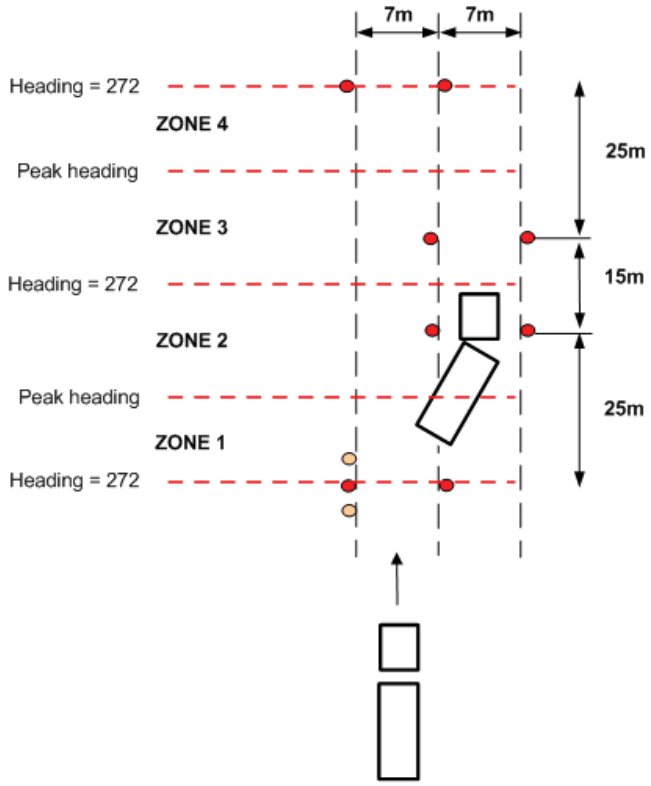


Figure DLC_B

3.2 Acceptance criteria

The test is deemed to have passed when there is no outrigger wheel touch-down during the manoeuvre.

The highest entrance speed, v_0, without a touch-down is recorded for system on and off and it is demonstrated that $v_{0\ ON} > v_{0\ OFF}$.*

* **Note**: Actually, the above criteria was verified by the more stringent test condition by comparing the entrance speed **$v_{0\ ON}$** of the “System ON Test” **N1** with the entrance speed **$v_{0\ OFF}$** of the “System OFF Test” **F2** which produced a touchdown.

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 9: Increasing Curvature Test "IC"

1. Increasing Curvature Test

1.1 Abbreviations used in this annex

F	Test with RoC disabled - OF**F**
F_{SIM}	**Sim**ulated test with RoC disabled - OF**F**
F1 & FA	Test **without** a touchdown
F2& FB	Test **with** a touchdown
N	Test with RoC enabled – O**N**
N_{SIM}	**Sim**ulated test with RoC enabled – O**N**
N1 & NA	Test **without** a touchdown
N2& NB	Test **with** a touchdown

EBS-System : **EB+**
Manufacturer : **Haldex**

1.2 Main test results (using standard vehicle parameters)

Test Vehicles "2"

Semi-trailer S 1 3 . 2 „ I n l o a d e r “							
Test code	**System**	**Test refer.**	**v_0 km/h**	**v_{In} km/h**	**v_{TD} km/h**	**ay_{max} g**	**TD**
S13_2C laden	OFF	F1	--	--	--	--	no
		F2	46	--	45,5	-0,45	yes
	ON	N1	49	48,8	--	-0,43	no
		N2	49	48,8	42,7	-0,41	yes
S13_2C unladen	OFF	F1	--	--	--	--	no
		F2	61	--	60,6	-0,58	yes
	ON	N1	73	72,6	--	-0,59	no
		N2	74	73,8	67,1	-0,51	yes
S13_2C laden remote	OFF	F1	--	--	--	--	no
		F2	46	--	45,5	-0,45	yes
	ON	N1	47	46,3	--	-0,47	no
		N2	48	47,7	44,7	-0,47	yes
S13_2C unladen remote	OFF	F1	--	--	--	--	no
		F2	61	--	60,6	-0,58	yes
	ON	N1	73	72,3	--	-0,6	no
		N2	74	73,3	67,1	-0,64	yes

Semi-trailer S 1 2 . 2 „ I n l o a d e r “							
Test code	**System**	**Test refer.**	**v_0 km/h**	**v_{In} km/h**	**v_{TD} km/h**	**ay_{max} g**	**TD**
S12_2F laden	OFF	F1	--	--	--	--	no
		F2	52	--	51,6	-0,44	yes
	ON	N1	54	53,9	--	-0,47	no
		N2	56	55,9	51,6	-0,5	yes
S12_2F unladen	OFF	F1	--	--	--	--	no
		F2	58	--	57,4	-0,63	yes
	ON	N1	71	70,4	--	-0,52	no
		N2	71	70,8	53,8	-0,55	yes
S12_4FR laden	OFF	F1	--	--	--	--	no
		F2	52	--	51,6	-0,44	yes

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 2 . 2 „ I n l o a d e r “**							
Test code	**System**	**Test refer.**	**v_0 km/h**	**v_{In} km/h**	**v_{TD} km/h**	**ay_{max} g**	**TD**
	ON	**N1**	**61**	**60,3**	**--**	**-0,42**	**no**
		N2	**62**	**61,6**	**57,8**	**-0,45**	**yes**
S12_4FR unladen	**OFF**	**F1**	**--**	**--**	**--**	**--**	**no**
		F2	**58**	**--**	**57,4**	**-0,63**	**yes**
	ON	**N1**	**72**	**71,7**	**--**	**-0,55**	**no**
		N2	**74**	**73,3**	**66,0**	**-0,54**	**yes**

Test Vehicles “0”

Semi-trailer **S 1 3 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S13_2C laden	**F**	**F1**	**55.9**	180			**54.8**	-5.3	**no**
		F2	**57.1**	149		**54.7**		-5.6	**yes**
	N	**N1**	**68.9**	9 54	**67.1** **50.2**			-5.5	**no**
		N2	**69.0**	7 16	**68.4**	**64.5**		-5.7	**yes**
	F_{SIM}	**FA**	**53.0**	180			**53.9**	-4.5	**no**
		FB	**54.0**	165		**53.2**		-5.1	**yes**
	N_{SIM}	**NA**	**66.9**	- 43	**66.5** **49.7**			-3.8	**no**
		NB	**68.0**	- 30	**66.5**	**59.0**		-4.5	**yes**
S13_2C unladen	**F**	**F1**	**66.8**	180			**62.8**	-7.4	**no**
		F2	**68.3**	157		**65.5**		-7.7	**yes**
	N	**N1**	**78.5**	9 56	**76.5** **59.3**			-7.1	**no**
		N2	*	*	*	*		*	*
	F_{SIM}	**FA**	**77.0**	180			**67.1**	-6.4	**no**
		FB	**78.0**	142		**67.3**		-7.7	**yes**
	N_{SIM}	**NA**	**78.0**	- 25	**75.7** **74.8**			-5.2	**no**

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 3 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
		NB	*	*	*	*		*	*
S13_1CS laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**68.4**	8 56	**66.4** **54.1**			-4.9	**no**
		N2	**69.2**	6 21	**66.9**	**62.2**		-5.0	**yes**
S13_1SC laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**68.4**	8 56	**66.5** **54.3**			.4.9	**no**
		N2	**68.6**	8 35	**67.3**	**59.5**		-5.0	**yes**
S13_4CR laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**67.4**	8 42	**65.4** **49.7**			-5.0	**no**
		N2	**68.6**	10 21	**66.9**	**61.7**		-5.4	**yes**
S13_3FC laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**67.4**	12 59	**65.8** **51.9**				**no**
		N2	**68.6**	9 25	**67.3**	**61.9**			**yes**
S13_3FR laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**68.4**	9 57	**66.1** **52.0**				**no**
		N2	**69.0**	9 24	**66.9**	**62.0**			**yes**
S13_6FR laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 3 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
	N	**N1**	**68.7**	8 56	**67.7** **53.5**			-5.1	**no**
		N2	**68.8**	6 17	**68.0**	**64.4**		-5.4	**yes**
S13_6CR laden	**F**	**F1**	***55.9***	*180*			***54.8***	*-5.3*	**no**
		F2	***57.1***	*149*		***54.7***		*-5.6*	**yes**
	N	**N1**	**68.1**	7 57	**66.4** **53.3**			-5.19	**no**
		N2	**69.1**	6 15	**67.8**	**64.7**		-6.0	**yes**

Semi-trailer **S 1 2 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S12_2F laden	**F**	**F1**	**59.9**	180			**59.1**	-5.8	**no**
		F2	**60.2**	148		**59.1**		-6.1	**yes**
	N	**N1**	**71.1**	7 56	**69.0** **55.5**				**no**
		N2	**71.2**	6 23	**69.5**	**63.9**		-6.0	**yes**
S12_2FD laden 'DAR'	**F_{SIM}**	**FA**	***60.0***	*180*			***60.2***	*-5.5*	**no**
		FB	***61.0***	*170*		***59.6***		*-6.0*	**yes**
	N_{SIM}	**NA**	**73.0**	8 173	**72.0** **44.5**			-5.4	**no**
		NB	**74.0**	12 40	**72.4**	**69.5**		-5.6	**yes**
S12_2R laden	**F**	**F1**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		F2	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N	**N1**	**70.5**	8 58	**68.9** **54.1**			-5.9	**no**
		N2	**71.5**	5 17	**69.9**	**65.3**		-6.4	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 2 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
	F_{SIM}	**FA**	**60.0**	180			**60.2**	-5.5	**no**
		FB	**61.0**	170		**59.6**		-6.0	**yes**
	N_{SIM}	**NA**	**75.0**	- 44	**73.5 56.0**			-5.2	**no**
		NB	**76.0**	- 37	**74.5**	**65.6**		-5.4	**yes**
S12_2RD laden 'DAR'	F_{SIM}	**FA**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		FB	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N_{SIM}	**NA**	**73.0**	48 168	**69.0 44.5**			-5.3	**no**
		NB	**74.0**	5 40	**73.6**	**68.8**		-5.6	**yes**
S12_2R unladen	**F**	**F1**	**66.3**	180			**62.7**	-7.4	**no**
		F2	**67.9**	177		**63.4**		-7.5	**yes**
	N	**N1**	**76.2**	6 106	**73.7**	**47.7**		-6.4	**no**
		N2	*	*	*	*		*	*
	F_{SIM}	**FA**	**68.0**	180			**65.5**	-6.4	**no**
		FB	**69.0**	177		**64.5**		-6.8	**yes**
	N_{SIM}	**NA**	**76.0**	- 52	**74.6**	**57.0**		-4.5	**no**
		NB	*	*	*	*		*	*
S12_1FS laden	**F**	**F1**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		F2	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N	**N1**	**68.5**	8 104	**67.6 51.4**			-5.6	**no**
		N2	**70.3**	7 24	**68.8**	**63.8**		-7.2	**yes**
S12_4FR laden	**F**	**F1**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		F2	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N	**N1**	**71.8**	7 58	**69.8 55.7**			-5.8	**no**
		N2	**72.7**	8	**71.3**			-6.3	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 2 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
				22		**66.1**			
S12_3FR laden	**F**	**F1**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		F2	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N	**N1**	**70.7**	7 103	**68.7** **51.0**			-5.6	**no**
		N2	**71.9**	8 31	**70.4**	**64.3**		-6.2	**yes**
S12_6FR laden	**F**	**F1**	***59.9***	*180*			***59.1***	*-5.8*	**no**
		F2	***60.2***	*148*		***59.1***		*-6.1*	**yes**
	N	**N1**	**69.4**	11 106	**67.8** **44.0**			-5.2	**no**
		N2	**70.7**	7 35	**69.8**	**64.4**		-6.8	**yes**

Semi-trailer **S 1 1 . 0**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S11_2F laden	**F**	**F1**	**65.4**	180			**59.6**	-7.4	**no**
		F2	**70.0**	142		**64.5**		-7.7	**yes**
	N	**N1**	**75.1**	5 180	**74.1** **59.4**			-6.6	**no**
		N2	**78.8**	4 26	**76.5**	**69.3**		-8.8	**yes**
	F_{SIM}	**FA**	**68.0**	180			**65.6**	-6.6	**no**
		FB	**69.0**	180		**77.2**		-6.9	**yes**
	N_{SIM}	**NA**	**81.0**	- 23	**79.4** **64.0**			-5.3	**no**
		NB	**82.0**	- 22	**80.3**	**78.2**		-5.3	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Centre-axle trailer **C 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
C13_2C laden	**F**	**F1**	**56.4**	180			**54.6**	-4.5	**no**
		F2	**56.4**	151		**54.1**			**yes**
	N	**N1**	**64.8**	11 49	**62.7** **47.2**			-5.3	**no**
		N2	**65.6**	11 40	**63.3**	**51.7**		-5.9	**yes**
	F_{SIM}	**FA**	**62.0**	180			**56.4**	-5.2	**no**
		FB	**63.0**	169		**56.4**		-5.5	**yes**
	N_{SIM}	**NA**	**72.2**	15 48	**70.4** **53.7**			-4.3	**no**
		NB	**73.5**	16 36	**71.6**	**61.3**		-4.8	**yes**
C13_1CS laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**64.2**	11 51	**62.6** **51.5**			-5.0	**no**
		N2	**64.8**	10 25	**62.8**	**58.9**		-6.0	**yes**
C13_1SC laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**64.5**	10 58	**63.4** **52.6**			-5.3	**no**
		N2	**65.4**	10 40	**63.3**	**55.3**		-5.5	**yes**
C13_4CR laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**65.7**	10 50	**64.2** **48.2**			-5.5	**no**
		N2	**65.9**	11 18	**63.2**	**60.4**		-6.9	**yes**
	F_{SIM}	**FA**	***62.0***	*180*			***56.4***	*-5.2*	**no**
		FB	***63.0***	*169*		***56.4***		*-5.5*	**yes**
	N_{SIM}	**NA**	**72.2**	15 48	**70.4** **53.6**			-4.3	**no**

EBS-System : **EB+**
Manufacturer : **Haldex**

Centre-axle trailer **C 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
		NB	**73.5**	14 36	**73.5**	**62.6**		-4.8	**yes**
C13_4CR unladen	**F**	**F1**	**73.2**	180			**60.8**	-5.9	**no**
		F2	*	*		*		*	*
	N	**N1**	**76.4**	180	**none**		**60.0**	-6.3	**no**
		N2	*	*	*	*		*	*
	F_{SIM}	**FA**	**73.1**	180			**62.1**	-5.6	**no**
		FB	*	*		*		*	*
	N_{SIM}	**NA**	**76.1**	180	**none**		**61.3**	-5.5	**no**
		NB	*	*	*	*		*	*
C13_3FC laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**65.6**	12 51	**64.2** **51.2**			-5.5	**no**
		N2	**65.5**	12 37	**64.0**	**55.3**		-6.2	**yes**
C13_3FR laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**65.5**	11 57	**63.8** **48.0**			-5.1	**no**
		N2	**65.8**	10 26	**64.2**	**59.2**		-6.4	**yes**
C13_6FR laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**65.5**	11 58	**63.8** **49.8**			-5.2	**no**
		N2	**66.3**	11 23	**64.1**	**60.9**		-6.9	**yes**
C13_6CR laden	**F**	**F1**	***56.4***	*180*			***54.6***	*-4,5*	**no**
		F2	***56.4***	*151*		***54.1***			**yes**
	N	**N1**	**65.6**	11 54	**63.3** **47.4**			-4.9	**no**
		N2	**65.9**	10	**64.2**			-5.9	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Centre-axle trailer **C 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
				18		**61.8**			

Centre-axle trailer **C 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
C12_2F laden	**F**	**F1**	***68.8***	*180*			***62.6***	*-6.4*	**no**
		F2	***70.2***	*144*		***59.2***		*-6.6*	**yes**
	N	**N1**	**74.9**	7 59	**72.3** **55.9**			-5.7	**no**
		N2	**78.8**	7 35	**73.3**	**63.8**		-6.1	**yes**
	F_{SIM}	**FA**	**68.1**	180			**59.9**	-5.7	**no**
		FB	**69.1**	173		**59.5**		-5.9	**yes**
	N_{SIM}	**NA**	**75.7**	37 55	**74.5** **56.8**			-4.7	**no**
		NB	**76.7**	28 53	**76.7**	**60.1**		-5.2	**yes**
C12_2FD laden 'DAR'	**F_{SIM}**	**FA**	***68.1***	*180*			***59.9***	*-5.7*	**no**
		FB	***69.1***	*173*		***59.5***		*-5.9*	**yes**
	N_{SIM}	**NA**	**74.6**	8 178	**74.0** **52.5**			-5.2	**no**
		NB	**75.6**	4 49	**75.4**	**68.8**		-5.8	**yes**
C12_2R laden	**F**	**F1**	***68.8***	*180*			***62.6***	*-6.4*	**no**
		F2	***70.2***	*144*		***59.2***		*-6.6*	**yes**
	N	**N1**	**74.4**	10 61	**72.1** **55.7**			-5.9	**no**
		N2	**75.0**	10 39	**72.8**	**61.9**		-6.7	**yes**
	F_{SIM}	**FA**	***68.1***	*180*			***59.9***	*-5.7*	**no**
		FB	***69.1***	*173*		***59.5***		*-5.9*	**yes**
	N_{SIM}	**NA**	**76.7**	15	**75.4**			-3.8	**no**

EBS-System : **EB+**
Manufacturer : **Haldex**

Centre-axle trailer **C 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
				89	**43.3**				
		NB	**78.0**	14 41	**76.4**	**67.9**		-5.4	**yes**
C12_2RD laden 'DAR'	**F_{SIM}**	**FA**	***68.1***	*180*			***59.9***	*-5.7*	**no**
		FB	***69.1***	*173*		***59.5***		*-5.9*	**yes**
	N_{SIM}	**NA**	**74.6**	18 173	**72.0** **48.0**			-5.2	**no**
		NB	**75.6**	16 53	**75.4**	**68.8**		-5.8	**yes**
C12_1FS laden	**F**	**F1**	***68.8***	*180*			***62.6***	*-6.4*	**no**
		F2	***70.2***	*144*		***59.2***		*-6.6*	**yes**
	N	**N1**	**73.5**	10 65	**71.5** **60.8**			-6.1	**no**
		N2	**74.0**	9 46	**72.0**	**63.4**		-6.2	**yes**
C12_4FR laden	**F**	**F1**	**68.8**	180			**62.6**	-6.4	**no**
		F2	**70.2**	144		**59.2**		-6.6	**yes**
	N	**N1**	**74.3**	8 62	**71.4** **56.9**			-5.7	**no**
		N2	**75.9**	7 42	**74.9**	**63.6**		-6.3	**yes**
C12_4FR unladen	**F**	**F1**	**70.7**	180			**62.2**	-5.6	**no**
		F2	*	*		*		*	**yes**
	N	**N1**	**76.1**	180	**none**		**61.3**	-5.9	**no**
		N2	*	*	*	*		*	**yes**
C12_3FR laden	**F**	**F1**	***68.8***	*180*			***62.6***	*-6.4*	**no**
		F2	***70.2***	*144*		***59.2***		*-6.6*	**yes**
	N	**N1**	**73.8**	9 108	**71.6** **52.3**			-6.0	**no**
		N2	**74.1**	10 24	**71.1**	**66.7**		-7.4	**yes**
C12_6FR laden	**F**	**F1**	***68.8***	*180*			***62.6***	*-6.4*	**no**
		F2	***70.2***	*144*		***59.2***		*-6.6*	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Centre-axle trailer **C 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
	N	**N1**	**73.3**	9 65	**71.8** **59.9**			-5.9	**no**
		N2	**73.9**	10 43	**72.0**	**62.7**		-6.5	**yes**

Centre-axle trailer **C 1 1**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
C11_2F laden	**F**	**F1**	**64.1**	180			**59.8**	-6.5	**no**
		F2	**65.9**	170		**56.3**		-6.6	**yes**
	N	**N1**	**73.4**	8 164	**71.6** **50.7**			-6.1	**no**
		N2	**75.4**	8 23	**72.7**	**66.3**		-6.7	**yes**
	F_{SIM}	**FA**	**71.0**	180			**62.2**	-6.2	**no**
		FB	**72.0**	179		**61.6**		-6.2	**yes**
	N_{SIM}	**NA**	**77.1**	14 111	**76.0** **52.3**			-4.4	**no**
		NB	**78.1**	15 53	**77.0**	**67.4**		-5.5	**yes**

Full trailer **F 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
F13_3FC laden	**F**	**F1**	**56.5**	180			**54.4**	-4.9	**no**
		F2	**58.6**	148		**54.7**		-6.2	**yes**
	N	**N1**	**66.4**	5 51	**64.5** **50.9**			-5.9	**no**
		N2	**68.2**	5 22	**66.7**	**59.4**		-6.6	**yes**
	F_{SIM}	**FA**	**58.9**	180			**55.2**	-5.3	**no**

EBS-System : **EB+**
Manufacturer : **Haldex**

Full trailer **F 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
		FB	**60.0**	171		**55.1**		-5.8	**yes**
	N_{SIM}	**NA**	**72.4**	- 58	**70.5 53.7**			-4.3	**no**
		NB	**73.9**	- 38	**72.1**	**63.4**		-4.9	**yes**
F13_3FC unladen	**F**	**F1**	**67.6**	180			**60.4**	-5.4	**no**
		F2	*	*		*		*	*
	N	**N1**	**73.1**	142 180	**61.5 47.9**				**no**
		N2	*	*	*	*		*	*
	F_{SIM}	**FA**	**69.0**	180			**61.1**	-5.6	**no**
		FB	*	*		*		*	*
	N_{SIM}	**NA**	**73.1**	36 82	**70.4 57.2**			-4.2	**no**
		NB	*	*	*	*		*	*
F13_3FR laden	**F**	**F1**	**58.4**	180			**54.5**	-4.9	**no**
		F2	**60.7**	148		**56.7**		-5.7	**yes**
	N	**N1**	**66.8**	6 40	**64.8 49.3**			-5.9	**no**
		N2	**67.4**	4 12	**65.1**	**61.3**		-6.4	**yes**

Full trailer **F 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
F12_3FR laden	**F**	**F1**	**60.2**	180			**58.5**	-5.7	**no**
		F2	**61.3**	134		**58.5**		-6.3	**yes**
	N	**N1**	**68.2**	5 56	**66.8 55.3**			-5.7	**no**
		N2	**69.9**	5 20	**67.3**	**63.9**		-6.9	**yes**
	F_{SIM}	**FA**	**58.0**	180			**56.9**	-5.3	**no**

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EBS-System : **EB+**
Manufacturer : **Haldex**

Full trailer **F 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
		FB	**59.0**	173		**56.5**		-5.7	**yes**
	N_{SIM}	**NA**	**72.1**	- 66	**71.1 58.7**			-4.5	**no**
		NB	**72.9**	- 42	**72.0**	**65.1**		-5.1	**yes**
F12_3FR unladen	**F**	**F1**	**70.6**	180			**49.8**	-6.7	**no**
		F2	*	*		*		*	*
	N	**N1**	**74.6**	4 144	**73.2 35.7**			-6.5	**no**
		N2	*	*	*	*		*	*
	F_{SIM}	**FA**	**70.0**	180			**61.0**	-5.8	**no**
		FB	*	*		*		*	*
	N_{SIM}	**NA**	**75.1**	- 68	**74.1 60.8**			-4.5	**no**
		NB	*	*	*	*		*	*

* In the unladen condition the centre of gravity was very low, and with the EB⁺ system on it was not possible to enter the manoeuvre fast enough to roll the trailer. However, with the semi-trailer it was possible to roll the vehicle with the system off and demonstrate that the manoeuvre could successfully be entered at a higher speed with the system on.

** GPS heading refers to the corresponding recorded speeds (v_{In}, v_{TD}, v_E)

1.2.1 Conclusion (main test results)

The increasing curvature manoeuvre shows the ability of the RoC to adapt to steadily increasing lateral acceleration (and hence decreasing roll stability) due to reducing radius with near constant speed, and to intervene with automatically commanded braking in a timely manner. This test is representative of a typical motorway exit, which is a common roll-over situation.

The vehicle tests and simulated tests both show that the EB⁺ RoC intervenes to improve the roll stability of the combination in an appropriate manner with all EBS and vehicle configurations tested. When the brake intervention successfully prevented a roll-over (**tests N1**) it also slowed the combination sufficiently to ensure that roll-over would not occur even later in the manoeuvre (at the point of tightest radius). It was demonstrated in all cases that the manoeuvre could be entered at higher speed without a touch-down with the system on than with the system off ($v_{0\ ON} > v_{0\ OFF}$).

In the unladen cases it was not possible to roll the real test vehicles (within the limits of traction available) with the system on (and with the 2-axle and 3-axle semi-trailers also with the system off), but this was also confirmed with the simulator.

EBS-System : **EB+**
Manufacturer : **Haldex**

1.3 Additional test results (using vehicle parameter variations)

Parameter variations for semi-trailer **S 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S63_2C laden (simulated reference vehicle)	**F_{SIM}**	**FA**	**54.0**	180			**54.7**	-4.6	**no**
		FB	**55.0**	176		**54.4**		-4.9	**yes**
	N_{SIM}	**NA**	**69.0**	- 44	**67.6 51.7**			-4.2	**no**
		NB	**70.0**	- 30	**68.5**	**61.1**		-4.7	**yes**
S63_2C laden (lateral acc. sensor FL_S*)	**F_{SIM}**	**FA**	***54.0***	*180*			***54.7***	*-4.6*	**no**
		FB	***55.0***	*176*		***54.4***		*-4.9*	**yes**
	N_{SIM}	**NA**	**69.0**	- 45	**67.6 51.2**			-4.2	**no**
		NB	**70.0**	- 31	**68.6**	**60.4**		-4.7	**yes**
S63_2C laden (lateral acc. sensor RR_S*)	**F_{SIM}**	**FA**	***54.0***	*180*			***54.7***	*-4.6*	**no**
		FB	***55.0***	*176*		***54.4***		*-4.9*	**yes**
	N_{SIM}	**NA**	**67.9**	- 45	**66.5 50.7**			-3.9	**no**
		NB	**69.0**	- 35	**68.0**	**57.9**		-4.6	**yes**
S23_2C laden (high CoG 2200mm)	**F_{SIM}**	**FA**	**49.0**	180			**50.1**	-4.0	**no**
		FB	**50.0**	170		**49.5**		-4.3	**yes**
	N_{SIM}	**NA**	**63.0**	- 44	**61.7 46.8**			-3.4	**no**
		NB	**64.0**	- 26	**62.6**	**58.8**		-4.1	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Parameter variations for semi-trailer **S 1 3**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S33_2C laden (low CoG 1500mm)	**F_{SIM}**	**FA**	**76.0**	180			**62.2**	-6.1	**no**
		FB	**76.8**	163		**62.35**		-6.35	**yes**
	N_{SIM}	**NA**	**79.6**	- 60	**77.8 59.5**			-4.9	**no**
		NB	**80.7**	- 32	**78.9**	**71.6**		-5.5	**yes**
S43_2C laden (+20% roll stiffness, see diagrams below)	**F_{SIM}**	**FA**	**55.0**	180			**55.5**	-4.6	**no**
		FB	**55.0**	176		**55.1**		-4.9	**yes**
	N_{SIM}	**NA**	**69.0**	- 45	**67.4 51.5**			-3.9	**no**
		NB	**70.0**	- 36	**68.5**	**58.5**		-4.6	**yes**
S53_2C laden (-20% roll stiffness, see diagrams below)	**F_{SIM}**	**FA**	**53.0**	180			**53.8**	-4.7	**no**
		FB	**54.0**	164		**53.3**		-5.1	**yes**
	N_{SIM}	**NA**	**67.9**	- 43	**66.5 50.6**			-4.0	**no**
		NB	**69.0**	- 26	**67.5**	**62.0**		-4.6	**yes**

* FL_S = Front left limiting position of lateral accelerometer for semi-trailer fitment (1.5m forward of centre axle and on left chassis rail).

RR_S = Rear right limiting position of lateral accelerometer for semi-trailer fitment (1.5m rearward of centre axle and on right chassis rail).

See also ID_GS0471, Appendix 5.

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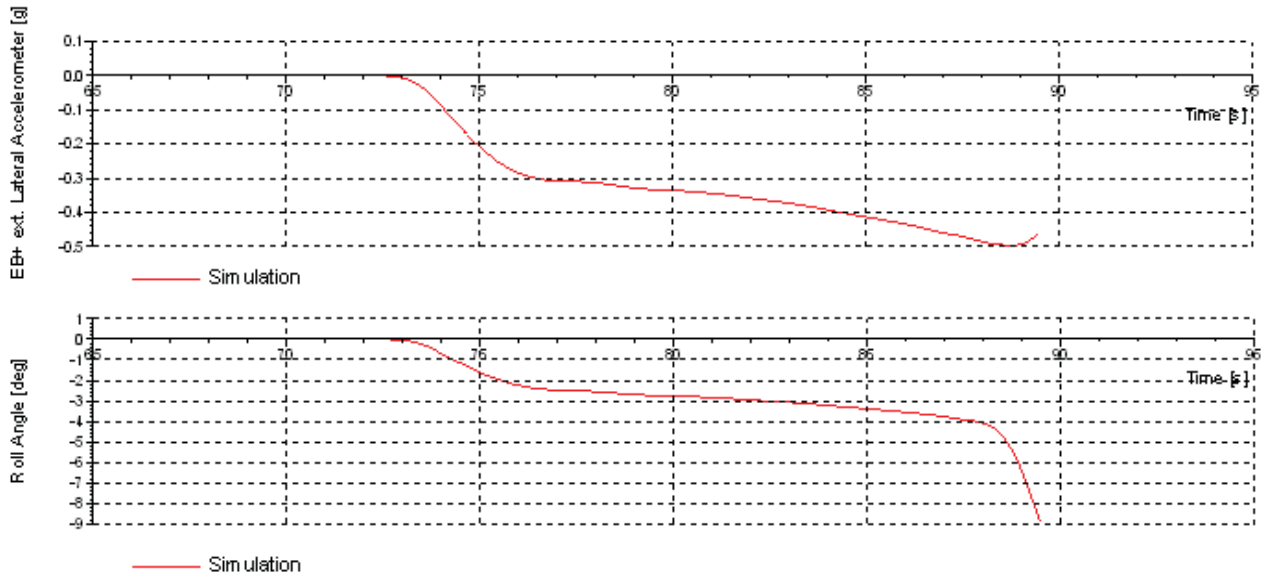
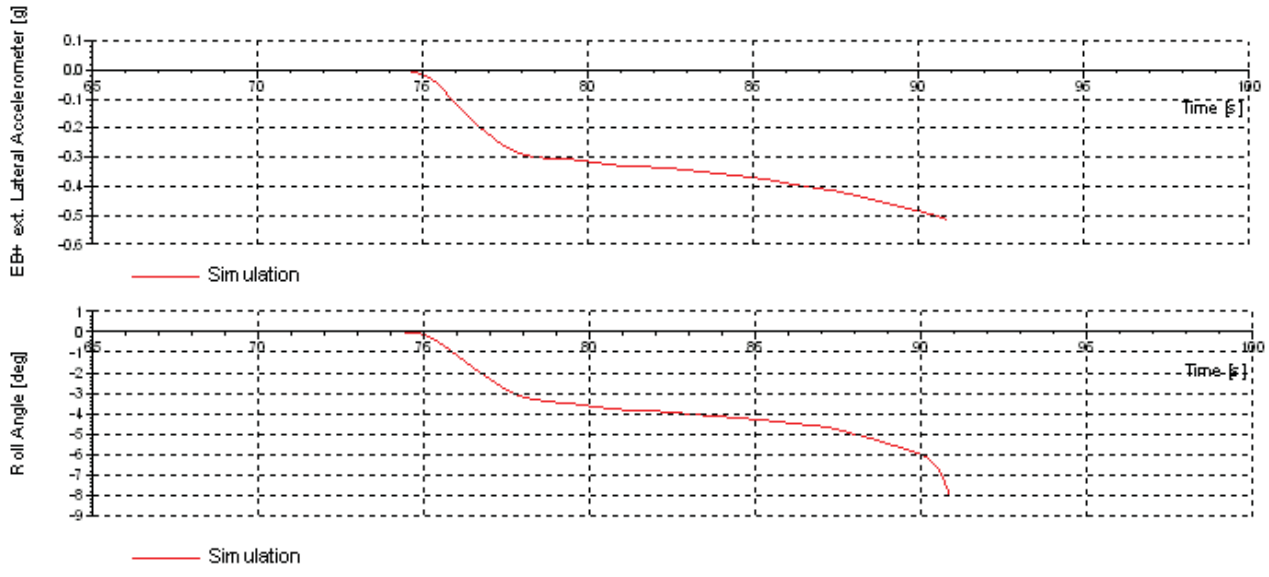
EBS-System : **EB+**
Manufacturer : **Haldex**

S43_2C_01_+20% Roll stiffness +20%



At a roll angle of **-4 °** the point of physical limit is reached; see also comment to paragraph 3.6 of the report.

S53_2C_02_-20% Roll stiffness -20%



At a roll angle of **-6 °** the point of physical limit is reached; see also comment to paragraph 3.6 of the report.

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EBS-System : **EB+**
Manufacturer : **Haldex**

Parameter variations for full trailer **F 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
F12_3FR laden (standard vehicle for reference)	**F**	**F1**	***60.2***	*180*			***58.5***	*-5.7*	**no**
		F2	***61.3***	*134*		***58.5***		*-6.3*	**yes**
	N	**N1**	***68.2***	*5* *56*	***66.8*** ***55.3***			*-5.7*	**no**
		N2	***69.9***	*5* *20*	***67.3***	***63.9***		*-6.9*	**yes**
	F_{SIM}	**FA**	***58.0***	*180*			***56.9***	*-5.3*	**no**
		FB	***59.0***	*173*		***56.5***		*-5.7*	**yes**
	N_{SIM}	**NA**	***72.1***	*-* *66*	***71.1*** ***58.7***			*-4.5*	**no**
		NB	***72.9***	*-* *42*	***72.0***	***65.1***		*-5.1*	**yes**
F12_3FR laden (lateral acc. sen-sor FL_F*)	**F**	**F1**	***60.2***	*180*			***58.5***	*-5.7*	**no**
		F2	***61.3***	*134*		***58.5***		*-6.3*	**yes**
	N	**N1**	**68.8**	3 90	**66.5** **42.5**			-5.7	**no**
		N2	**70.3**	3 18	**68.3**	**64.2**		-7.4	**yes**
F12_3FR laden (lateral acc. sen-sor RR_F*)	**F**	**F1**	***60.2***	*180*			***58.5***	*-5.7*	**no**
		F2	***61.3***	*134*		***58.5***		*-6.3*	**yes**
	N	**N1**	**68.8**	18 58	**66.4** **52.3**			-5.9	**no**
		N2	**69.7**	5 21	**67.6**	**63.9**		-7.4	**yes**
F22_3FR laden (short wheel base 3000mm)	**F_{SIM}**	**FA**	**58.0**	180			**56.8**	-5.5	**no**
		FB	**59.0**	169		**56.4**		-6.0	**yes**
	N_{SIM}	**NA**	**72.1**	- 111	**71.2** **42.7**			-3.7	**no**
		NB	**72.9**	- 44	**72.1**	**64.3**		-5.0	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Parameter variations for full trailer **F 1 2**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
F32_3FR laden (long wheel base 5000mm)	**F_{SIM}**	**FA**	**58.0**	180			**57.6**	-5.2	**no**
		FB	**59.0**	174		**56.5**		-5.4	**yes**
	N_{SIM}	**NA**	**72.1**	- 65	**71.1 58.6**			-4.4	**no**
		NB	**72.9**	- 41	**72.1**	**65.2**		-5.1	**yes**

* FL_F = Front left limiting position of lateral accelerometer for full trailer fitment (3.0m forward of centre axle and on left chassis rail).

RR_F = Rear right limiting position of lateral accelerometer for full trailer fitment (1.5m rearward of centre axle and on right chassis rail).

See also ID_GS0471, Appendix 5.

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1.3.1 Conclusion (additional test results)

The additional tests conducted with a simulated 3-axle semi-trailer with a typical air suspension show that the performance of the RoC is not unduly affected by variation of the following parameters:

- Lateral accelerometer position (within the limits set by the manufacturer)
- Centre of gravity height (1.5 m to 2.2 m tested)
- Roll stiffness (± 20% tested)

The additional tests conducted with a simulated 2-axle full trailer with a typical air suspension show that the performance of the RoC is not unduly affected by variation of the following parameter:

- Wheel base (3.0 m to 5.5 m tested)

The additional tests conducted with a real 2-axle full trailer with a typical air suspension show that the performance of the RoC is not unduly affected by variation of the following parameter:

- Lateral accelerometer position (within the limits set by the manufacturer)

1.4 Conclusion

The vehicle tests and simulated tests both show that the EB⁺ RoC intervenes to improve the roll stability of the combination in an appropriate manner with all EBS and vehicle configurations tested, and with variations in key vehicle parameters.

EBS-System : **EB+**
Manufacturer : **Haldex**

1.5 Comparative test results (Gen 2 vs. Gen 3)

To show evidence that the modifications of EB+ Gen 3 have no impact on the roll-over control function, a comparative test on a HIL rig with a validated simulation tool (see Annex 2) has been carried out. Simulations were done for semi-, centre axle- and full trailer with EB+ Gen 3 (hardware and software) with 12V and 24V supply voltage compared to EB+ Gen 2 (hardware and software).

According to Annex 2, 1.2.2 of this report the modified software version A3.0.3 of the simulation tool does not change the function of TruckMaker as far as ECE-Regulation No. 13 is concerned. This is confirmed by IPG (simulation tool manufacturer) release notes and comparison of the simulation results of the two versions.

Simulations with reduced voltage supply of 12 V at EB+ Gen 3 were only carried out with the EB+ stability system enabled (ON) because without intervention of the system the simulation is identical independent of the supply voltage.

For verification it was deemed to be sufficient to simulate the increasing curvature tests because it is significant especially for roll-over testing. Simulated vehicles were the same as used in the previous test report (see Annex 5, 1.2.2).

Equipment of HIL	**EB + Gen 2**	**EB + Gen 3**
Simulation tool	**TruckMaker**	
Software version	**Truck_Generic A3.0.3**	
Hardware version	**Xpack4**	
Integrated 2M/3M ECU/Valve assembly	**820 026 001**	**823 034 001**
Main Assembly 3M Slave	**810 011 001**	**810 023 001**
Software Code	**D523**	**E642**

EBS-System : **EB+**
Manufacturer : **Haldex**

Semi-trailer **S 1 3 . 1**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
S13_2C laden Gen 2	**F_{SIM}**	**FA**	**53.0**	180			**53.5**	- 4.7	**no**
		FB	**54.0**	165		**53.2**		- 5.0	**yes**
	N_{SIM}	**NA**	**67.0**	15 43	**65.8** **49.3**			- 3.8	**no**
		NB	**68.0**	15 27	**66.6**	**59.9**		- 4.5	**yes**
S13_2C laden Gen 3 24 V	**F_{SIM}**	**FA**	**53.0**	180			**53.5**	- 4.6	**No**
		FB	**54.0**	165		**53.2**		- 5.0	**Yes**
	N_{SIM}	**NA**	**67.0**	14 43	**65.6** **49.0**			- 3.6	**No**
		NB	**68.0**	13 30	**66.7**	**57.1**		-4.4	**Yes**
ditto 12 V	**N_{SIM}**	**NA**	**67.0**	14 43	**65.7** **49.0**			-3.6	**No**
		NB	**68.0**	13 30	**66.7**	**57.1**		-4.4	**Yes**

Center axle trailer **C 1 3 . 1**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
C13_4CR laden Gen 2	**F_{SIM}**	**FA**	**62.0**	180			**56.3**	- 5.2	**No**
		FB	**63.1**	174		**56.2**		-5.4	**Yes**
	N_{SIM}	**NA**	**72.1**	13 46	**70.6** **53.3**			- 4.1	**No**
		NB	**73.7**	12 35	**72.0**	**60.2**		- 4.8	**Yes**
C13_4CR laden Gen 3	**F_{SIM}**	**FA**	**62.0**	180			**56.3**	- 5.2	**No**
		FB	**63.1**	174		**56.2**		- 5.4	**Yes**
	N_{SIM}	**NA**	**72.1**	12 48	**70.6** **53.1**			- 4.0	**No**
		NB	**73.7**	12 38	**72.0**	**58.4**		- 4.8	**Yes**

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EBS-System : **EB+**
Manufacturer : **Haldex**

Full trailer **F 1 3 . 1**									
Test code	**System OFF =F ON = N**	**Test refer.**	**v_0 km/h**	**GPS** [°]**	**v_{In_S} v_{In_E} km/h**	**v_{TD} km/h**	**v_E km/h**	**ay_{max} m/s²**	**TD**
F13_3FC laden Gen 2	**F_{SIM}**	**FA**	**58.9**	180			**55.3**	- 5.3	**No**
		FB	**59.9**	172		**55.1**		- 5.6	**Yes**
	N_{SIM}	**NA**	**71.1**	12 59	**69.6** **51.8**			- 3.9	**No**
		NB	**72.4**	11 36	**70.8**	**62.0**		- 4.9	**Yes**
F13_3FC laden Gen 3 24 V	**F_{SIM}**	**FA**	**58.9**	180			**55.3**	- 5.3	**No**
		FB	**59.9**	171		**55.1**		- 5.6	**Yes**
	N_{SIM}	**NA**	**71.1**	11 59	**69.6** **51.3**			- 3.9	**No**
		NB	**72.4**	11 37	**70.8**	**61.6**		- 4.9	**Yes**
ditto 12 V	**N_{SIM}**	**NA**	**71.1**	11 58	**69.6** **51.3**			- 3.9	**No**
		NB	**72.3**	11 36	**70.8**	**61.7**		- 4.9	**Yes**

1.5.1 Conclusion (Comparative test results)

The simulated tests with a semi, a centre-axle and a full trailer show that the performance of the RoC function is not unduly affected either by the modifications of EB+ Gen 3 or by a reduced supply voltage of 12 V.

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 10: Circle Test (constant Radius) "CR"

1. Circle Test (constant Radius)

1.1 Test results ".2"

CR			System disabled [OFF]		System enabled [ON]		
Trailer S13.2	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[g]	[km/h]	[g]	[km/h]	[kPa]
S13_2C laden	2S/2M_C	Clockw.	-0,47	33,0	-0,39	30,6	520
		A-Clockw.	0,50	31,4	0,40	28,7	650
S13_2C unladen	2S/2M_C	Clockw.	-0,62	39,2	- 0,47	36,4	380
		A-Clockw.	0,67	35,2	0,51	34,7	410
S13_2C remote laden	2S/2M_C	Clockw.	-0,47	33,0	- 0,43	31,3	650
		A-Clockw.	0,50	31,4	0,44	29,6	640
S13_2C remote unladen	2S/2M_C	Clockw.	-0,62	39,2	-0,48	36,2	390
		A-Clockw.	0,67	35,2	0,55	34,2	420

EBS-System : **EB+**
Manufacturer : **Haldex**

CR			System disabled [OFF]		System enabled [ON]		
Trailer S12.2	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
S12_2F laden	2S/2M_F	Clockw.	- 0,52	35,8	- 0,43	34,1	630
		A-Clockw.	0,57	33,3	0,49	32,0	620
S12_2F unladen	2S/2M_F	Clockw.	- 0,62	39,2	- 0,54	37,6	505
		A-Clockw.	0,62	35,9	0,48	33,3	490
S12_4FR laden	4S/2M_FR	Clockw.	- 0,51	36,7	- 0,45	34,1	620
		A-Clockw.	0,57	33,3	0,48	31,3	640
S12_4FR unladen	4S/2M_FR	Clockw.	- 0,64	39,2	- 0,51	37,1	480
		A-Clockw.	0,66	35,9	0,52	34,4	496

1.1 Test results ".0"

CR			System disabled [OFF]		System enabled [ON]		
Trailer S13	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
S13_2C laden	2S/2M_C	Clockw.	-5.49	32.20	-4.70	31.60	480
		A-Clockw.	4.90	35.71	4.00	35.34	470
S13_2C laden_SIM	2S/2M_C	Clockw.	-4.98	33.50	-4.33	31.63	470
		A-Clockw.	4.94	33.19	4.18	30.81	480

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EBS-System : **EB+**
Manufacturer : **Haldex**

CR			System disabled [OFF]		System enabled [ON]		
Trailer S13	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
S13_2C unladen	2S/2M_C	Clockw.	-6.18	[38.13] *	*	*	*
		A-Clockw.	5.10	[42.84] *	*	*	*
S13_2C unlad_SIM	2S/2M_C	Clockw.	*	*	*	*	*
		A-Clockw.	*	*	*	*	*
S13_1CS laden	2S/2M_C with SLV on 3rd axle	Clockw.	-5.39	33.82	-3.92	30.02	460
		A-Clockw.	5.29	35.31	4.02	33.19	480
S13_1SC laden	2S/2M_C with SLV on 1st axle	Clockw.	-5.39	33.47	-4.31	31.28	470
		A-Clockw.	5.19	36.08	4.02	34.06	480
S13_4CR laden	4S/2M_CR	Clockw.	-5.29	32.82	-4.21	30.47	450
		A-Clockw.	5.19	34.78	4.41	33.94	470
S13_3FC laden	4S/3M_FC with SL control on front axle	Clockw.	-5.19	33.24	-3.92	30.13	460
		A-Clockw.	5.39	35.25	4.31	33.95	470
S13_3FR laden	4S/3M_FR with SL control on front axle	Clockw.	-5.19	33.10	-3.62	29.44	440
		A-Clockw.	5.29	35.24	3.82	32.41	450
S13_6FR laden	4S/3M_FR with SL control on rear axle	Clockw.	-5.59	33.41	-4.90	32.52	470
		A-Clockw.	4.90	36.10	3.92	33.97	460
S13_6CR laden	4S/3M_CR with SL control on rear axle	Clockw.	-5.39	32.98	-4.31	30.06	460
		A-Clockw.	4.80	36.90	4.02	34.67	460

EBS-System : **EB+**
Manufacturer : **Haldex**

* In the unladen condition the centre of gravity was very low, and the roll-over speed was above that capable of being achieved without loss of motor vehicle traction. Larger radii were attempted, but this in turn raises the roll-over speed even higher and the tyres began to overheat. The highest speed achieved before loss of traction on the real vehicle tests is recorded in square brackets []. It was also not possible to roll these vehicles in the simulation.

EBS-System : **EB+**
Manufacturer : **Haldex**

			System disabled [OFF]		System enabled [ON]		
Trailer S 1 2	Config. & sensor ocation	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
S12_2F laden	2S/2M_F	Clockw.	-5.98	35.39	-5.39	34.11	470
		A-Clockw.	5.39	38.39	4.51	37.47	470
S12_2R laden	2S/2M_R	Clockw.	-5.88	35.56	-4.80	32.06	480
		A-Clockw.	5.29	37.73	4.21	36.73	480
S12_2R laden_SIM	2S/2M_R	Clockw.	-5.91	36.84	-4.73	33.62	440
		A-Clockw.	5.90	36.73	4.63	33.25	440
S12_2R unladen	2S/2M_R	Clockw.	-6.37	[39.17] *	*	*	*
		A-Clockw.	5.59	[42.30] *	*	*	*
S12_2R unlad_SIM	2S/2M_R	Clockw.	*	*	*	*	*
		A-Clockw.	*	*	*	*	*
S12_1FS laden	2S/2M_F with SLV on rear axle	Clockw.	-5.78	34.43	-5.00	33.61	480
		A-Clockw.	5.29	37.47	4.41	36.94	480
S12_4FR laden	4S/2M_FR	Clockw.	-5.98	34.82	-5.10	33.52	470
		A-Clockw.	5.39	38.04	4.51	37.00	490
S12_3FR laden	4S/3M_FR with SL control on front axle	Clockw.	-5.88	34.97	-4.90	32.09	480
		A-Clockw.	5.39	38.89	4.12	36.89	480
S12_6FR laden	4S/3M_FR with SL control on rear axle	Clockw.	-5.98	34.87	-5.19	33.69	470
		A-Clockw.	5.29	38.47	4.51	37.34	470

EBS-System : **EB+**
Manufacturer : **Haldex**

* In the unladen condition the centre of gravity was very low, and the roll-over speed was above that capable of being achieved without loss of motor vehicle traction. Larger radii were attempted, but this in turn raises the roll-over speed even higher and the tyres began to overheat. The highest speed achieved before loss of traction on the real vehicle tests is recorded in square brackets []. It was also not possible to roll these vehicles in the simulation.

			System disabled [OFF]		System enabled [ON]		
Trailer S 1 1	Config.	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
			[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
S11_2F laden	2S/2M	Clockw.	-7.55	38.90	-6.57	34.32	520
		A-Clockw.	6.37	40.28	5.49	39.87	530
S11_2F laden_SIM	2S/2M	Clockw.	-7.67	39.25	-5.61	36.47	510
		A-Clockw.	6.90	39.32	5.22	35.65	520

			System disabled [OFF]		System enabled [ON]		
Trailer F 1 3	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
F13_3FC laden	4S/3M_FC	Clockw.	-5.88	31.98	-4.41	31.00	610
		A-Clockw.	5.59	35.91	4.80	35.65	670
F13_3FC laden_SIM	4S/3M_FC	Clockw.	-5.41	33.36	-4.88	32.43	550
		A-Clockw.	5.56	33.93	4.80	32.18	610
F13_3FC unladen	4S/3M_FC	Clockw.	-5.68	[34.89]*	*	*	*
		A-Clockw.	4.90	[38.87]*	*	*	*

EBS-System : **EB+**
Manufacturer : **Haldex**

			System disabled [OFF]		System enabled [ON]		
Trailer F 1 3	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
F13_3FC unlad_SIM	4S/3M_FC	Clockw.	-5.40	*	*	*	*
		A-Clockw.	5.40	*	*	*	*
F13_3FR laden	4S/3M_FR	Clockw.	-5.53	32.17	-4.70	30.87	610
		A-Clockw.	5.59	35.76	4.86	35.36	660

* In the unladen condition the centre of gravity was very low, and the roll-over speed was above that capable of being achieved without loss of motor vehicle traction. Larger radii were attempted, but this in turn raises the roll-over speed even higher and the tyres began to overheat. The highest speed achieved before loss of traction on the real vehicle tests is recorded in square brackets []. It was also not possible to roll these vehicles in the simulation.

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			System disabled [OFF]		System enabled [ON]		
Trailer F 1 2	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
F12_3FR laden	4S/3M_FC	Clockw.	-5.98	33.37	-5.16	32.73	620
		A-Clockw.	5.97	36.69	5.00	36.17	660
F12_3FR laden_SIM	4S/3M_FC	Clockw.	-5.66	34.62	-4.93	33.76	520
		A-Clockw.	5.36	34.50	4.89	33.56	530
F12_3FR	4S/3M_FC	Clockw.	-5.10	[38.03]*	*	*	*

EBS-System : **EB+**
Manufacturer : **Haldex**

			System disabled [OFF]		System enabled [ON]		
Trailer F 1 2	Config. & sensor location	Direction of travel	ay_{max}	v_{TD}	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[m/s²]	[km/h]	[kPa]
unladen		A-Clockw.	5.88	[35.16]*	*	*	*
F12_3FR unlad_SIM	4S/3M_FR	Clockw.	-5.40	*	*	*	*
		A-Clockw.	5.40	*	*	*	*

* In the unladen condition the centre of gravity was very low, and the roll-over speed was above that capable of being achieved without loss of motor vehicle traction. Larger radii were attempted, but this in turn raises the roll-over speed even higher and the tyres began to overheat. The highest speed achieved before loss of traction on the real vehicle tests is recorded in square brackets []. It was also not possible to roll these vehicles in the simulation.

1.2 Conclusion

The circle test shows the ability of the RoC to adapt to steadily increasing lateral acceleration (and hence decreasing roll stability) due to increasing speed with constant radius, and to intervene with automatically commanded braking in a timely manner.

The vehicle tests and simulated tests both show that the EB⁺ RoC intervenes at a lower speed than the speed at which a touch-down occurs with the system off.

In the unladen cases it was not possible to roll the real test vehicles (within the limits of traction available), but this was also confirmed with the simulator.

EBS-System : **EB+**
Manufacturer : **Haldex**

Annex 11: Double Lane Change Test "DLC"

1. Double Lane Change Test

1.1 Test results

1.1.1 Test results Double Lane Change Test "Z" (ISO standard 3888-1:2002)

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max}* m/s²	TD
S 1 3 S13_2C laden	F	F1	45.3	-		41.7	-5.4	no
		F2	46.3	-	45.14		-6.5	yes
	N	N1	57.15	55.01		32.7	-4.5	no
		N2	59.1	57.51	50.42		4.6	yes
	F_{SIM}	FA	50.0	-		45.5	-4.8	no
		FB	51.0	-	45.94		-5.1	yes
	N_{SIM}	NA	57.0	55.91		50.2	4.8	no
		NB	57.9	56.91	51.92		5.4	yes
S 1 2 S12_2F laden	F	F1	50.0			53.6	-5.9	no
		F2	50.6		48.94		-6.9	yes
	N	N1	59.7	58.81		42.7	-5.1	no
		N2	60.7	59.21	53.22		-5.4	yes

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EBS-System : **EB+**
Manufacturer : **Haldex**

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max}* m/s²	TD
F 1 3	**F**	**F1**	**41.2**			**40.3**	-4.9	**no**
		F2	**42.4**				5.6	**yes**
F13_3FC laden	**N**	**N1**	**46.6**	**46.0 1**	**39.6 2**	**29.4**	-5.4	**no**
		N2	**47.8**	**46.7 1**	**39.6 2**		6.37	**yes**
F 1 2	**F**	**F1**	**43.3**	**-**		**41.3**	-4.9	**no**
		F2	**44.9**	**-**	**41.1 4**	**-**	-6.4	**yes**
F12_3FR laden	**N**	**N1**	**50.6**	**50.2 1**		**34.0**	5.6	**no**
		N2	**51.4**	**50.3 1**	**45.4 2**	**-**	8.6	**yes**

* The maximum lateral acceleration recorded is during the whole manoeuvre and not specifically related to a zone or event. For this reason either positive or negative acceleration may be recorded.

EBS-System : **EB+**
Manufacturer : **Haldex**

1.1.2 Test results Double Lane Change Test "D" (Haldex specification)

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max}* m/s²	TD
S 1 3	**F**	**F1**	**63.3**			**55.6**	-4,9	**no**
		F2	**63.3**		**58.92**		4.7	**yes**
S13_2C laden	**N**	**N1**	**68,6**	**64.82**		**40.6**	4.6	**no**
		N2	**68.7**	**66.41**	**58.92**		6.3	**yes**
	F_{SIM}	**FA**	**63.0**			**55.9**	4.7	**no**
		FB	**64.0**		**57.53**		5.1	**yes**
	N_{SIM}	**NA**	**61.2**	**57.12**		**44.7**	4.6	**no**
		NB	**62.2**	**58.12**	**52.73**		4.8	**yes**
S 1 2	**F**	**F1**	**64.0**	**-**		**56.6**	-4.5	**no**
		F2	**65.3**	**-**	**60.82**		5.6	**yes**
S12_2F laden	**N**	**N1**	**69.5**	**67.61**		**41.0**	4.7	**no**
		N2	**70.4**	**68.81**	**61.02**		5.7	**yes**
F 1 3	**F**	**F1**	**50.7**	**-**		**45.7**	5.4	**no**
		F2	**53.5**	**-**			-5.6	**yes**
F13_3FC laden	**N**	**N1**	**58.2**	**56.61**	**-**	**29.4**	5.1	**no**
		N2	**59.4**	**58.01**	**49.42**		6.4	**yes**

EBS-System : **EB+**
Manufacturer : **Haldex**

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max}* m/s²	TD
F 1 2 **F12_3FR laden**	F	F1	54.8	-	-	47.7	5.1	no
		F2	55.7	-	51.6 2	-	6.9	yes
	N	N1	61.7	60.0 1	-	39.2	6.6	no
		N2	63.2	61.0 1	54.7 2	-	8.3	yes

* The maximum lateral acceleration recorded is during the whole manoeuvre and not specifically related to a zone or event. For this reason either positive or negative acceleration may be recorded.

1.2 Conclusion

The lane change tests show the ability of the RoC to react quickly to rapidly increasing lateral acceleration (and hence decreasing roll stability) due to sudden, high-frequency steering inputs. This test is representative of an avoidance manoeuvre.

The vehicle tests and simulated tests both show that the EB+ RoC intervenes to improve the roll stability of the combination in an appropriate manner with all EBS and vehicle configurations tested. The highest entrance speed, v_0, without a touch-down, was higher with the system on than with the system off ($v_{0\,ON} > v_{0\,OFF}$).

Annex 12: Additional Assessment with respect to Dolly Application

1. Description of the application

The simulated test results for the increasing curvature manoeuvre in Annex 9 include a special 2S/2M control mode, known by the manufacturer as 'DAR' or 'Dolly Axle Regulation'. This control mode is valid for stand-alone approval of a two-axle centre-axle trailer that may be used as a dolly for converting a semi-trailer into a full trailer.

This control mode uses a different strategy to the standard EB+ 2S/2M roll-over control, in order to substantially limit the brake torque steer that could otherwise cause directional instability. This strategy is further described in paragraph 2.2.4 of the manufacturer's information document, ID_GS0471.

2. Additional confirmation tests

It was deemed appropriate to utilise the full trailer F12 for additional vehicle tests to confirm the operating function of 'DAR'. 2S/2M 'DAR' was installed to the single front axle, which in theory will be more prone to brake torque steer than a two-axle dolly used within a vehicle combination.

No stability control was fitted to the rear axle, and hence there was no braking on the rear axle during the tests. Any braking taking place independently on the rear axle would help to counteract the effect of any torque steer at the front and also improve the roll-over control performance by increasing the overall retardation.

Since trailer F12 was also used for roll-over control tests in the normal 4S/3M full trailer configuration, it is possible to directly compare these results with 'DAR'.

No directional instability was observed during any of the roll-over tests, including the system on touch-down tests N2 tabulated below.

The results for the **circle test (constant radius)** show that the system detects impending roll-over and makes a brake intervention at the same speeds as with the normal 4S/3M full trailer system, indicating that the relocation of the lateral accelerometer to the front axle does not affect roll detection with the wheelbase tested.

The results for the **increasing curvature test** are similar to those for the normal 4S/3M full trailer system. This is by virtue of longer controlled brake interventions (see GPS heading, prolonged brake interventions from "10" to "113" for test N1 and "9" to "155" for test N2) and braking at least partially on both front wheels, despite the actual brake pressures being considerably lower than the standard system and despite there not being any braking on the rear axle. It is expected that overall roll-over control performance would be reduced in cases where a greater share of the load is carried by the rear bogie, unless there is also a stability system on that bogie.

EBS-System : **EB+**
Manufacturer : **Haldex**

The results for the **double lane change tests** show a lower performance level than for the normal 4S/3M full trailer system, and this is due to the inability to use high brake pressures on the front axle alone in response to high frequency steering inputs. Nevertheless, a useful roll stabilisation benefit is demonstrable. Again, an independent stability system on the rear bogie would improve the overall performance.

It is considered that the control mode 'DAR' is appropriate for the dolly axle application.

2.1 Test results

2.1.1 Circle (Constant Radius)

			System enabled [ON]		
Trailer F 1 2	Config. & sensor location	Direction of travel	ay_{max}	v_{BA}	p_{BA}
	F = front axle C = centre axle R = rear axle		[m/s²]	[km/h]	[kPa]
F12_2FD laden 'DAR'	2S/2M_F	Clockw.	-5.39	31.50	~170
		A-Clockw.	5.29	35.84	~170

2.1.2 Increasing Curvature

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	GPS * [°]	v_{In_S} v_{In_E} km/h	v_{TD} km/h	v_E km/h	ay_{max} m/s²	TD
F12_2FD laden 'DAR'	**F**	**F1**	***60.2***	*180*			***58.5***	*-5.7*	**no**
		F2	***61.3***	*134*		***58.5***		*-6.3*	**yes**
	N	**N1**	**68.6**	10 113	**66.8** **53.6**			-5.7	**no**
		N2	**70.1**	9 155	**67.3**	**54.9**		-6.4	**yes**

* GPS heading refers to the corresponding recorded speeds (v_{In}, v_{TD}, v_E)

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EBS-System : **EB+**
Manufacturer : **Haldex**

2.1.3 Double Lane Change Test "Z" (ISO standard 3888-1:2002)

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max} m/s²	TD
F12_2FD 'DAR' Laden	F	F1	*43.3*	-		*41.3*	*-4.9*	no
		F2	*44.9*	-	*41.14*	-	*-6.4*	yes
	N	N1	46.8	45.92		41.1	7.4	no
		N2	47.7	46.72	42.94		-7.4	yes

2.1.4 Double Lane Change Test "D" (Haldex specification)

Test code	System OFF =F ON = N	Test refer.	v_0 km/h	v_{In} km/h in Zone	v_{TD} km/h in Zone	v_E km/h	ay_{max} m/s²	TD
F12_2FD 'DAR' laden	F	F1	*54.8*	-	-	*47.7*	*5.1*	no
		F2	*55.7*	-	*51.62*	-	*6.9*	yes
	N	N1	59.5	57.51		42.4	6.9	no
		N2	60.5	59.31	55.62	-	7.6	yes

Trailer Electronic Braking System

'Roll-over Control'

Information Document

System: EB+ Stability

Compiled By:	Approving Specialist:	Chief Engineer:
D J Harrison / J S Crawley	D J Harrison	D J Harrison
3 / 29/01/20 / C7149 C7150	Engineering Manager:	Technical Director:
Issue: / Date: / Ref:	W Storrie	C R Mellings

Trailer Electronic Braking System
Stability System Information Document

1 General

1.1 Name of manufacturer: **HALDEX BRAKE PRODUCTS Ltd.**
MIRA Technology Park
Lindley
Warwickshire
CV13 6DE
United Kingdom

1.2 System name: **EB+ Stability**

1.3 System variants: **EB+ Gen 1**

This is a modular EBS package consisting of one or two modulators and a removable ECU, with optional anti-compounding valve. The system operates from 19 – 32V.

EB+ Gen 2

This is an integrated EBS package consisting of a twin modulator, a non-removable ECU, and spring brake distribution with optional anti-compounding and quick release valves. The system operates from 19 – 32V.

EB+ Gen 3

This is an integrated EBS package substantially similar to Gen 2 in construction and features. The system operates from 8 – 32V.

In this document 'EB+' refers to all variants unless specifically stated otherwise.

1.4 Function: 'Roll-over control' as defined by ECE R13, paragraph 2.34.2.2 and Annex 21 paragraph 2.2.1.

Trailer vehicles are at particular risk of overturning when compared with rigid vehicles due to excessive lateral roll. This is because of their relatively high centre-of-gravity, which when coupled with an excessive speed for a cornering manoeuvre can lead to trailer roll-over. If available tyre-to-road adhesion is low, a trailer will slide before roll-over occurs but if the available tyre-to-road adhesion is high, trailer roll-over may occur.

1.5 Configurations: 2S/2M*, 2S/2M SL*, 2S/2M DAR, 4S/2M SxS* and 4S/3M

* = Integrated and non-integrated versions available with EB+ Gen 1

_S = Number of sensors (directly controlled wheels)

_M = Number of pressure modulators

SL = Using select low (inverse) double check valve

DAR = Dolly Axle Regulation

SxS = Side by side (control configuration)

1.5.1 'Inloader' configurations: 2S/2M Relay and 4S/2M Relay

'Inloader' configurations are special configurations for trailers such as sheet glass carriers, where it is impossible to install the master EBS close to the wheels. The master EBS is instead installed close to the king pin, with long pipes to the wheels on each side of the trailer and relay valves close to the actuators to improve response time.

1.6 System identification: When the EB+ braking system is installed with the roll-over function the word "Stability" is printed on the load plate (an example is shown in Appendix 4)

1.7 References to ABS and EBS Information Documents:

References in this Stability System Information Document to the manufacturer's 'EBS Information Document' refer to the following document as applicable: -

EB+ Gen 1 / 2 / 3: GS 0441 (Issue 5) which is part of the TÜV Nord report EB 128.11E.

References in this Stability System Information Document to the manufacturer's 'EBS Information Document' refer to the following document as applicable: -

EB+ Gen 1 / 2 / 3: GS 0440 (Issue 5) which is part of the TÜV Nord report EB 132.11E.

2. Applications

2.1 List of trailer types and configurations for which approval is sought

The EB$^+$ system has been designed for use on full, semi and centre-axle trailers. The following table illustrates the relationship between trailer type, number of axles and anti-lock configuration. Although outside the scope of ECE R13 Annex 19, it is possible to install the system on trailers with more than three axles.

Trailer Type	Number of Axles	Anti-lock System Configuration				
		2S / 2M	2S / 2M SL	2S / 2M DAR*	4S / 2M S x S	4S / 3M
Semi-trailer	1	✓				
	2	✓	✓	✓**	✓	✓
	3	✓	✓		✓	✓
Centre Axle Trailer	1	✓				
	2	✓	✓	✓	✓	✓
	3	✓	✓		✓	✓
Full Trailer	2					✓
	3					✓
	3					✓

Trailer Type	Number of Axles	Anti-lock System Configuration for 'Inloader' Trailers (with Air Suspension Only)	
		2S / 2M Relay	4S / 2M Relay
Semi-trailer	2	✓	✓
	3	✓	

*not applicable to EB+ Gen 1 **alternative to 2S/2M SL

2.2 Schematic diagrams of the respective configurations

Schematic diagrams of the respective ABS configurations installed on the trailers defined in 2.1 above, with consideration given to lift and steer axles, are shown in Appendix 1.

2.2.1 Lift Axles

The EB$^+$ system is suitable for use with lift axles with the following constraints.

Any un-sensed axle may be lifted regardless of system configuration and method of lift control. Up to two axles may be lifted independently using the EB+ auxiliary features.

On semi-trailers, using 2S configurations, sensed axles may not be lifted. On full trailers, no sensed axles may be lifted. In 4S side-by-side configurations either (but only one at any time) sensed axle may be lifted.

The lifting device (e.g. ILAS-E) must be under the control of the EB+ system if the axle is to be lifted or lowered while the vehicle is in motion. This may be by the use of a CAN command according to ISO 11992 RGE 11, or by a manual switch input or according to pre-set suspension pressures. It is also possible to request a lifting action as may be required for traction support; in this case, an over-load is permitted until a speed threshold is exceeded in accordance with EC97/27.

If the lifting device is not under control of the EB+ system, then any lifting or lowering of sensed axles must be completed with the vehicle at rest.

2.2.2 Steering Axles

Any axle designated as either forced or self-steering may be directly or indirectly controlled from any configuration of anti-lock system.

To provide additional stability to a self-steering axle on a semi-trailer or centre-axle trailer then the following solutions are recommended –

1) A 4S/3M system with the slave valve controlling the steering axle as select low.
2) A solenoid-controlled axle steering lock programmed to lock with speed. This can be controlled by the EB+ system and used with any anti-lock configuration.
3) A select low (inverse double check) valve may be used for the steering axle with 2S/2M configurations (2S/2M SL).

2.2.3 Anti-lock braking configurations

The schematic diagrams of the ABS configurations (mentioned in paragraph 2.2 above) define the location of sensors and modulators for the various anti-lock configurations with respect to a trailer of a given type and number of axles including steering and lift axles.

2.2.4 Dolly Axles

The system configuration ‘2S/2M DAR’ (Dolly Axle Regulation) is designed primarily for use on dollies intended to convert semi-trailers into full trailers, but which may be approved as stand-alone centre-axle trailers. The system limits both the absolute brake pressure and relative pressure left/right that is used for roll-over control, thereby eliminating the risk of unintentionally inducing a directional instability when used in the dolly application. The system will function independently and does not need or hinder any stability control system on the attached semi-trailer. Due to the lower-level, gradual braking used when compared to the standard system, the roll stability benefit is mainly apparent in constant radius, increasing speed or constant speed, reducing radius situations such as motorway exits and roundabouts. For

potential roll situations caused by high frequency steering inputs, e.g. lane change at speed, more benefit will be obtained by having a roll-over control system on the attached semi-trailer as well.

The configuration '2S/2M DAR' provides the optimum roll stability package for an independent dolly system, within the physical limits of the application.

The configuration '2S/2M DAR' is only available with EB+ Gen 2 software versions with a 'D' prefix, and when specifically activated at end-of-line. If the configuration '2S/2M DAR' is not available, then roll-over control should not be installed on a stand-alone dolly.

2.3 Scope of application with respect to suspension type:

Air suspension:	Any type of balanced "trailing arm" air suspension.
Other suspensions:	See manufacturer's ABS Information Document. NOTE: Where mechanical spring deflection sensing is installed a minimum vertical deflection between laden and unladen states of 10mm is required.

2.4 Additional information

2.4.1 Main Features

The EB+ Stability system is a trailer roll stability function for semi-trailers, centre axle and full trailers. It is an optional function of the EB+ Trailer EBS using a lateral accelerometer connected to the EB+ and software internal to the EB+. The system may use either an internal mounted accelerometer or an external mounted accelerometer (connected to Aux 5 channel of EB+). The microprocessor receives the data from either device via its analogue-to-digital converter. See Appendix 2 for electrical connections.

The system is compatible with either an electronically and pneumatically signalled or only pneumatically signalled towing vehicle.

2.4.2 Description of System Function

When the system detects an imminent possibility of trailer roll-over it attempts to reduce the vehicle speed using the trailer brakes until the possibility of trailer roll-over is sufficiently reduced. This application of the trailer brakes is autonomous and is of the type defined as "Automatically Commanded Braking" in Para. 2.29 of ECE-Regulation 13. It does not attempt to influence any other vehicle systems (e.g. suspension). Detection of an imminent possibility of roll-over uses an adaptive algorithm to accommodate a wide variety of both vehicle types and load conditions. See Appendix 3 for a schematic system of the functional blocks.

Initial activation of the system is controlled by the signal from the lateral accelerometer. If the signal shows a lateral acceleration in excess of a predefined limit in either direction, a brake pressure test pulse regime is instigated on the de-

weighting side [both sides with DAR, see 2.2.4]. The brake pressure test pulse is set just above the threshold of normal braking so as to be sufficient to cause a detectable increase in wheel slip of a wheel that is de-weighting due to roll. The level of this test pulse is based upon the braking parameters entered during parameterisation at vehicle End of Line Test, but with certain dynamic adaptations.

Should the test pulse return a negative result, the threshold of lateral acceleration before further test pulses is increased to a maximum predefined limit. This increased threshold may also be reduced if the lateral acceleration threshold is continuously exceeded. This regime adapts to differing vehicle types and load conditions by modifying the initial lateral acceleration threshold for the onset of the test pulse regime on subsequent events. This modified level is re-initialised upon re-powering or lift axle movements (up or down) or a significant change in load as measured through the suspension transducer. The threshold for left and right side of the vehicle is semi-independent, to allow for unequal loading etc.

Should the test pulse return a positive result, braking action is then initiated automatically on the increasing weight (outer) side [both sides with DAR, see 2.2.4]. In order to reduce vehicle speed quickly this braking is at a high level but is subject to load sensing modification and anti-lock control [more gradual braking is used with DAR, see 2.2.4]. This braking is also proportional to the “excess” level of lateral acceleration over the detection threshold and is maintained until the lateral acceleration returns to a proportion below the threshold level. If the system is re-quired to operate as above, the threshold level for subsequent test pulse operation is reduced.

If the lateral acceleration signal is high enough, for a given load condition, the test pulse phase may be terminated or bypassed and the controlling brake pressure applied immediately.

Note that software versions with prefix ‘B’, ‘D’ and ‘E’ have different test pulse pressure determination and wheel slip detection methods to the earlier ‘B’ prefix software, but in all other respects are as described above.

2.4.3 Limits of Functional Operation

EB+ Stability does not operate below 16 km/h. All other functional limits are defined by the EB+ system.

EB+ Stability meets the same environmental limits applicable to EB+ system with the exception of the internal and external lateral accelerometers that have a reduced operational vibration resistance; 5 - 600Hz and a maximum of 0.4g.

2.4.4 System Safeguards

If during operation of the system a driver commanded brake demand is received, either from the ISO11992 data link or by the operation of the pressure switch and pressure transducer in the pneumatic control transmission then this will be performed without delay. However, the roll stability function will remain active which may result in the actual pressure to a wheel being higher than the driver demanded pressure until the risk of roll is sufficiently reduced.

The integral anti-lock control algorithm may further modify the pressure demanded by the stability algorithm in order to prevent wheel lock-up that may induce trailer swing.

2.4.5 Current operational status of the EB+ Stability System

This can be verified by turning the system off and then on and checking the correct operation of the warning signal. If there is a fault detected with the accelerometer, the EBS / ABS Yellow warning signal will be given. A diagnostic code will also be issued on the diagnostic link.

2.4.6 End-of-Line Programming

The following parameter blocks, normally programmed at end-of-line, are relevant to the roll-over control function.

System Configuration	Informs the system of the vehicle type, wheel-to-modulator relationship, mounting orientation and system logic to employ Example: centre-axle trailer, 2S/2M, modulator 2.1 on the left, DAR logic enabled
Load sensing	Informs the system how to calculate the load condition of the trailer, by giving suspension data for the 0% and 100% load conditions; also sets the brake threshold which is an input parameter for the stability test pulse pressure calculation
Auxiliary	Informs the system whether to use the internal accelerometer, the optional external accelerometer or neither (roll-over control disabled)
Geometric	Informs the system about the type and dimensions of the trailer, number of axles, axle spacing etc. This information is transmitted to the motor vehicle as required by ECE R13 Annex 16

2.4.7 Illumination of Stop Lamps

EB+ sends the 'Stop Lamps Request' in message EBS22 (Byte 4, Bits 5 – 6) to the towing vehicle on ISO11992 during roll-over control brake interventions. EB+ does not send the 'Stop Lamps Request' when it uses stability control test pulses (see ECE R13 Annex 21 paragraph 2.2.4). Note that EB+ does not control the stop lamps directly.

3. Component Description

A list of EB+ part numbers is contained in Appendix 7 of the manufacturer's ABS Information Document.

3.1. Sensor external to the controller

3.1.1 Function:

External Lateral Accelerometer

An external accelerometer, connected to Aux 5, can be used to determine the lateral acceleration of the trailer. This uses a MEMS (Micro-Machined Silicon) sensor responsive to the capacitance change as a proof mass moves between the capacitance plates. It has on-board signal conditioning and provides a ratio-metric output based on a 5V supply. The working range is +/- 1.7g.

The external lateral accelerometer must be rigidly mounted to the trailer chassis, details of the mounting are provided in Appendix 5.

3.1.2 Input / Output variables

The EB+ Stability, in addition to the normal EB+ system incorporates as an extra input variable a lateral accelerometer (internal or external). The working range of the sensor is ± 1.7g. It makes use of other shared inputs of the EB+, notably brake pressure, suspension pressure and wheel speed.

There are no additional output variables required by EB+ Stability.

Only on-board generated data is used by EB+ Stability.

3.1.3 Limitations on the location of the sensors.

Appendix 5 defines the location of the external and internal lateral accelerometer.

3.1.4 Identification

External accelerometer: part number 815 012 001.

Internal accelerometer: see controller part numbers contained in Appendix 7 of the manufacturer's ABS Information Document.

3.2. Controller(s)

3.2.1	General description and function:	See paragraph 2.1.3.2.1 of the manufacturer's ABS Information Document. Internal lateral accelerometer: The accelerometer mounted internally in the ECU provides the same voltage output as the external lateral accelerometer (see paragraph 3.1 above) over the same range. The internal lateral accelerometer is rigidly mounted to the ECU assembly, which is rigidly mounted to the valve assembly. The ECU/valve assembly must be rigidly mounted to the trailer chassis, details of the mounting are provided in Appendix 5.
3.2.2	Identification:	By the part number; see paragraph 3 above
3.2.3	Limitations on the location of the controller(s)	Appendix 5 defines the location of the external and internal lateral accelerometer (which is integrated into the controller).
3.2.4	Additional features	N/A

3.3. Modulators

3.3.1	General description and function:	See paragraph 2.1.3.3.2 of the manufacturer's ABS Information Document.
3.3.2	Identification:	By the part number; see paragraph 3 above
3.3.2	Limitations:	See paragraph 3.3.1 above
3.4.	Electrical Equipment	See paragraph 2.1.3.4 of the manufacturer's ABS Information Document.
3.4.1	Circuit diagrams:	See Appendix 2
3.4.2	Powering methods:	Permanent via the connector according to ISO7638 (7-pin or 5-pin)

3.5. Pneumatic circuits

3.5.1 System schematics (including anti-lock braking)

See system schematics of 2M and 3M systems contained in Appendix 12 of the manufacturer's ABS Information Document.

3.6 Safety aspects of the electronic system in accordance with Annex 18 of ECE-13

See paragraph 5 of the manufacturer's EBS Information Document.

3.7. Electro Magnetic Compatibility

3.7.1. Documentation demonstrating compliance with Regulation No. 10

To fulfil the prescribed legal requirements regarding EMC (paragraph 5.1.1.4 of ECE Regulation No. 13), the electronics are certified according to ECE Regulation 10. The following approval numbers have been assigned:

Component / System	ECE Approval
EB+ Gen 3	E11 - 10R-057673 Ext. 5
EB+ Gen 2 (2M)	E11 - 10R-033942 Ext. 6
EB+ Gen 2 (3M) **	E11 - 10R-033825 Ext. 4
EB+ Gen 1 (1M/2M)	E11 - 10R-033807 Ext. 4
EB+ Gen 1 (3M) **	E11 - 10R-033825 Ext. 4
EB+ CAN Hub	E11 - 10R-0511053
Pressure sensor	E11 - 10R-034038 Ext. 3
Height Sensor	E1 - 10R-055852 Ext.1

** These products are covered by the same EMC approval

Appendix 6 contains copies of the above-mentioned EMC approvals (including the list of variants covered by these approvals).

4 Appendices

Appendix 1: System Configurations

Appendix 2: Wiring Diagram

Appendix 3: Function Blocks

Appendix 4: Stability Identification on Load Plate

Appendix 5: Valve/ECU assembly mounting with either internal or external lateral accelerometer

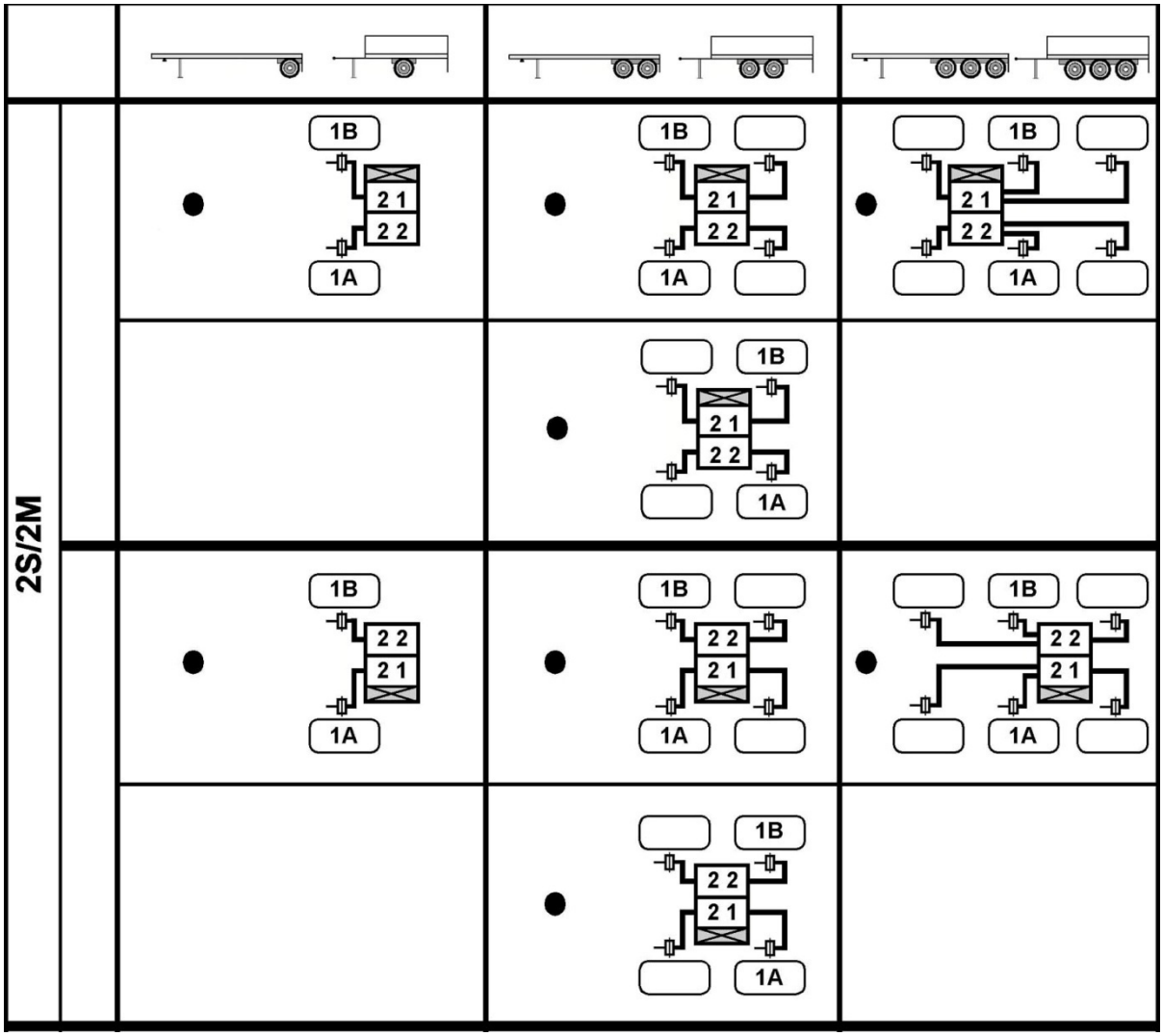
Appendix 6: EMC Approval Certificates

Revision History:

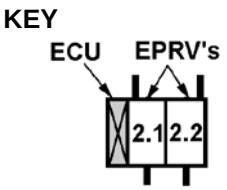
Issue:	Ref:	Date:	Revision
3	C7149 C7150	29/01/20	Addition of CAN Hub Addition of Inloader
2	C6240	19/07/12	Introduction of Gen 3
1	PR2029	06/10/09	New document replaces GS0333

EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers

Integrated Side By Side (SxS)

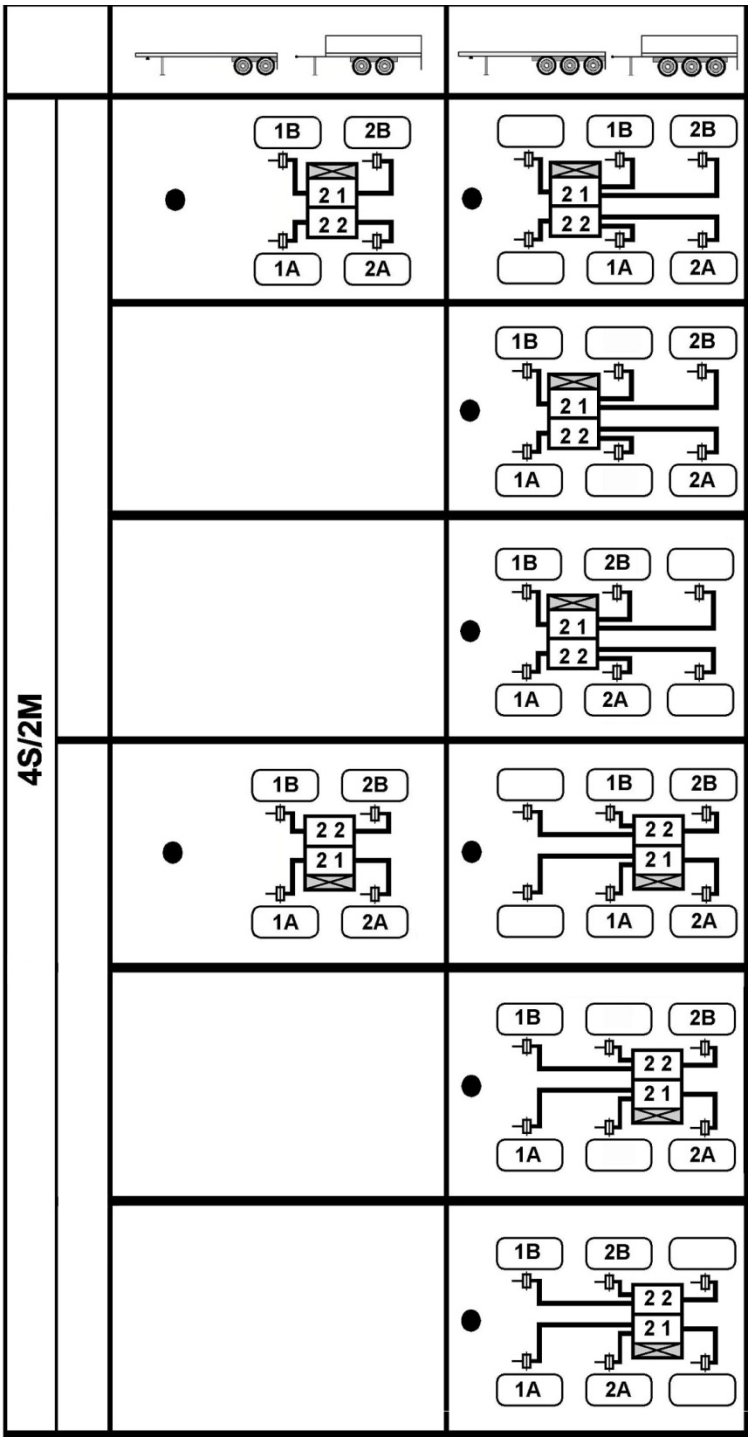


Any axle without directly controlled wheels may be a lifted
Any axle may be a steered axle



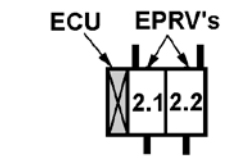
EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers

Integrated Side By Side (SxS)



Either axle (but only one at a time) directly controlled axle may be a lift axle
Any axle may be a steered axle

KEY



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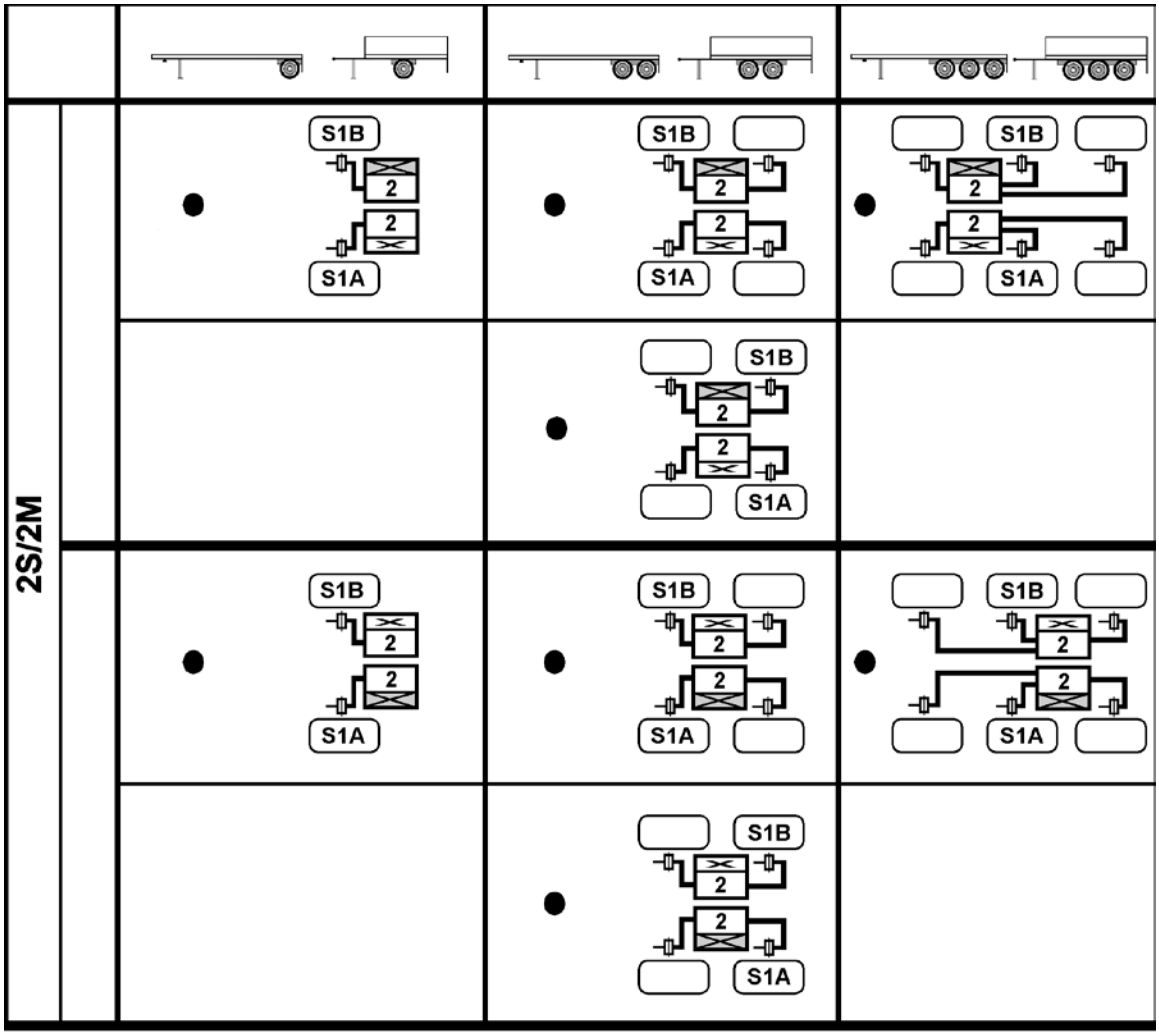
EB+ Gen 1 Installation Options - Semi & Centre Axle Trailers

Non-Integrated Side By Side (SxS)



N1 – All sensors must be connected to Master ECU.

KEY

EPRV's

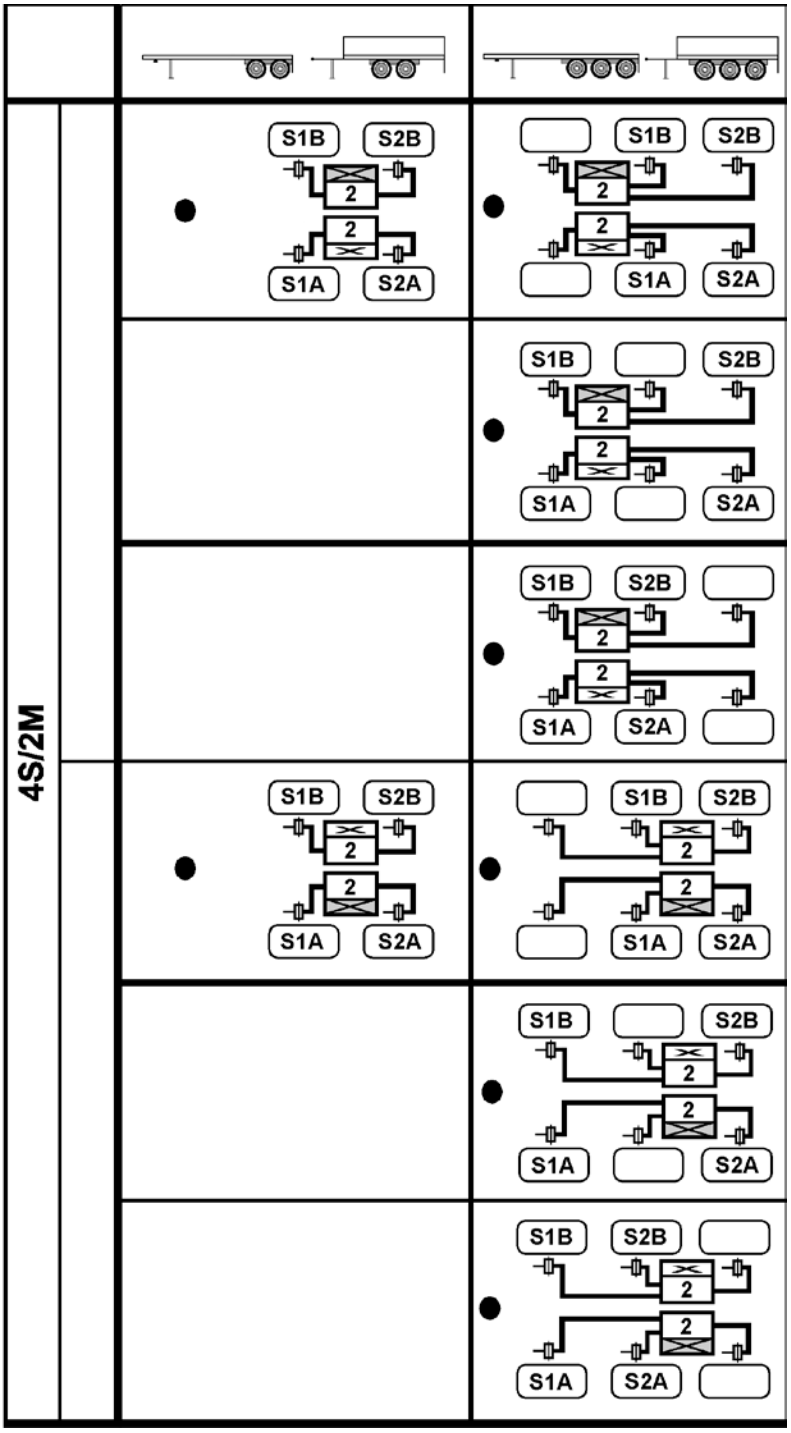
Master ECU

Slave ECU

EPRV

EB+ Gen 1 Installation Options - Semi & Centre Axle Trailers

Non-Integrated Side By Side (SxS)

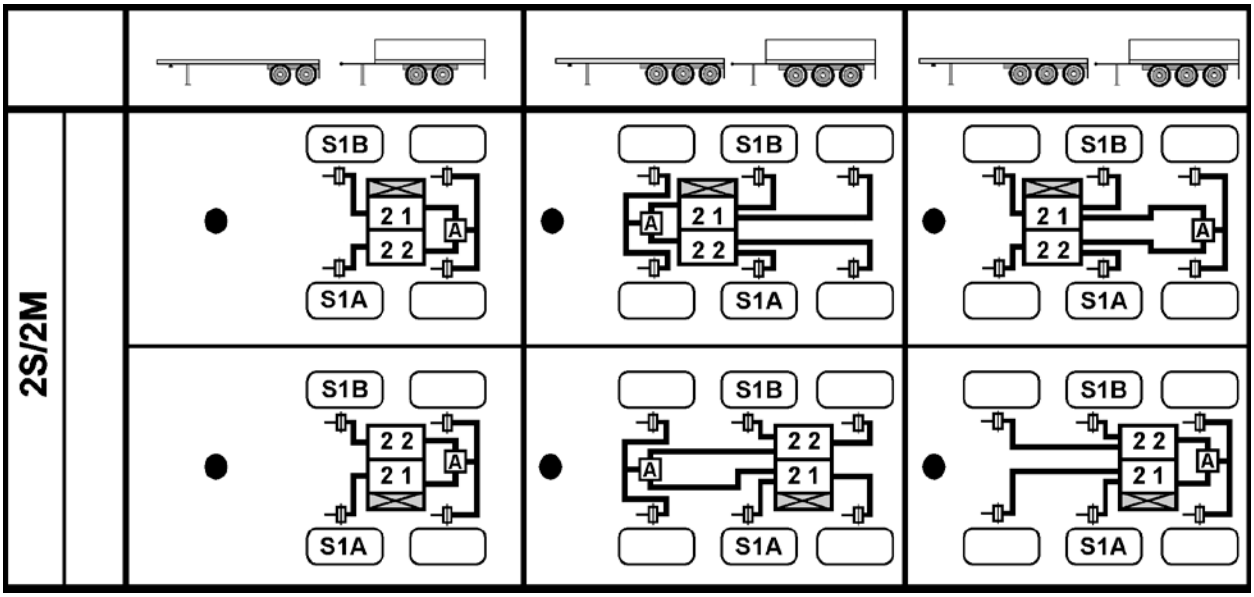


KEY

N1 – All sensors must be connected to Master ECU.

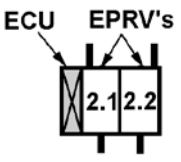
EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers

Side by Side (SxS) 2S/2M + Select low valve



Any axle without directly controlled wheels may be a lift axle

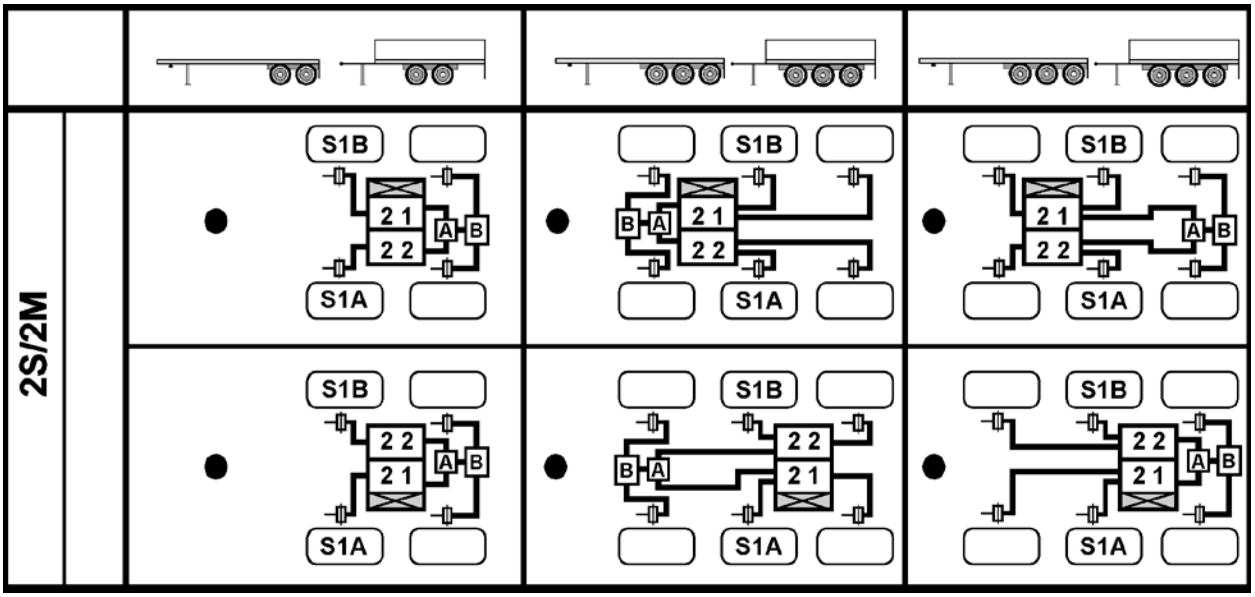
KEY



A = Select Low Valve

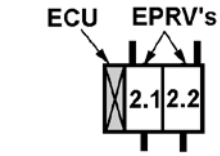
EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers

Side by Side (SxS) 2S/2M + Select low valve + Relay Valve



Any axle without directly controlled wheels may be a lift axle

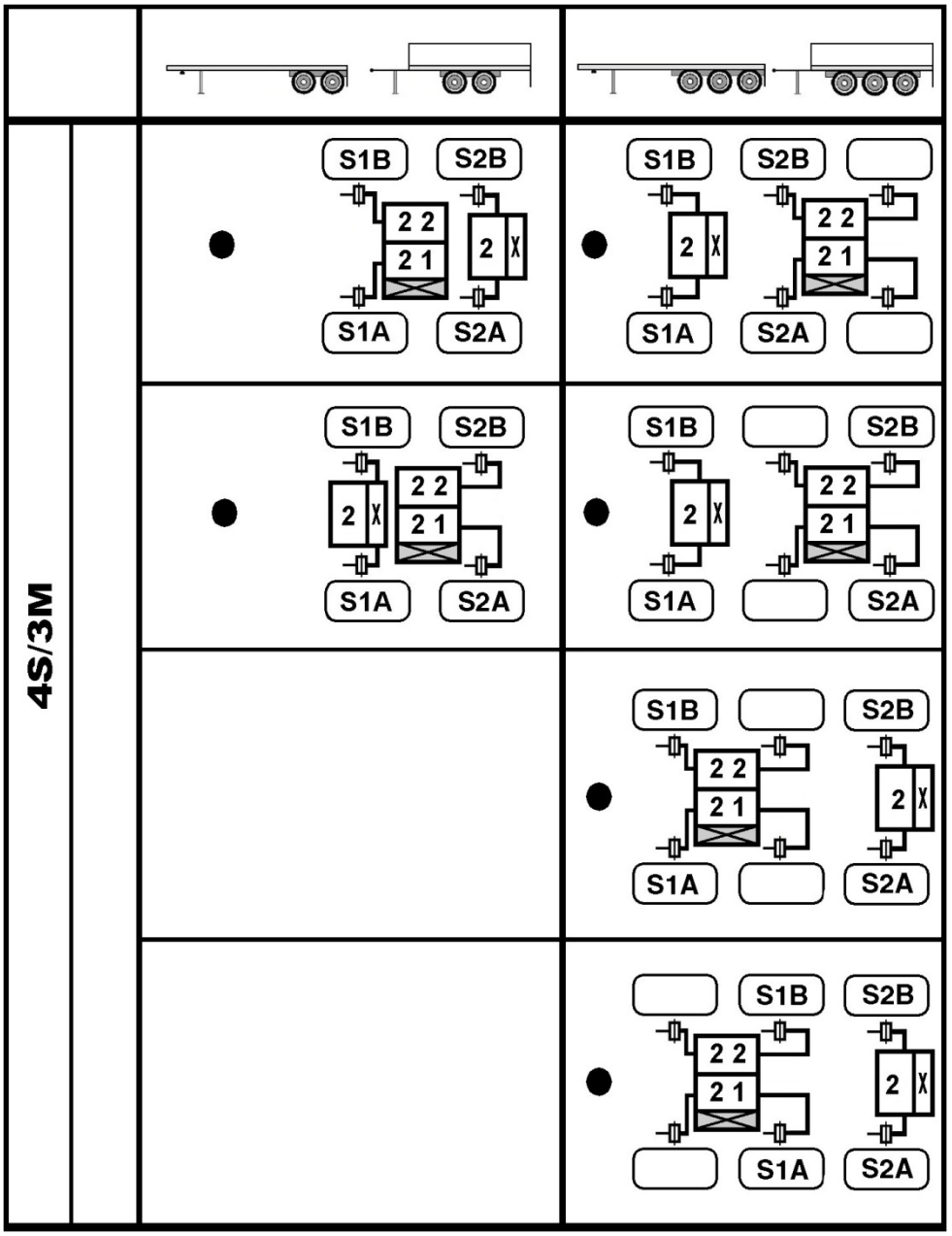
KEY



A = Select Low Valve

B = Relay Valve

EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers



N1 – Master ECU is mounted to EPRV's 21/22. All sensors must be connected to this Master ECU.

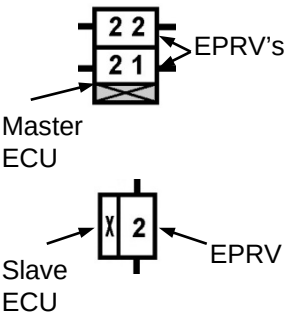
N2 – Directly controlled wheels connected pneumatically to EPRV's 21/22 cannot be lifted.

N3 – Slave ECU is mounted to EPRV 2 and is controlled by Master ECU.
Slave ECU/EPRV 2 is shown facing rear but can also be installed facing forward, left or right, as EPRV 2 is always select low control.

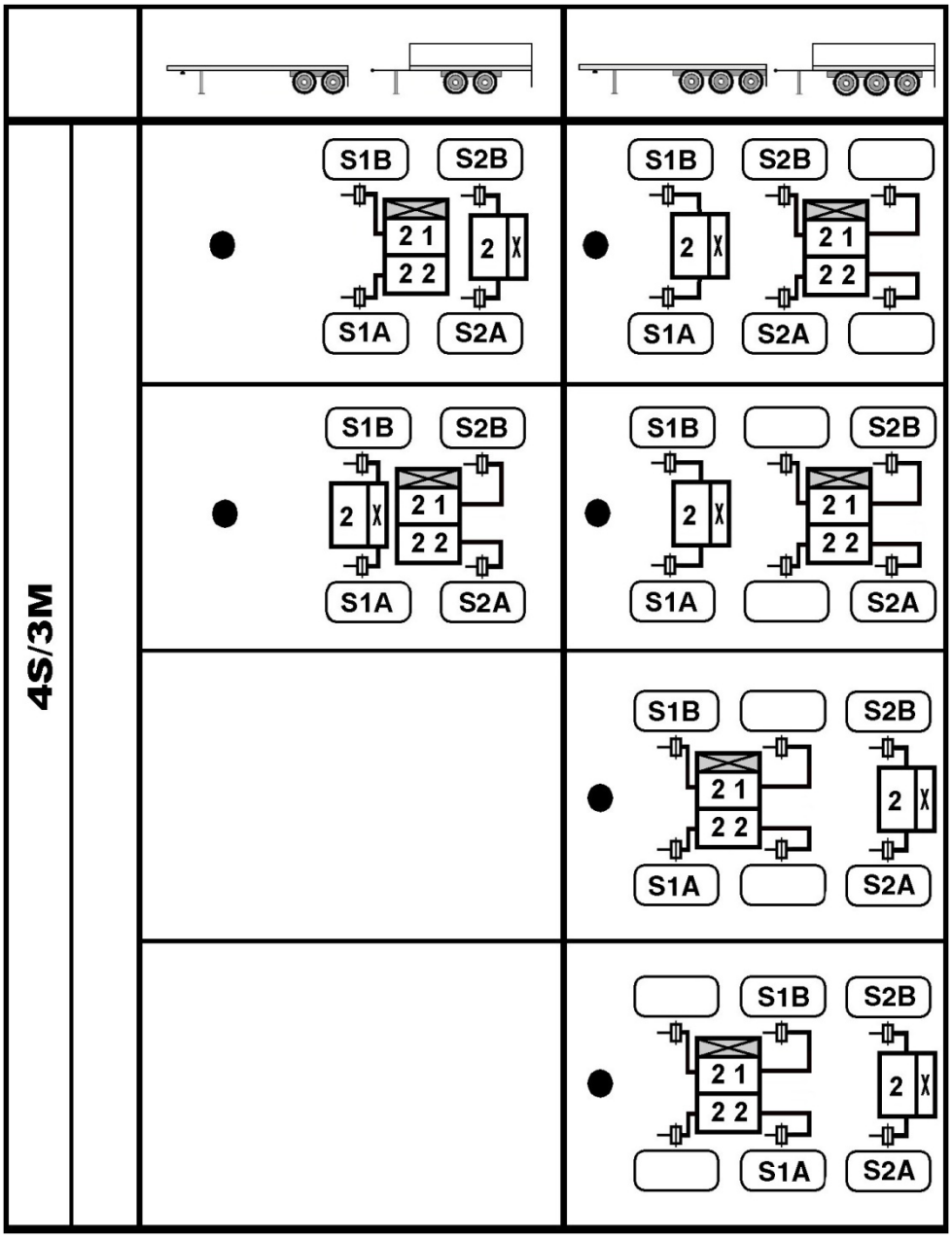
N4 – Sensed wheel connected pneumatically to EPRV 2 can be lifted.

Any axle without directly controlled wheels may be lifted.
Any axle may be a steered axle.

KEY



EB+ Gen 1, Gen 2 & Gen 3 Installation Options - Semi & Centre Axle Trailers



N1 – Master ECU is mounted to EPRV's 21/22. All sensors must be connected to this Master ECU.

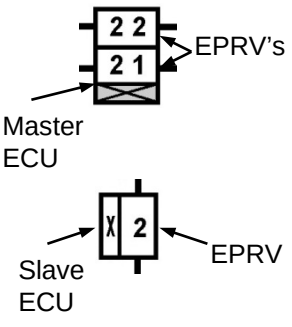
N2 – Directly controlled wheels connected pneumatically to EPRV's 21/22 cannot be lifted.

N3 – Slave ECU is mounted to EPRV 2 and is controlled by Master ECU.
Slave ECU/EPRV 2 is shown facing rear but can also be installed facing forward, left or right, as EPRV 2 is always select low control.

N4 – Sensed wheel connected pneumatically to EPRV 2 can be lifted.

Any axle without directly controlled wheels may be lifted.
Any axle may be a steered axle.

KEY



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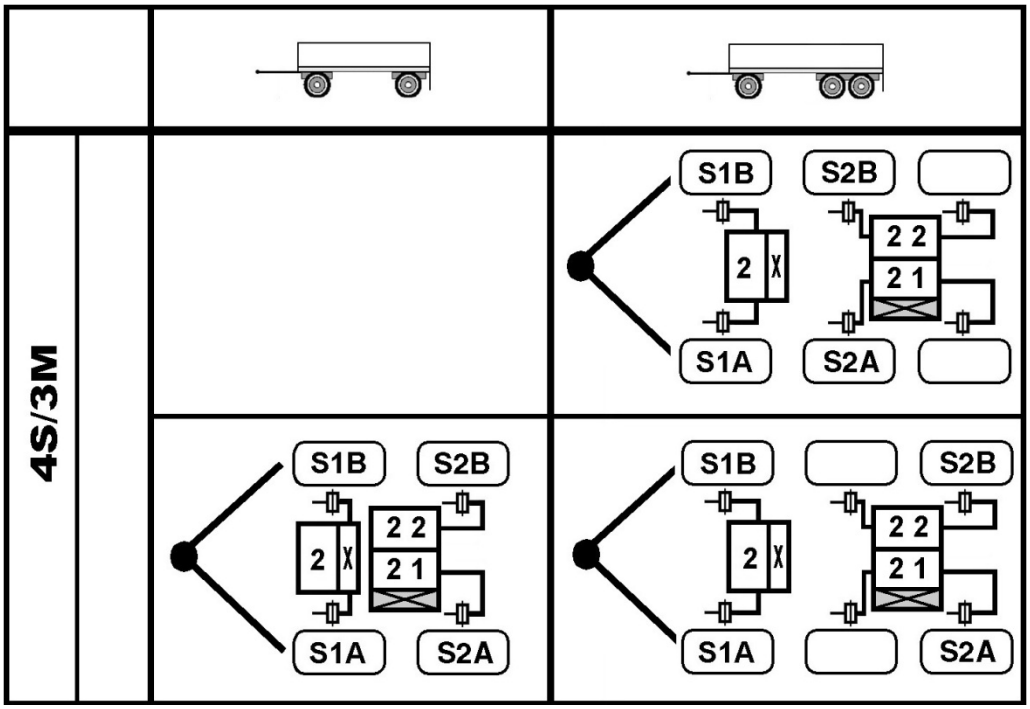
EB+ Gen 1, Gen 2 & Gen 3 Installation Options – Full trailers

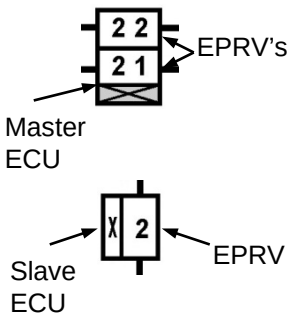


N1 – Master ECU is mounted to EPRV's 21/22. All sensors must be connected to this Master ECU.

N2 – Slave ECU is mounted to EPRV 2 and is controlled by Master ECU.
Slave ECU/EPRV 2 is shown facing rear but can also be installed facing forward, left or right, as EPRV 2 is always select low control.

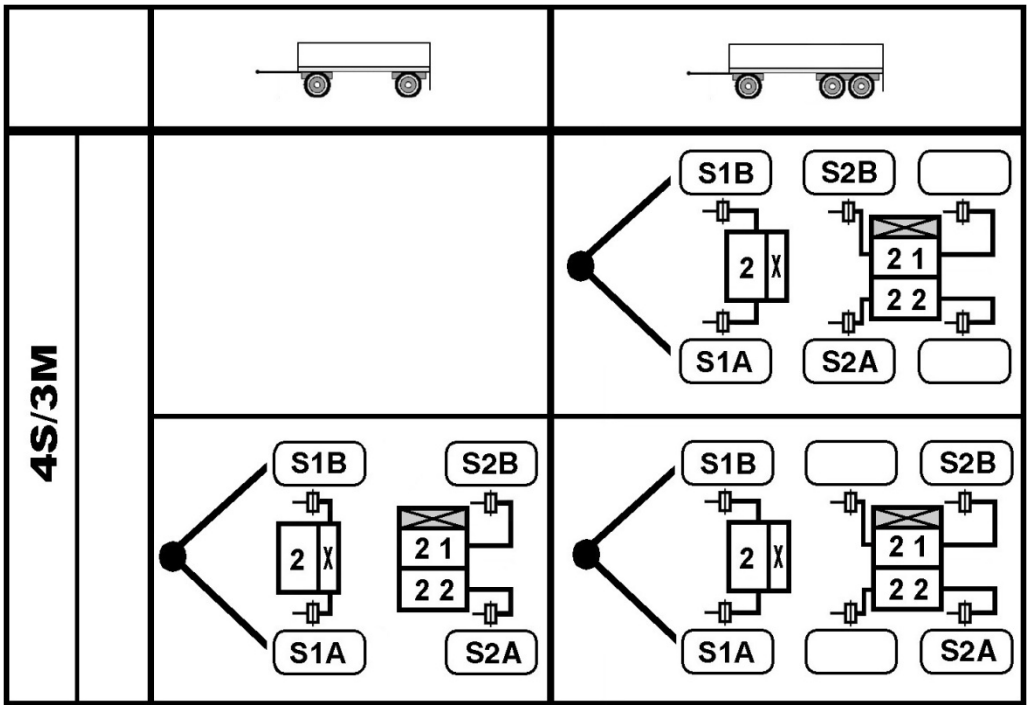
Sensed axles cannot be lifted.
Any axle without directly controlled wheels may be lifted.

KEY



R13 190534

EB+ Gen 1, Gen 2 & Gen 3 Installation Options – Full trailers

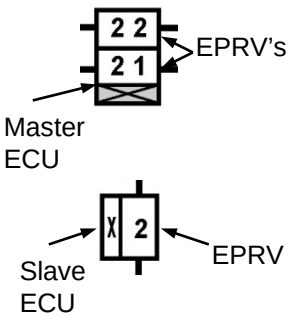


N1 – Master ECU is mounted to EPRV's 21/22. All sensors must be connected to this Master ECU.

N2 – Slave ECU is mounted to EPRV 2 and is controlled by Master ECU.
Slave ECU/EPRV 2 is shown facing rear but can also be installed facing forward, left or right, as EPRV 2 is always select low control.

Sensed axles cannot be lifted.
Any axle without directly controlled wheels may be lifted.

KEY



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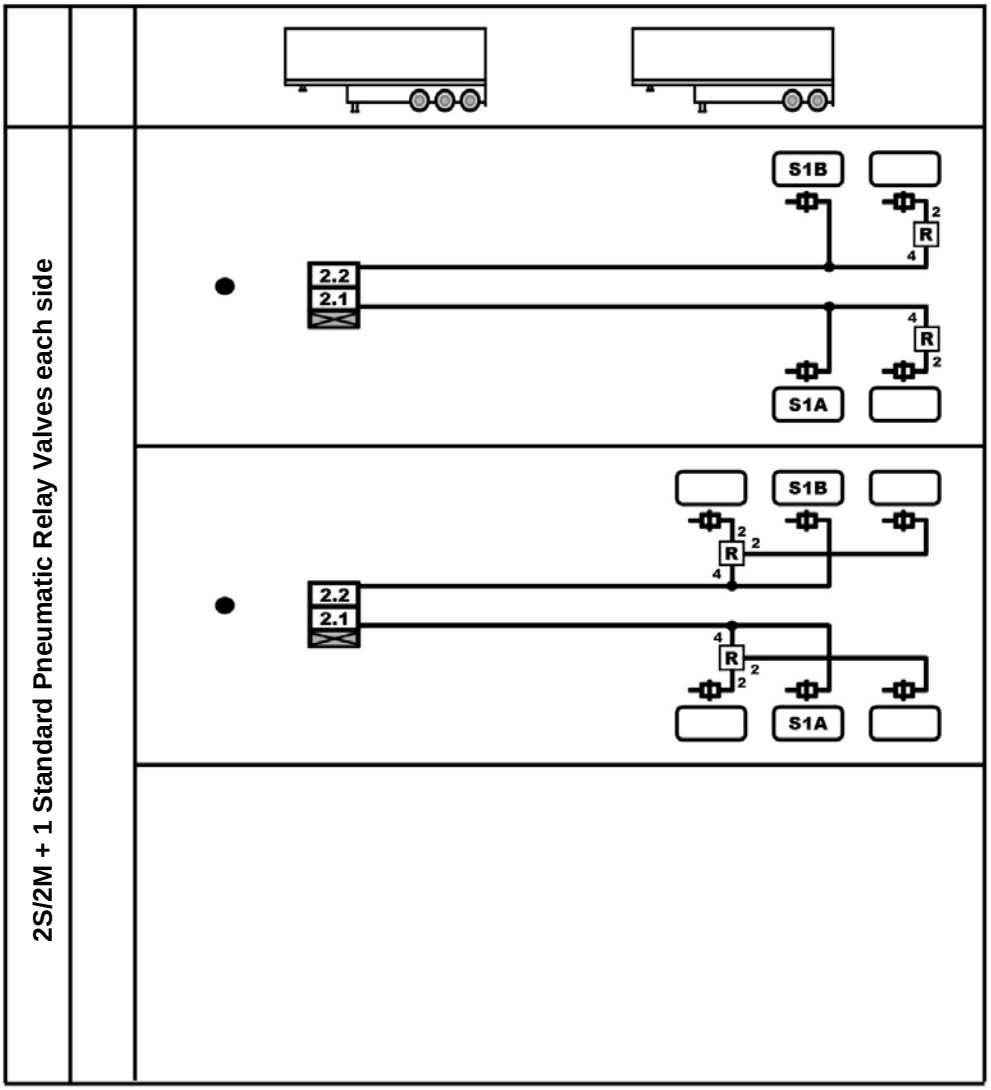
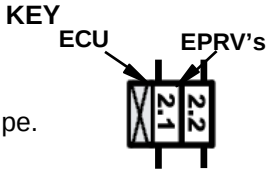
EB+ Gen3 Installation Options – Inloader Semi Trailers

Integrated Side By Side (SxS) with 1 Standard Pneumatic Relay Valve on each side controlled by the EB+ EPRV's



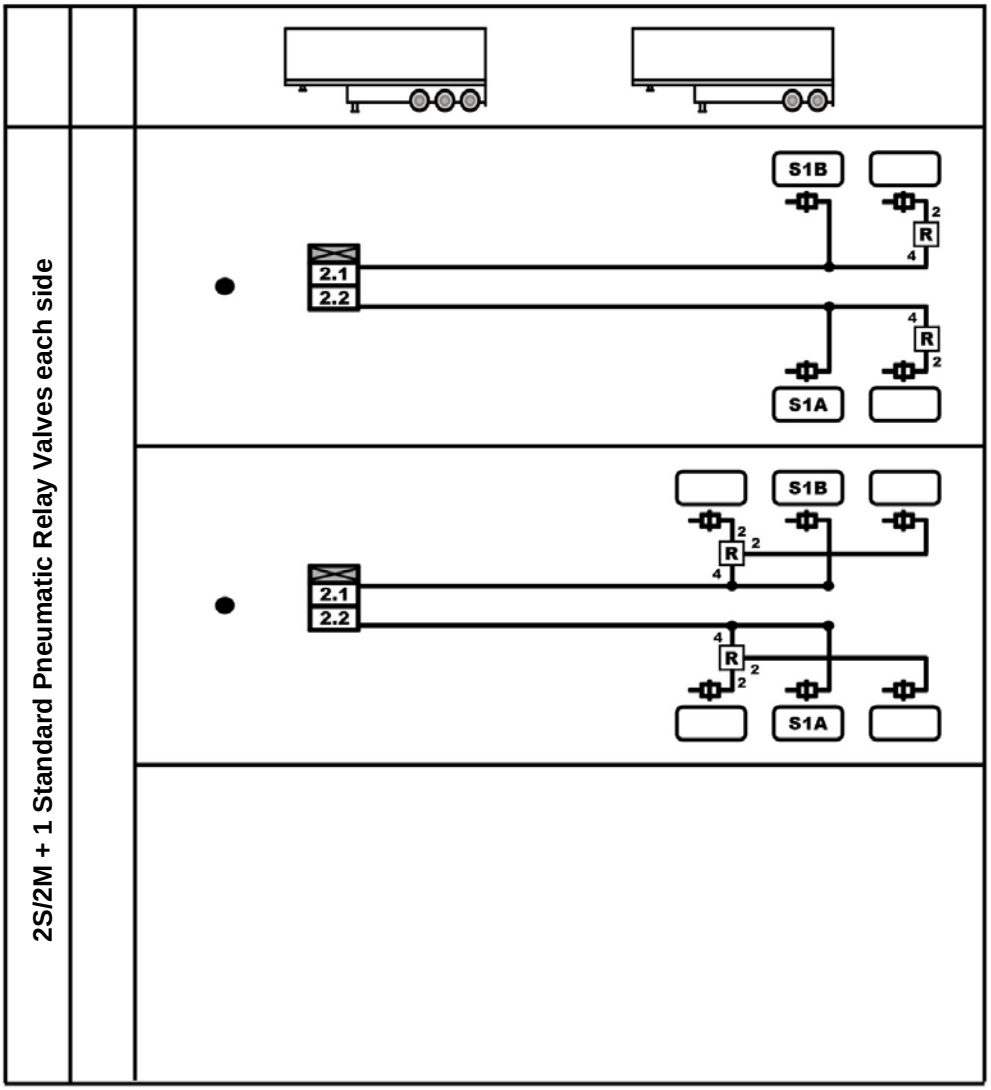
Any axle without directly controlled wheels may be lifted
Any axle may be a command steered axle.

Pipe dimensions:-
EB+ delivery pipe to brake actuators of directly controlled axle maximum length 10m of 12x1.5mm pipe.
EB+ reservoir minimum diameter 15x2mm x 2 pipes maximum length 3m.
Conventional relay delivery port 2 to each axle maximum length 4m of 12x1.5mm pipe.
Conventional relay reservoir pipe minimum diameter 15x2mm and maximum length 4m.



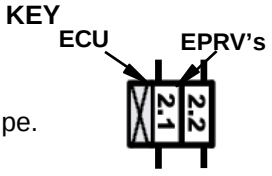
EB+ Gen3 Installation Options – Inloader Semi Trailers

Integrated Side By Side (SxS) with 1 Standard Pneumatic Relay Valve on each side controlled by the EB+ EPRV's



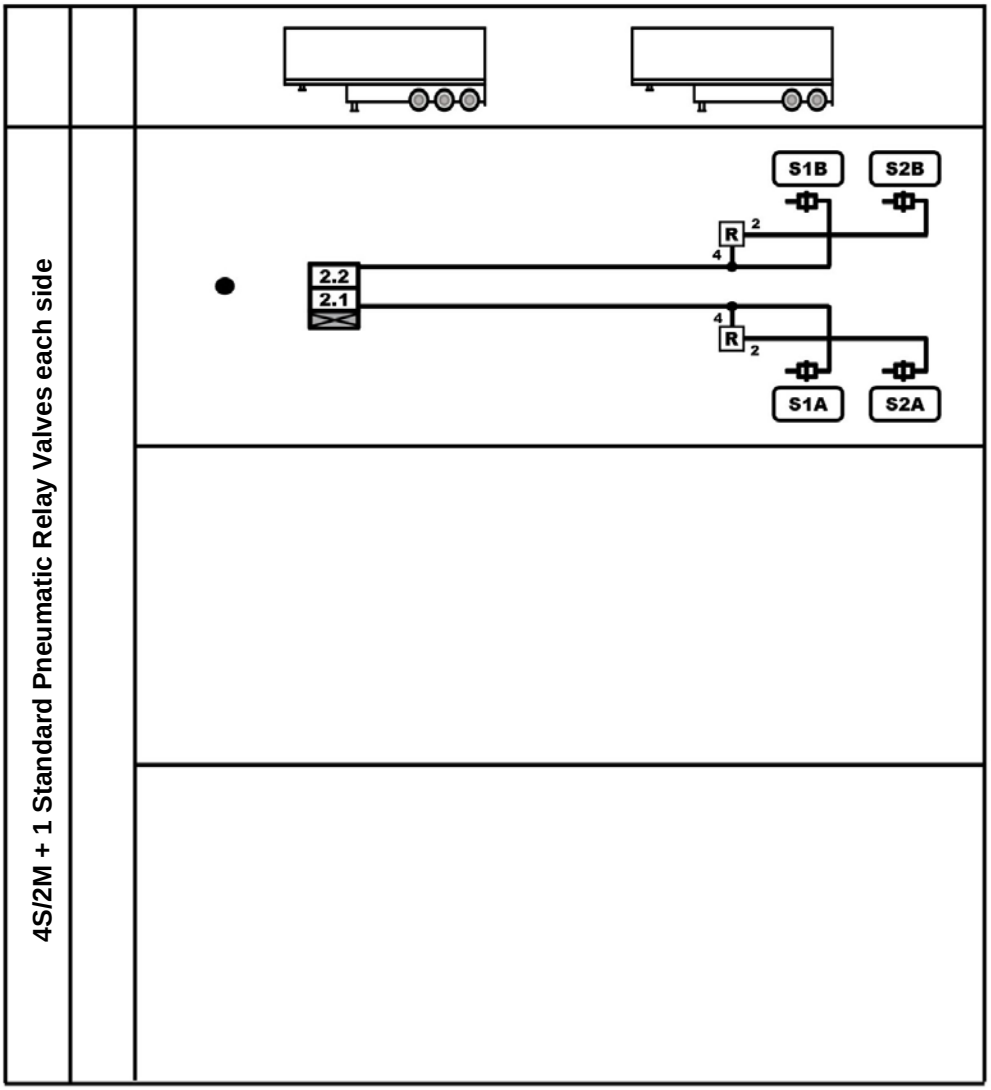
Any axle without directly controlled wheels may be lifted
Any axle may be a command steered axle.

Pipe dimensions:-
EB+ delivery pipe to brake actuators of directly controlled axle maximum length 10m of 12x1.5mm pipe.
EB+ reservoir minimum diameter 15x2mm x 2 pipes maximum length 3m.
Conventional relay delivery port 2 to each axle maximum length 4m of 12x1.5mm pipe.
Conventional relay reservoir pipe minimum diameter 15x2mm and maximum length 4m.



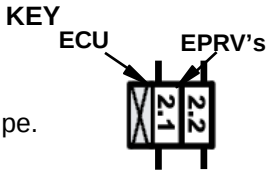
EB+ Gen3 Installation Options – Inloader Semi Trailers

Integrated Side By Side (SxS) with 2 Standard Pneumatic Relay Valves on each side controlled by the EB+ EPRV's



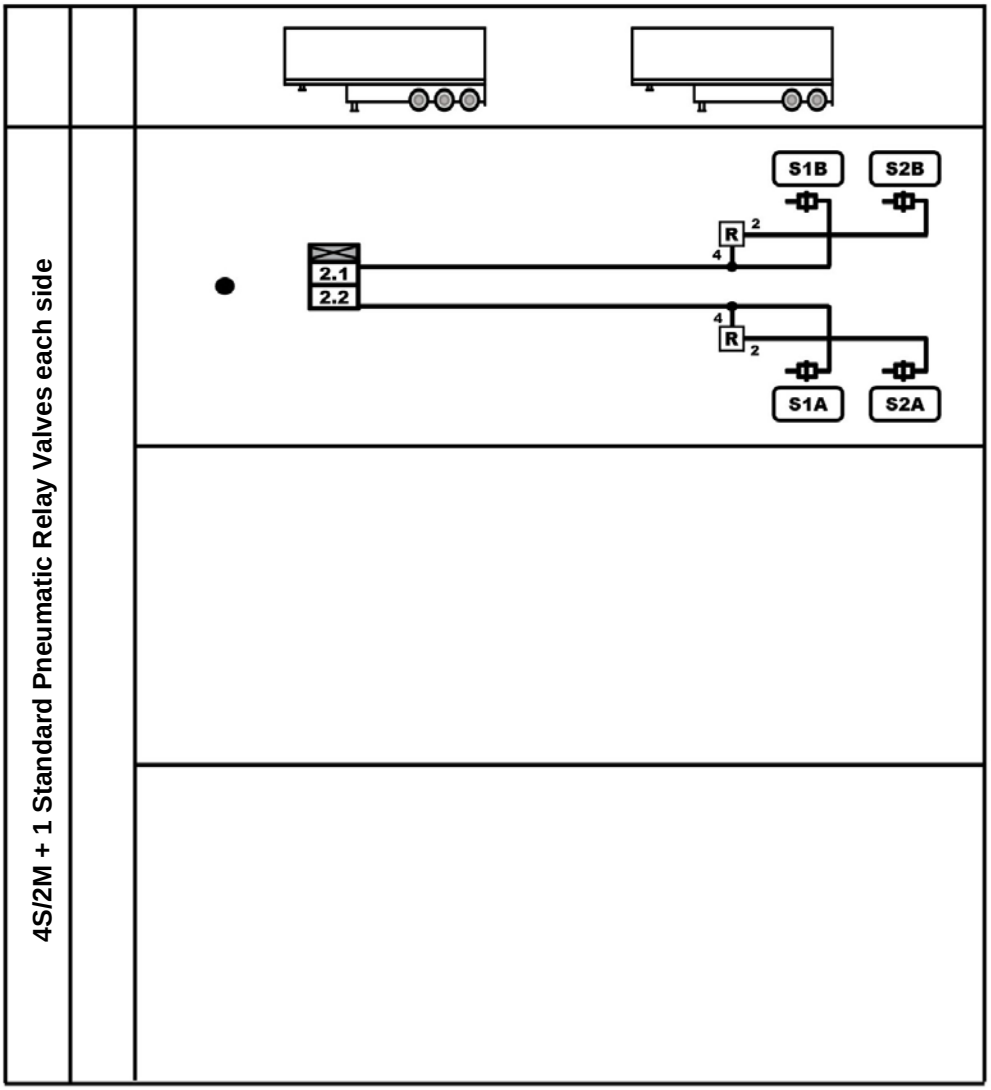
Any axle without directly controlled wheels may be lifted
Any axle may be a command steered axle.

Pipe dimensions:-
EB+ delivery pipe to brake actuators of directly controlled axle maximum length 10m of 12x1.5mm pipe.
EB+ reservoir minimum diameter 15x2mm x 2 pipes maximum length 3m.
Conventional relay delivery port 2 to each axle maximum length 4m of 12x1.5mm pipe.
Conventional relay reservoir pipe minimum diameter 15x2mm and maximum length 4m.



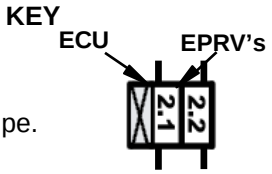
EB+ Gen3 Installation Options – Inloader Semi Trailers

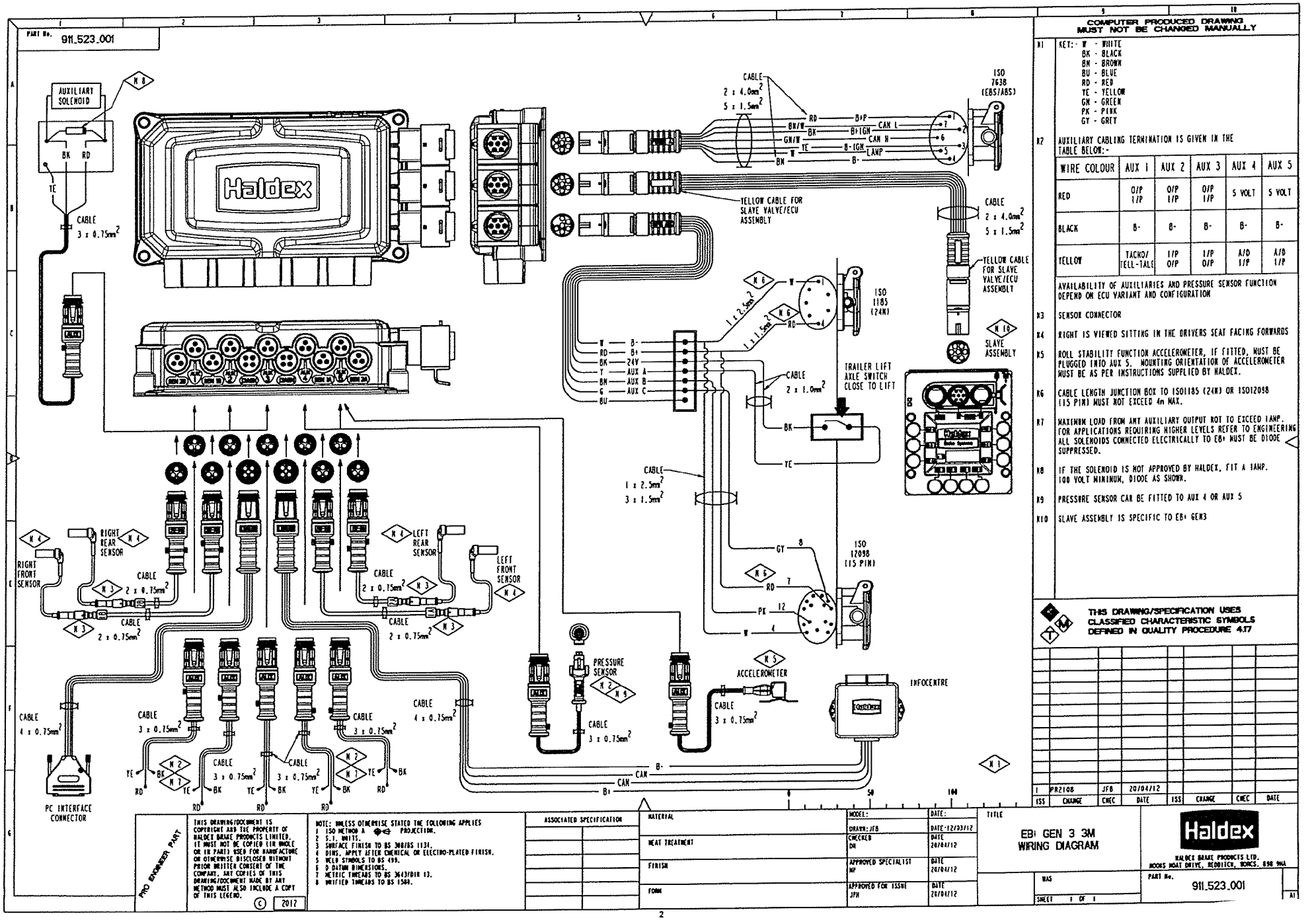
Integrated Side By Side (SxS) with 2 Standard Pneumatic Relay Valves on each side controlled by the EB+ EPRV's



Any axle without directly controlled wheels may be lifted
Any axle may be a command steered axle.

Pipe dimensions:-
EB+ delivery pipe to brake actuators of directly controlled axle maximum length 10m of 12x1.5mm pipe.
EB+ reservoir minimum diameter 15x2mm x 2 pipes maximum length 3m.
Conventional relay delivery port 2 to each axle maximum length 4m of 12x1.5mm pipe.
Conventional relay reservoir pipe minimum diameter 15x2mm and maximum length 4m.





N1 KEY:- W - WHITE
BK - BLACK
BN - BROWN
BU - BLUE
RD - RED
YE - YELLOW
GN - GREEN
PK - PINK
GY - GREY

N2 AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-

WIRE COLOUR	AUX 1	AUX 2	AUX 3	AUX 4	AUX 5
RED	O/P I/P	O/P I/P	O/P I/P	5 VOLT	5 VOLT
BLACK	B-	B-	B-	B-	B-
YELLOW	TACHO/ TELL-TALE	I/P O/P	I/P O/P	A/D I/P	A/D I/P

AVAILABILITY OF AUXILIARIES AND PRESSURE SENSOR FUNCTION DEPEND ON ECU VARIANT AND CONFIGURATION

N3 SENSOR CONNECTOR

N4 RIGHT IS VIEWED SITTING IN THE DRIVERS SEAT FACING FORWARDS

N5 ROLL STABILITY FUNCTION ACCELEROMETER, IF FITTED, MUST BE PLUGGED INTO AUX 5. MOUNTING ORIENTATION OF ACCELEROMETER MUST BE AS PER INSTRUCTIONS SUPPLIED BY HALDEX.

N6 CABLE LENGTH JUNCTION BOX TO ISO1185 (24N) OR ISO12098 (15 PIN) MUST NOT EXCEED 4m MAX.

N7 MAXIMUM LOAD FROM ANY AUXILIARY OUTPUT NOT TO EXCEED 1AMP. FOR APPLICATIONS REQUIRING HIGHER LEVELS REFER TO ENGINEERING ALL SOLENOIDS CONNECTED ELECTRICALLY TO EB+ MUST BE DIODE SUPPRESSED.

N8 IF THE SOLENOID IS NOT APPROVED BY HALDEX, FIT A 1AMP. 100 VOLT MINIMUM, DIODE AS SHOWN.

N9 PRESSURE SENSOR CAN BE FITTED TO AUX 4 OR AUX 5

N10 SLAVE ASSEMBLY IS SPECIFIC TO EB+ GEN3

ISS	CHANGE	CHEC	DATE
1	PR2108	JFB	20/04/12

PRO ENGINEER PART

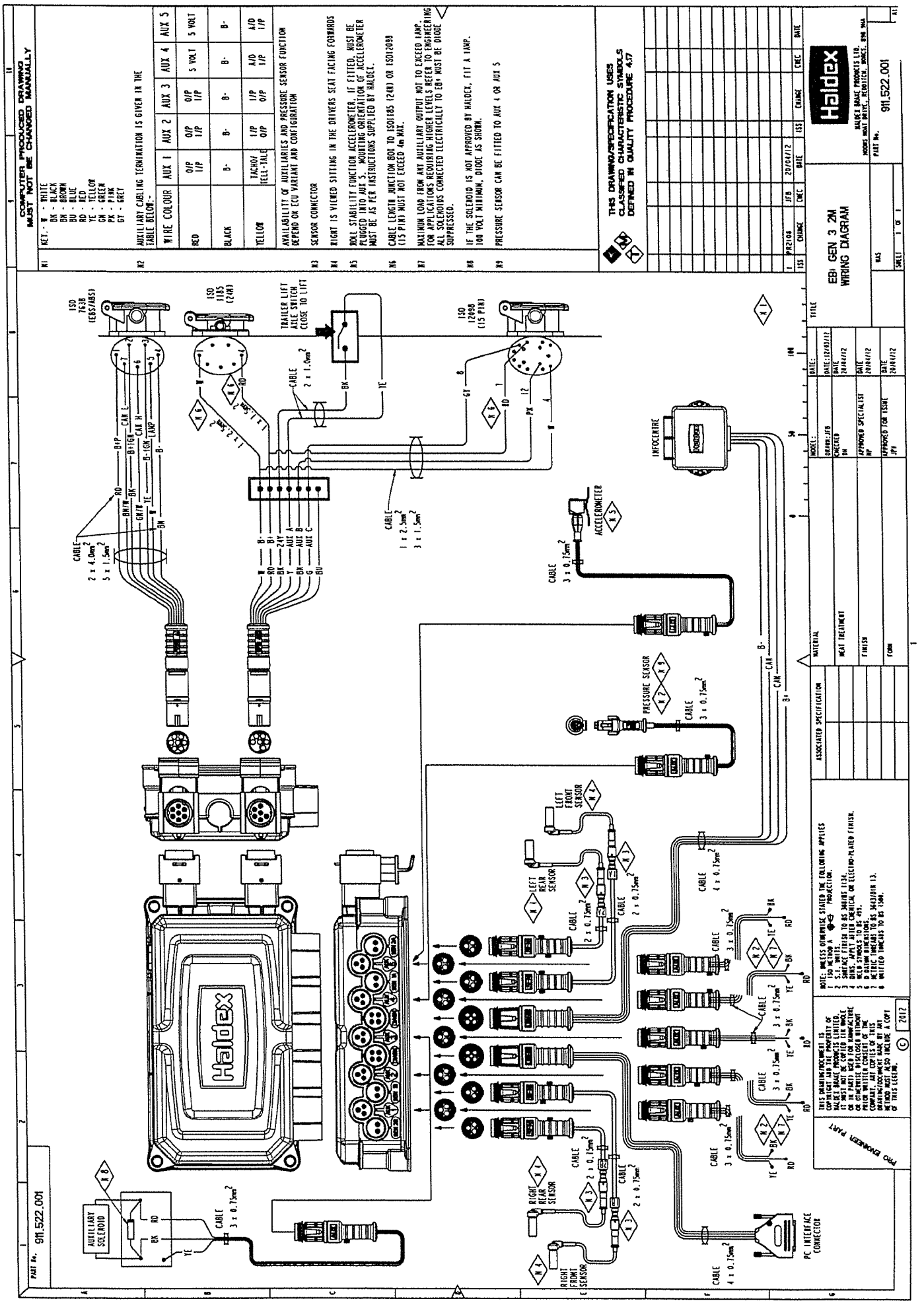
NOTE: UNLESS OTHERWISE STATED THE FOLLOWING APPLIES
1 ISO METHOD A PROJECTION.
2 S.I. UNITS.
3 SURFACE FINISH TO BS 308/BS 1134.
4 DIMS. APPLY AFTER CHEMICAL OR ELECTRO-PLATED FINISH.
5 WELD SYMBOLS TO BS 499.
6 0 DATUM DIMENSIONS.
7 METRIC THREADS TO BS 3643/DIN 13.
8 UNIFIED THREADS TO BS 1580.

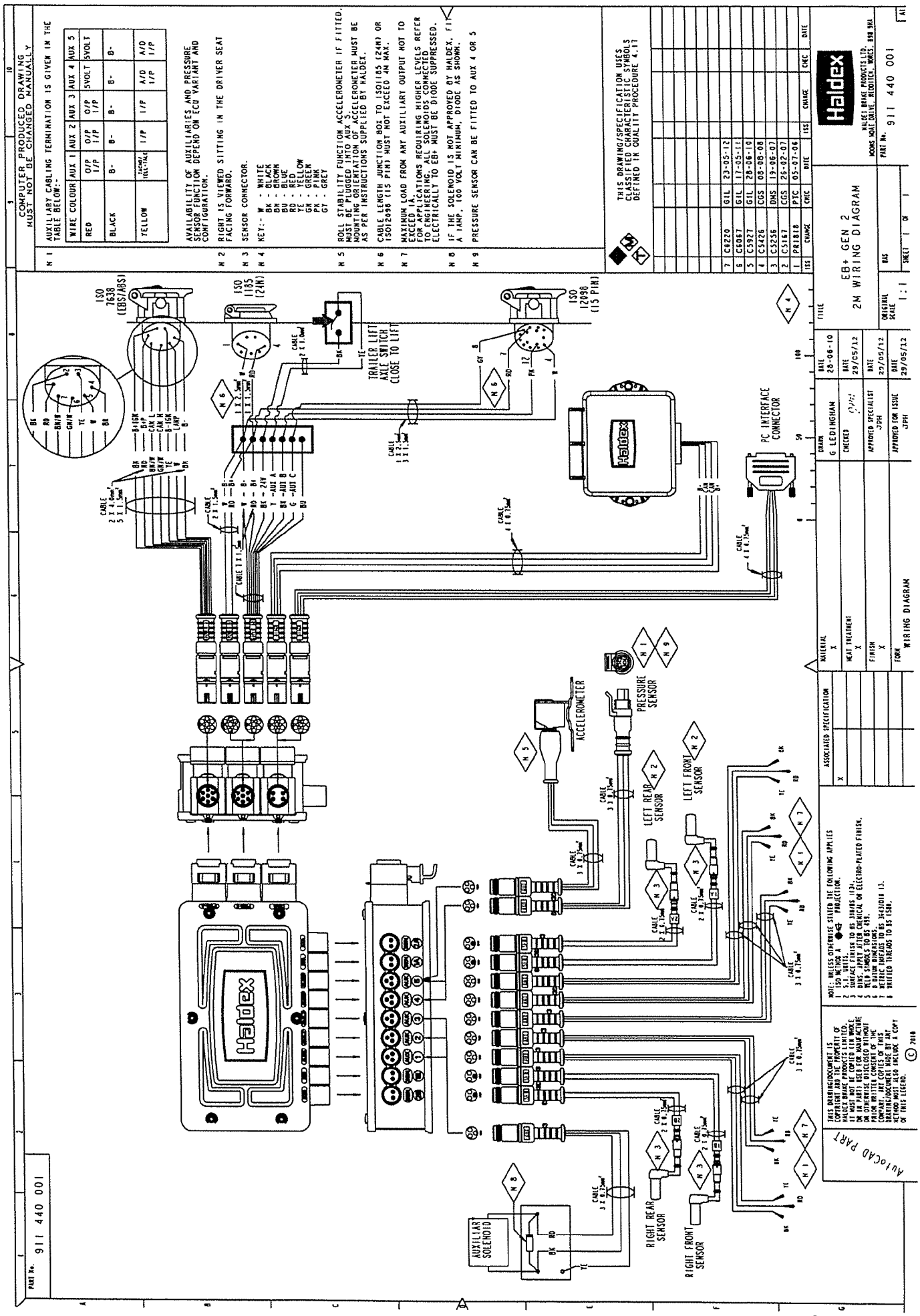
ASSOCIATED SPECIFICATION			
MATERIAL	MODEL:	DATE:	
HEAT TREATMENT	DRAWN: JFB	DATE: 12/03/12	
FINISH	CHECKED DR	DATE 20/04/12	
FORM	APPROVED SPECIALIST MP	DATE 20/04/12	
	APPROVED FOR ISSUE JPH	DATE 20/04/12	

WAS

SHEET 1 OF 1

A1


COMPUTER PRODUCED DRAWING
MUST NOT BE CHANGED MANUALLY
KEY - W - WHITE
BK - BLACK
BR - BROWN
BU - BLUE
RD - RED
YE - YELLOW
GN - GREEN
PK - PINK
GY - GREY
AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-
WIRE COLOUR | AUX 1 | AUX 2 | AUX 3 | AUX 4 | AUX 5
RED | O/P I/P | O/P I/P | O/P I/P | 5 VOLT | 5 VOLT
BLACK | B- | B- | B- | B- | B-
YELLOW | TACHO/ TELL-TALE | I/P O/P | I/P O/P | A/D I/P | A/D I/P
AVAILABILITY OF AUXILIARIES AND PRESSURE SENSOR FUNCTION DEPEND ON ECU VARIANT AND CONFIGURATION
SENSOR CONNECTOR
RIGHT IS VIEWED SITTING IN THE DRIVERS SEAT FACING FORWARDS
ROLL STABILITY FUNCTION ACCELEROMETER, IF FITTED, MUST BE PLUGGED INTO AUX 5. MOUNTING ORIENTATION OF ACCELEROMETER MUST BE AS PER INSTRUCTIONS SUPPLIED BY HALDEX.
CABLE LENGTH JUNCTION BOX TO ISO7185 (24N) OR ISO12098 (15 PIN) MUST NOT EXCEED 4m MAX.
MAXIMUM LOAD FROM ANY AUXILIARY OUTPUT NOT TO EXCEED 1AMP. FOR APPLICATIONS REQUIRING HIGHER LEVELS REFER TO ENGINEERING ALL SOLENOIDS CONNECTED ELECTRICALLY TO 'CB+' MUST BE DIODE SUPPRESSED.
IF THE SOLENOID IS NOT APPROVED BY HALDEX, FIT A 1AMP. 100 VOLT MINIMUM, DIODE AS SHOWN.
PRESSURE SENSOR CAN BE FITTED TO AUX 4 OR AUX 5
THIS DRAWING/SPECIFICATION USES CLASSIFIED CHARACTERISTIC SYMBOLS DEFINED IN QUALITY PROCEDURE 4.57
EBS GEN 3 2M
WIRING DIAGRAM
PART No. 911.522.001
ISO 7638 (EBS/ABS)
ISO 1185 (24N)
ISO 12098 (15 PIN)
TRAILER LIFT AXLE SWITCH CLOSE TO LIFT
INFOCENTRE
ACCELEROMETER
PRESSURE SENSOR
LEFT FRONT SENSOR
LEFT REAR SENSOR
RIGHT REAR SENSOR
RIGHT FRONT SENSOR
AUXILIARY SOLENOID
PC INTERFACE CONNECTOR
CABLE 2 x 4.0mm² 5 x 1.5mm²
CABLE 1 x 2.5mm² 3 x 1.5mm²
CABLE 3 x 0.75mm²
CABLE 2 x 0.75mm²
CABLE 4 x 0.75mm²
Haldex


COMPUTER PRODUCED DRAWING
MUST NOT BE CHANGED MANUALLY
AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-
WIRE COLOUR | AUX 1 | AUX 2 | AUX 3 | AUX 4 | AUX 5
RED | O/P I/P | O/P I/P | O/P I/P | 5VOLT | 5VOLT
BLACK | B- | B- | B- | B- | B-
YELLOW | 12/24V TOLERANT | I/P | I/P | A/D I/P | A/D I/P
AVAILABILITY OF AUXILIARIES AND PRESSURE SENSOR FUNCTION DEPEND ON ECU VARIANT AND CONFIGURATION.
RIGHT IS VIEWED SITTING IN THE DRIVER SEAT FACING FORWARD.
SENSOR CONNECTOR.
KEY:- W - WHITE
BK - BLACK
BN - BROWN
BU - BLUE
RD - RED
YE - YELLOW
GN - GREEN
PK - PINK
GY - GREY
ROLL STABILITY FUNCTION ACCELEROMETER IF FITTED. MUST BE PLUGGED INTO AUX 5. MOUNTING ORIENTATION OF ACCELEROMETER MUST BE AS PER INSTRUCTIONS SUPPLIED BY HALDEX.
CABLE LENGTH JUNCTION BOX TO ISO11105 (24W) OR ISO12098 (15 PIN) MUST NOT EXCEED 4M MAX.
MAXIMUM LOAD FROM ANY AUXILIARY OUTPUT NOT TO EXCEED 1A.
FOR APPLICATIONS REQUIRING HIGHER LEVELS REFER TO ENGINEERING. ALL SOLENOIDS CONNECTED ELECTRICALLY TO EB+ MUST BE DIODE SUPPRESSED.
IF THE SOLENOID IS NOT APPROVED BY HALDEX, FIT A 1AMP, 100 VOLT MINIMUM, DIODE AS SHOWN.
PRESSURE SENSOR CAN BE FITTED TO AUX 4 OR 5
THIS DRAWING/SPECIFICATION USES CLASSIFIED CHARACTERISTIC SYMBOLS DEFINED IN QUALITY PROCEDURE 4.17
ISS | CHANGE | CHEC | DATE | ISS | CHANGE | CHEC | DATE
7 C6220 GIL 23-05-12
6 C6067 GIL 17-05-11
5 C5927 GIL 28-06-10
4 C5426 CGS 08-08-08
3 C5256 DMS 19-06-07
2 C5167 CGS 26-02-07
1 P81818 PJC 05-07-06
EB+ GEN 2
2M WIRING DIAGRAM
Haldex
PART No. 911 440 001
ISO 7638 (EBS/ABS)
ISO 1185 (24W)
ISO 12098 (15 PIN)
TRAILER LIFT AXLE SWITCH CLOSE TO LIFT
PC INTERFACE CONNECTOR
ACCELEROMETER
PRESSURE SENSOR
LEFT REAR SENSOR
LEFT FRONT SENSOR
RIGHT REAR SENSOR
RIGHT FRONT SENSOR
AUXILIARY SOLENOID
DRAWN G LEDINGHAM 28-06-10
CHECKED 23/05/12
APPROVED SPECIALIST JPH 29/05/12
APPROVED FOR ISSUE JPH 29/05/12
MATERIAL X
HEAT TREATMENT X
FINISH X
FORM WIRING DIAGRAM
ASSOCIATED SPECIFICATION
ORIGINAL SCALE 1:1
SHEET 1 OF 1
HALDEX BRAKE PRODUCTS LTD. MOOR WAY DRIVE, REDDITCH, WORCS. B98 9NA
AutoCAD PART
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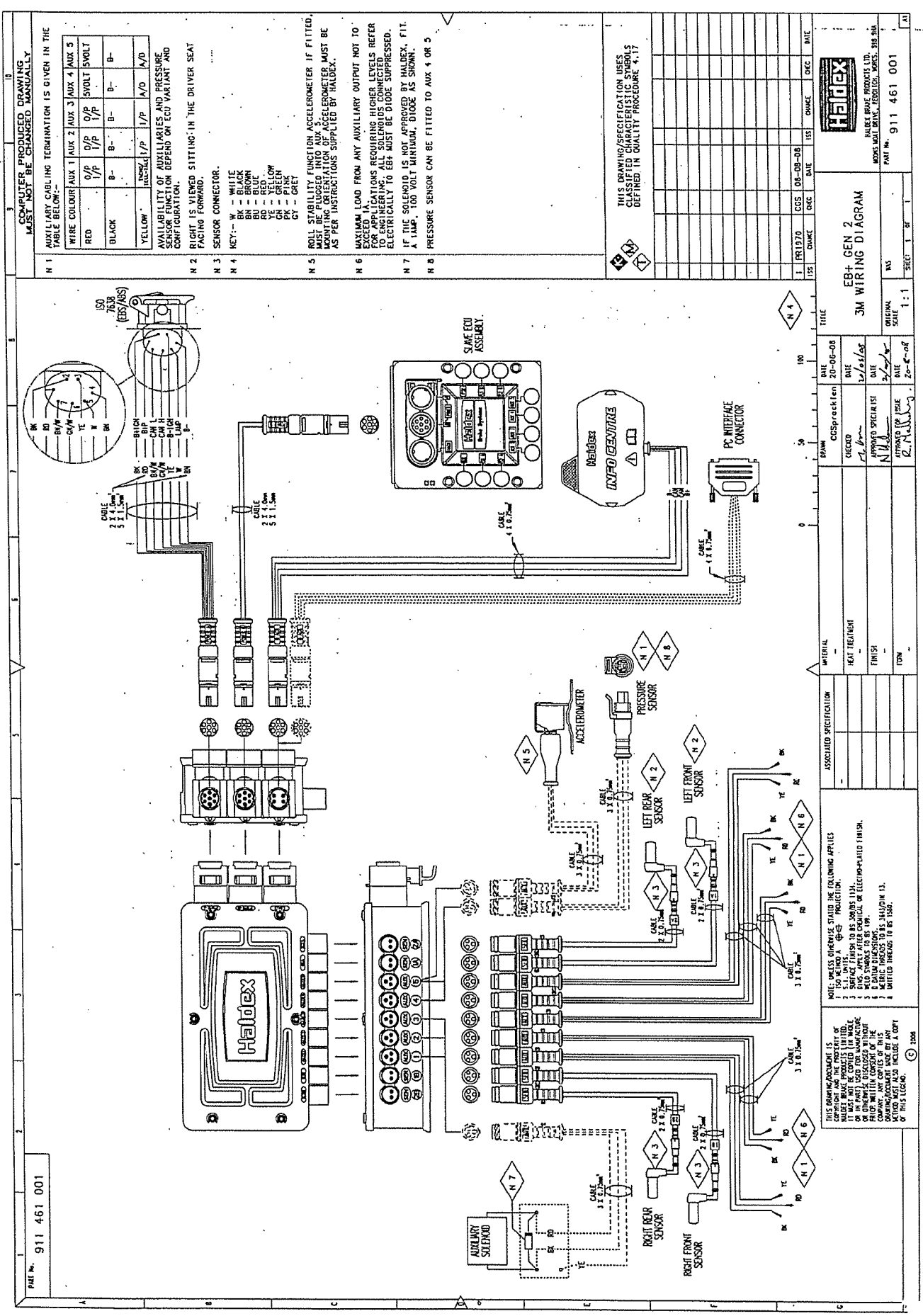
NOTE: UNLESS OTHERWISE STATED THE FOLLOWING APPLIES
1 ISO METRIC A
2 SURFACE ROUGHNESS TO BS 1134.
3 SURFACE FINISH TO BS 3straight 1134.
4 DIMS. APPLY AFTER CHEMICAL OR ELECTRO-PLATED FINISH.
5 WELD SYMBOLS TO BS 499.
6 BLANK DIMENSIONS TO BS 3643/DIN 13.
7 METRIC THREADS TO BS 3643/DIN 13.
8 UNIFIED THREADS TO BS 1580.


COMPUTER PRODUCED DRAWING
MUST NOT BE CHANGED MANUALLY
AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-
WIRE COLOUR | AUX 1 | AUX 2 | AUX 3 | AUX 4 | AUX 5
RED | O/P 1/P | O/P 1/P | O/P 1/P | 5VOLT | 5VOLT
BLACK | B- | B- | B- | B- | B-
YELLOW | TACHO/I/P | I/P | I/P | A/O | A/O
AVAILABILITY OF AUXILIARIES AND PRESSURE SENSOR FUNCTION DEPEND ON ECU VARIANT AND CONFIGURATION.
RIGHT IS VIEWED SITTING IN THE DRIVER SEAT FACING FORWARD.
SENSOR CONNECTOR.
KEY:- W - WHITE
BK - BLACK
BN - BROWN
BU - BLUE
RD - RED
YE - YELLOW
GN - GREEN
PK - PINK
GY - GREY
ROLL STABILITY FUNCTION ACCELEROMETER IF FITTED, MUST BE PLUGGED INTO AUX 5. MOUNTING ORIENTATION OF ACCELEROMETER MUST BE AS PER INSTRUCTIONS SUPPLIED BY HALDEX.
MAXIMUM LOAD FROM ANY AUXILIARY OUTPUT NOT TO EXCEED 1A.
FOR APPLICATIONS REQUIRING HIGHER LEVELS REFER TO APPLICATIONS MANUAL. ALL SOLENOIDS CONNECTED ELECTRICALLY TO 88+ MUST BE DIODE SUPPRESSED.
IF THE SOLENOID IS NOT APPROVED BY HALDEX, FIT A 1.1AMP, 100 VOLT MINIMUM, DIODE AS SHOWN.
PRESSURE SENSOR CAN BE FITTED TO AUX 4 OR 5
THIS DRAWING/SPECIFICATION USES CLASSIFIED CHARACTERISTIC SYMBOLS DEFINED IN QUALITY PROCEDURE 4.17
EB+ GEN 2
3M WIRING DIAGRAM
PART No. 911 461 001
ISO 7638 (EBS/ABS)
SLAVE ECU ASSEMBLY
Haldex
INFO CENTRE
PC INTERFACE CONNECTOR
ACCELEROMETER
PRESSURE SENSOR
LEFT REAR SENSOR
LEFT FRONT SENSOR
RIGHT REAR SENSOR
RIGHT FRONT SENSOR
AUXILIARY SOLENOID
CABLE 2 X 4.5mm² 5 X 1.5mm²
CABLE 2 X 1.5mm² 5 X 1.5mm²
CABLE 4 X 0.75mm²
CABLE 2 X 0.75mm²
CABLE 3 X 1.5mm²
CABLE 3 X 0.75mm²
CABLE 1 X 1.5mm²
CABLE 1 X 0.75mm²
NOTES: UNLESS OTHERWISE STATED THE FOLLOWING APPLIES
1. DIMENSIONS ARE IN mm.
2. TOLERANCES TO BS 308/BS 7121.
3. SURFACE FINISH TO BS 308/BS 7121.
4. BOLTS, SCREWS TO BS 1083.
5. DATUM DIMENSIONS.
6. METRIC THREADS TO BS 3643/DIN 13.
7. UNLESS OTHERWISE STATED ALL DIMENSIONS AFTER PLATING.
8. UNIFIED THREADS TO BS 1580.
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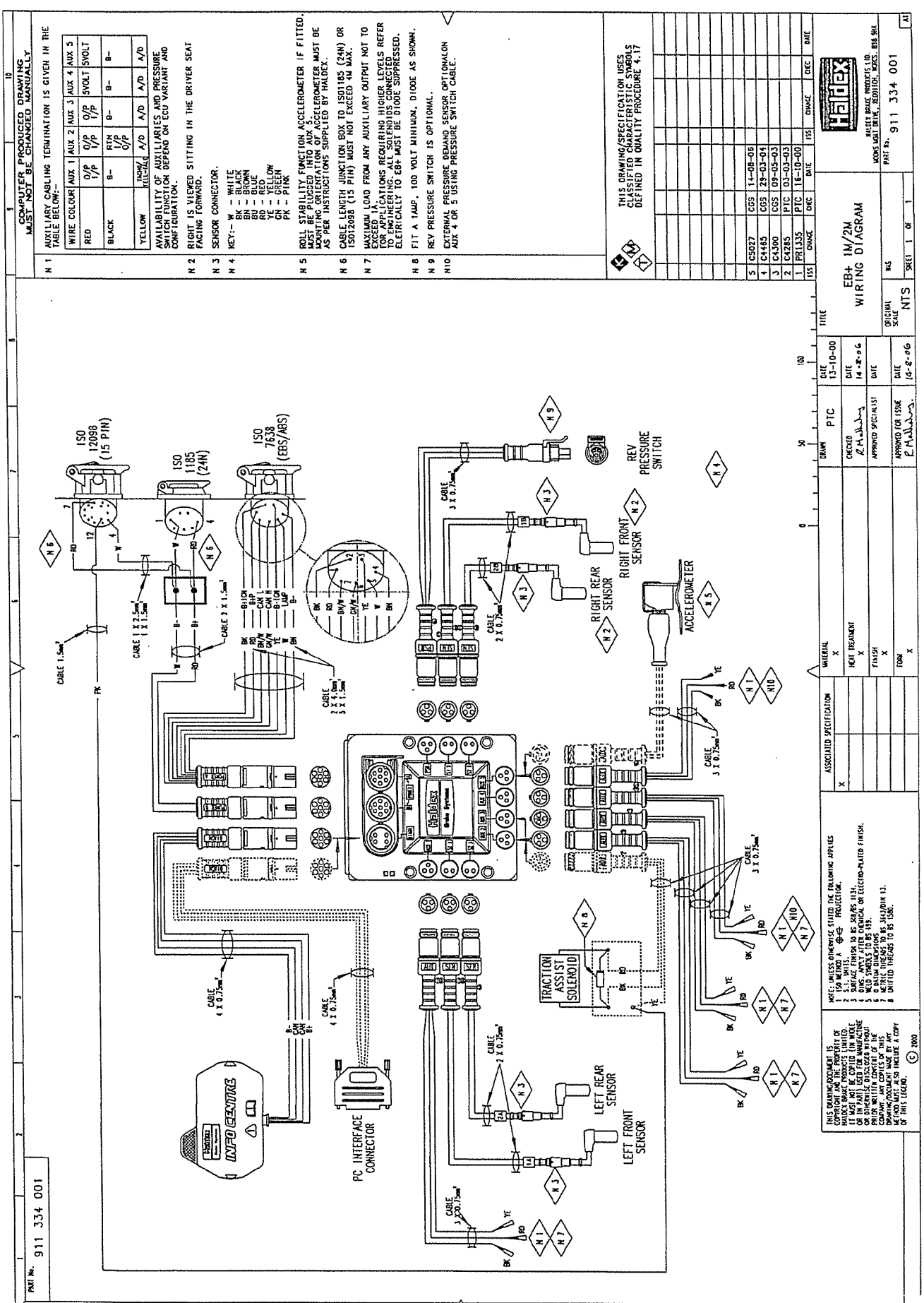
ASSOCIATED SPECIFICATION
MATERIAL
HEAT TREATMENT
FINISH
TOM
DRAWN CCGSprackelen DATE 20-06-08
CHECKED DATE
APPROVED SPECIALIST DATE
APPROVED FOR ISSUE DATE 20-6-08
ORIGINAL SCALE 1:1
WEIGHT
SHEET 1 OF 1
HALDEX BRAKE PRODUCTS LTD. WORKS MOAT DRIVE, FERDITH, WORCS. WR8 9HA
PART No. 911 461 001
A1


COMPUTER PRODUCED DRAWING
MUST NOT BE CHANGED MANUALLY
N 1 AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-
WIRE COLOUR | AUX 1 | AUX 2 | AUX 3 | AUX 4 | AUX 5
RED | O/P I/P | O/P I/P | O/P I/P | 5VOLT | 5VOLT
BLACK | B- | RTN I/P O/P | B- | B- | B-
YELLOW | 74HC/ HCU-PULSE | A/D | A/D | A/D | A/D
AVAILABILITY OF AUXILIARIES AND PRESSURE SWITCH FUNCTION DEPEND ON ECU VARIANT AND CONFIGURATION.
N 2 RIGHT IS VIEWED SITTING IN THE DRIVER SEAT FACING FORWARD.
N 3 SENSOR CONNECTOR.
N 4 KEY:- W - WHITE
BK - BLACK
BN - BROWN
BU - BLUE
RD - RED
YE - YELLOW
GN - GREEN
PK - PINK
N 5 ROLL STABILITY FUNCTION ACCELEROMETER IF FITTED, MUST BE PLUGGED INTO AUX 5.
MOUNTING ORIENTATION OF ACCELEROMETER MUST BE AS PER INSTRUCTIONS SUPPLIED BY HALDEX.
N 6 CABLE LENGTH JUNCTION BOX TO ISO1185 (24N) OR ISO12098 (15 PIN) MUST NOT EXCEED 1M MAX.
N 7 MAXIMUM LOAD FROM ANY AUXILIARY OUTPUT NOT TO EXCEED 1A.
FOR APPLICATIONS REQUIRING HIGHER LEVELS REFER TO APPLICATIONS MANUAL.
ELECTRICALLY TO EB+ MUST BE DIODE SUPPRESSED.
N 8 FIT A 1AMP, 100 VOLT MINIMUM, DIODE AS SHOWN.
N 9 REV PRESSURE SWITCH IS OPTIONAL.
N10 EXTERNAL PRESSURE DEMAND SENSOR OPTIONALON AUX 4 OR 5 USING PRESSURE SWITCH CABLE.
THIS DRAWING/SPECIFICATION USES CLASSIFIED CHARACTERISTIC SYMBOLS DEFINED IN QUALITE PROCEDURE 4.17
ISO 12098 (15 PIN)
ISO 1185 (24N)
ISO 7638 (EBS/ABS)
CABLE 1.5mm²
CABLE 1 X 2.5mm² 1 X 1.5mm²
CABLE 2 X 1.5mm²
CABLE 2 X 4.0mm² 3 X 1.5mm²
CABLE 3 X 0.75mm²
CABLE 2 X 0.75mm²
CABLE 4 X 0.75mm²
CABLE 1 X 20.75mm²
RIGHT REAR SENSOR
RIGHT FRONT SENSOR
REV PRESSURE SWITCH
ACCELEROMETER
TRACTION ASSIST SOLENOID
LEFT REAR SENSOR
LEFT FRONT SENSOR
PC INTERFACE CONNECTOR
INFO CENTRE
5 CS027 CGS 11-08-06
4 C4485 CGS 29-03-04
3 C4300 CGS 09-05-03
2 C4285 PTC 03-03-03
1 PR1335 PTC 16-10-00
ISS CHANGE ORG DATE ISS CHANGE CHEC DATE
DRAWN PTC DATE 13-10-00
CHECKED DATE 14-2-06
APPROVED SPECIALIST DATE
APPROVED FOR ISSUE DATE 14-2-06
ORIGINAL SCALE NTS
WAS
SHEET 1 OF 1
TITLE
EB+ 1M/2M WIRING DIAGRAM
HALDEX
HALDEX BRAKE PRODUCTS LTD
WORKS ROAD DRIVE, REDDITCH, WORCS. B98 9HA
PART No. 911 334 001
ASSOCIATED SPECIFICATION
MATERIAL X
HEAT TREATMENT X
FINISH X
TOSAI X
NOTE: UNLESS OTHERWISE STATED THE FOLLOWING APPLIES
1 ISO METHOD A
2 SURFACE FINISH TO BS 5436 1:93.
3 ALL FINISH TO BS 5436 1:93.
4 DIMS. APPLY AFTER CHEMICAL OR ELECTRO-PLATED FINISH.
5 WELD SYMBOLS TO BS 499.
6 DATUM DIMENSIONS TO BS 3643 PART 2.
7 GEOMETRICAL TOLERANCING TO BS 3643 PART 3.
8 DRILLED THREADS TO BS 1580.
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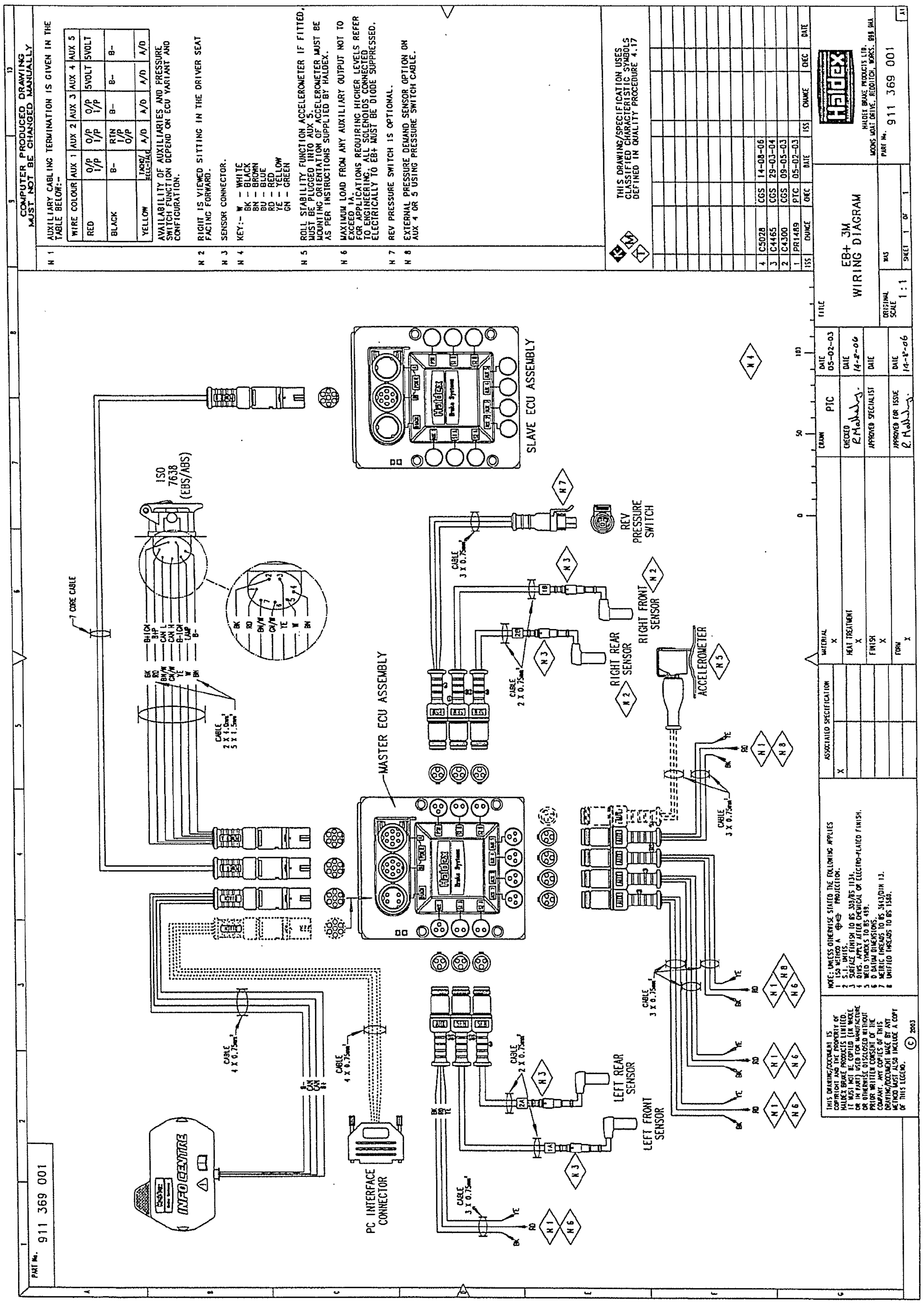
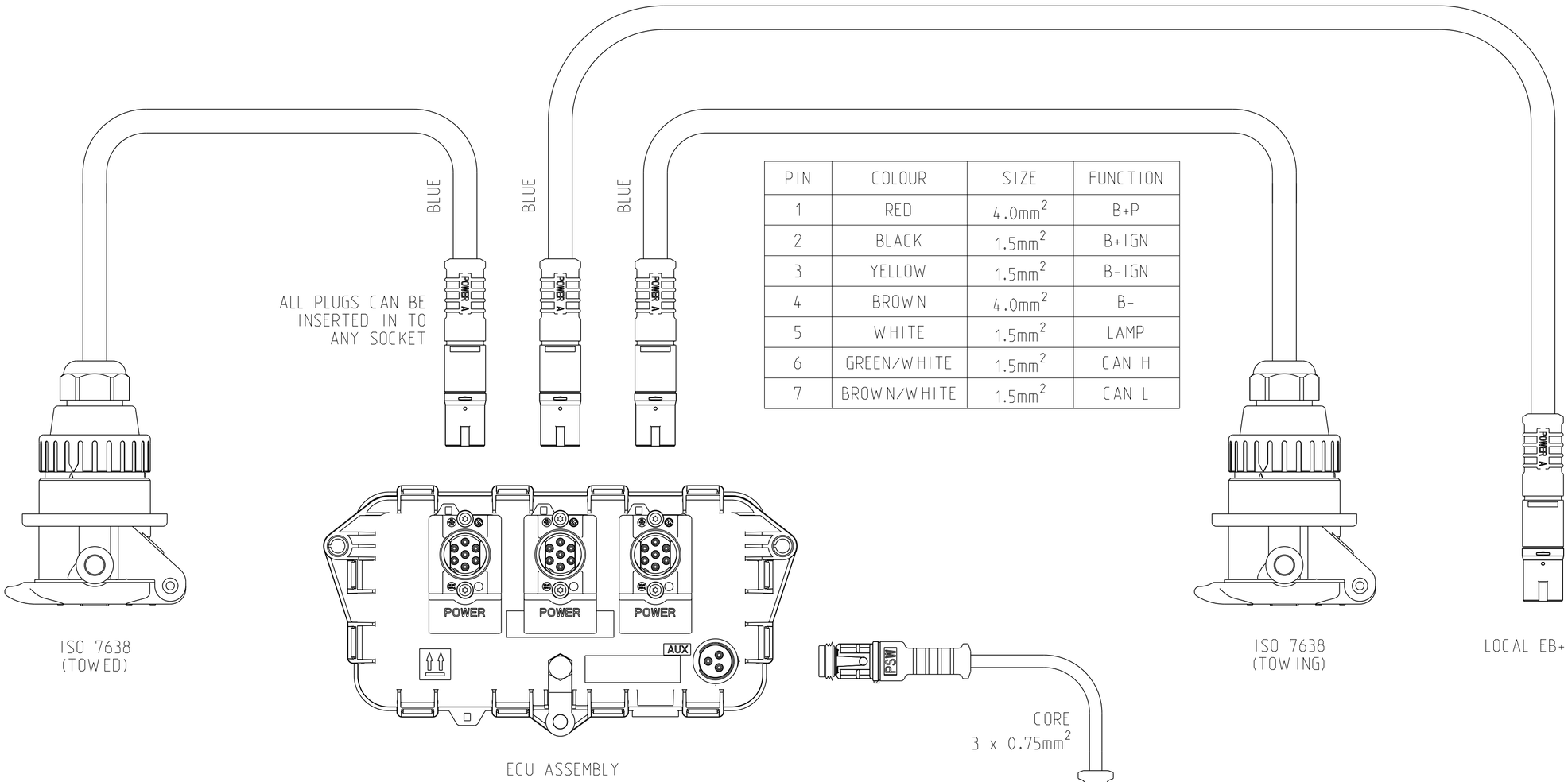
© 2000
PART No. 911 334 001

R13 190534



COMPUTER PRODUCED DRAWING MUST NOT BE CHANGED MANUALLY
AUXILIARY CABLING TERMINATION IS GIVEN IN THE TABLE BELOW:-
RIGHT IS VIEWED SITTING IN THE DRIVER SEAT FACING FORWARD.
SENSOR CONNECTOR.
KEY:- W - WHITE BK - BLACK BN - BROWN BU - BLUE RD - RED YE - YELLOW GN - GREEN
REV PRESSURE SWITCH IS OPTIONAL.
EB+ 3M WIRING DIAGRAM
911 369 001
MASTER ECU ASSEMBLY
SLAVE ECU ASSEMBLY
ISO 7638 (EBS/ABS)
REV PRESSURE SWITCH
RIGHT FRONT SENSOR
RIGHT REAR SENSOR
ACCELEROMETER
LEFT REAR SENSOR
LEFT FRONT SENSOR
PC INTERFACE CONNECTOR
INFO CENTRE

REV	CHANGE DESCRIPTION AND ORDER NUMBER	DATE	CHANGED	CHECKED	APPROVED
0	PR2209 - INITIAL RELEASE	20180613	FIELD	HOLDE	AK



PIN	COLOUR	SIZE	FUNCTION
1	RED	4.0mm^2	B+P
2	BLACK	1.5mm^2	B+IGN
3	YELLOW	1.5mm^2	B-IGN
4	BROWN	4.0mm^2	B-
5	WHITE	1.5mm^2	LAMP
6	GREEN/WHITE	1.5mm^2	CAN H
7	BROWN/WHITE	1.5mm^2	CAN L

ISO 7638
(TOWED)

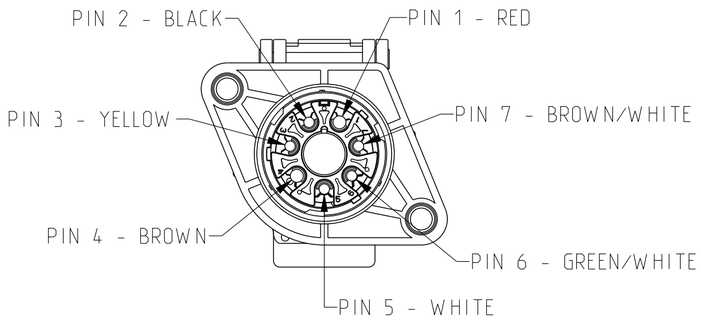
ECU ASSEMBLY

CORE
3 x 0.75mm^2

CONTROL LINE
PRESSURE SENSOR
(OPTIONAL)

ISO 7638
(TOWING)

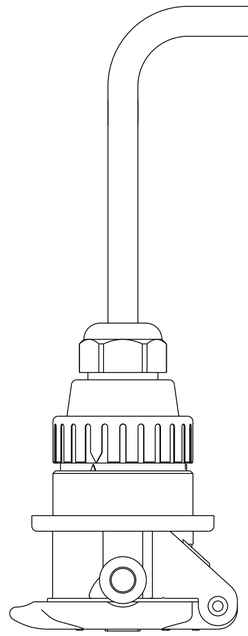
LOCAL EB+ ECU



REAR VIEW OF
ISO 7638 SOCKET

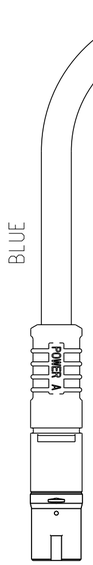
TOLERANCES UNLESS OTHERWISE SPECIFIED: N/A	DOC TYPE: ASSEM	SCALE: NTS	MATERIAL: N/A
THIS DOCUMENT USES SPECIAL CHARACTERISTICS AS DEFINED IN PROCEDURE HDX2-3-364	DRAWN: FIELD	DATE: 20180613	WEIGHT [ONLY FOR INFO.]: - / DIMENSION IN: DO NOT SCALE DRAWING
Haldex	CHECKED: HOLDE	DATE: 20180619	TITLE: CAN HUB (ROUTER) WIRING DIAGRAM
HALDEX BRAKE PRODUCTS LTD, MIRA TECHNOLOGY PARK	APPROVED: AK	DATE: 18/06/20	ITEM NUMBER: 911_552_001 / PROJECTION / SHEET: 1(1) / FORMAT: A2
			GENERIC MODEL (INFO ONLY): 911_552_001

REV	CHANGE DESCRIPTION AND ORDER NUMBER	DATE	CHANGED	CHECKED	APPROVED
0	PR2209 - INITIAL RELEASE	20180613	FIELD	HOLDE	AK

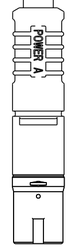


ISO 7638
(TOWED)

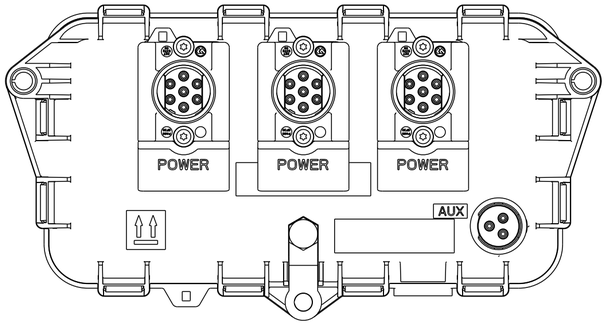
ALL PLUGS CAN BE
INSERTED IN TO
ANY SOCKET



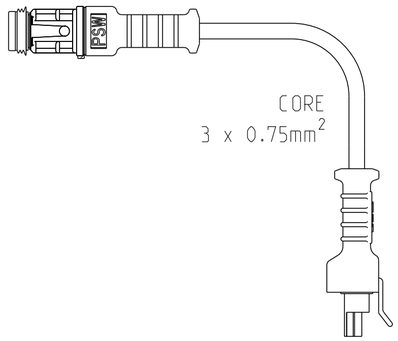
PIN	COLOUR	SIZE	FUNCTION
1	RED	4.0mm^2	B+P
2	BLACK	1.5mm^2	B+IGN
3	YELLOW	1.5mm^2	B-IGN
4	BROWN	4.0mm^2	B-
5	WHITE	1.5mm^2	LAMP
6	GREEN/WHITE	1.5mm^2	CAN H
7	BROWN/WHITE	1.5mm^2	CAN L



LOCAL EB+ ECU

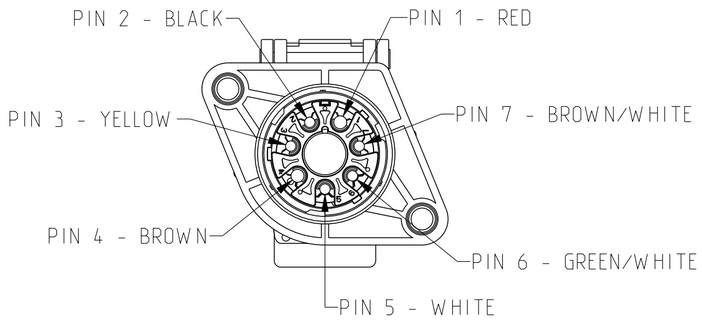


ECU ASSEMBLY



CORE
3 x 0.75mm^2

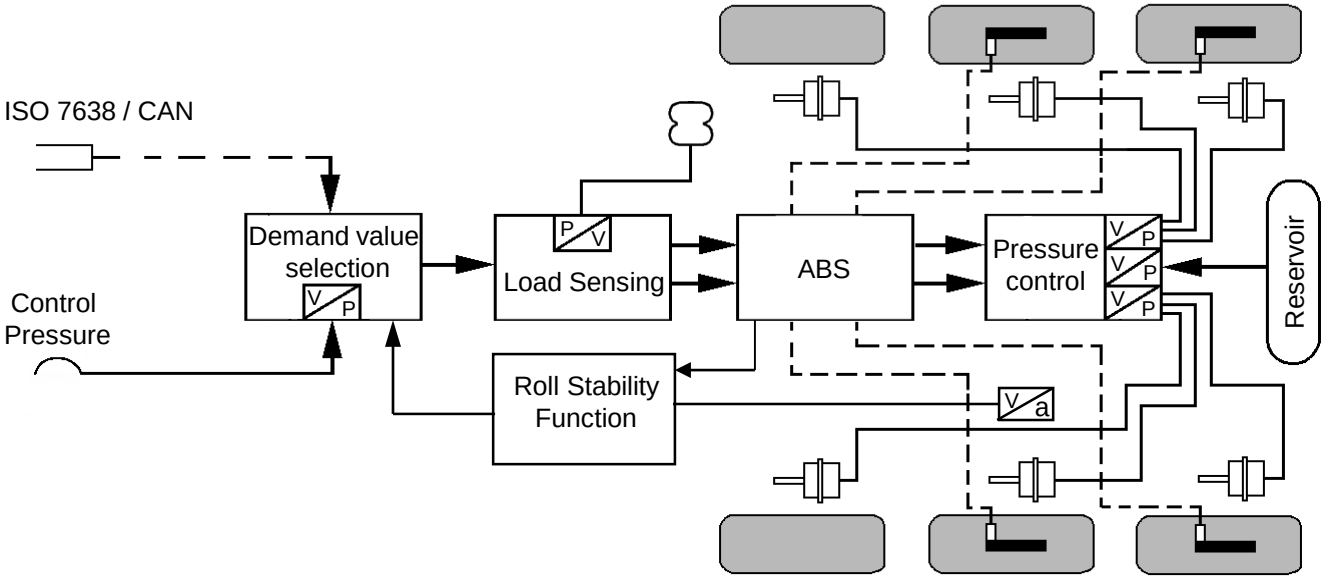
CONTROL LINE
PRESSURE SENSOR
(OPTIONAL)



REAR VIEW OF
ISO 7638 SOCKET

TOLERANCES UNLESS OTHERWISE SPECIFIED: N/A	DOC TYPE: ASSEM	SCALE: NTS	MATERIAL: N/A		
THIS DOCUMENT USES SPECIAL CHARACTERISTICS AS DEFINED IN PROCEDURE HDX2-3-364	DRAWN: FIELD	DATE: 20180613	WEIGHT [ONLY FOR INFO.]: -	DIMENSION IN: DO NOT SCALE DRAWING	
Haldex HALDEX BRAKE PRODUCTS LTD MIRA TECHNOLOGY PARK	CHECKED: HOLDE	DATE: 20180619	TITLE: CAN HUB (REPEATER) WIRING DIAGRAM		
	APPROVED: AK	DATE: 18/06/20	ITEM NUMBER: 911_553_001	PROJECTION	SHEET: 1(1) / FORMAT: A2
			GENERIC MODEL (INFO ONLY): 911_553_001		

EB+ Functional Blocks



R13 190534

Example Semi Trailer 'Load Plate'

Haldex	EB+ ADR TÜ.EGG.094-04			2S/2M Stability		S1A S1B	520mm 100t	S2A S2B	
TRAILER MANUFACTURER FAHRZEUGHERSTELLER PRODUCTUEUR DE VEHICULE	Haldex			BRAKE CALCULATION NO. BREMSBERECHNUNGSNUMMER CALCUL DE FREINAGE NO.		BC123456/1			
CHASSIS NUMBER FAHRGESTELLNUMMER NUMERO DE CHASSIS	12345678901234567			TYPE TYP TYPE		Semi			
THRESHOLD PRESSURE ANSPRECHDRUCK PRESSION D'APPROCHE [bar]	0.20			PRESSURE LIMIT DRUCKBEGRENZUNG LIMITE DE PRESSION [bar]		-			
E11 13R - 123456	UNLADEN / LEER / A VIDE			LADEN / BELADEN / EN CHARGE					
	INPUT PRESSURE EINGANGSDRUCK PRESSION D'ENTRÉE [bar]		6.50	INPUT PRESSURE EINGANGSDRUCK PRESSION D'ENTRÉE [bar]		0.70	-	-	6.50
	AXLE LOAD ACHSLAST CHARGE ESSIEU [kg]	SUSPENSION PRESSURE BALGDRUCK PRESSION DE SUSPENSION [bar]	OUTPUT PRESSURE AUSGANGSDRUCK PRESSION DE SORTIE [bar]	AXLE LOAD ACHSLAST CHARGE ESSIEU [kg]	SUSPENSION PRESSURE BALGDRUCK PRESSION DE SUSPENSION [bar]	OUTPUT PRESSURE AUSGANGSDRUCK PRESSION DE SORTIE [bar]			
1 AXLE 1 ACHSE 1 ESSIEU	3000	0.70	3.00	9000	5.00	0.50	-	-	6.50
2 AXLE 2 ACHSE 2 ESSIEU	3000	0.70	3.00	9000	5.00	0.50	-	-	6.50
3 AXLE 3 ACHSE 3 ESSIEU	3000	0.70	3.00	9000	5.00	0.50	-	-	6.50

[Generated by Haldex DIAG+ V5.00]

Chassis Installation - External Lateral Accelerometer

POSITION OF EB+ STABILITY ASSEMBLY

Assembly must be mounted so that the direction of the cable is facing the RIGHT HAND side of the vehicle. Right hand is as if sat in the driver's seat facing forward.

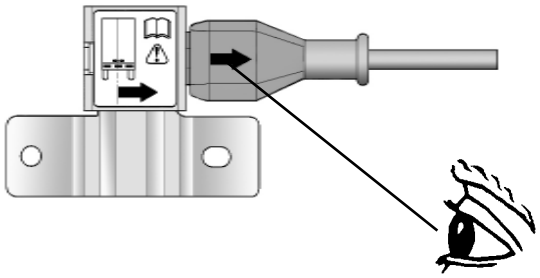
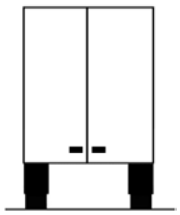


Fig 2

The following installation paramerters are required for correct operation.

The parameters are applicable to the trailer being on FLAT LEVEL GROUND

Roll angle : ± 3° (1:20)



Rear End view

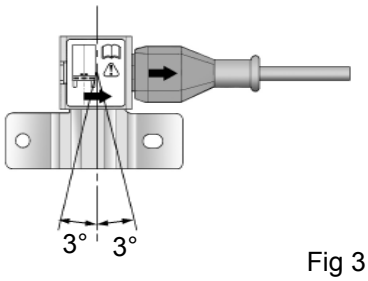
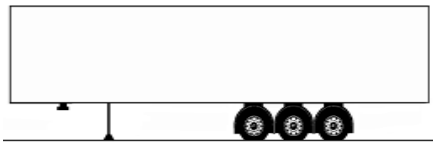


Fig 3

Pitch angle : 360°



Side view

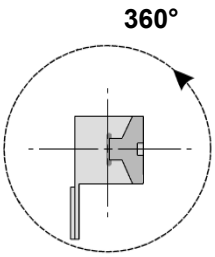


Fig 4

Yaw angle : ± 5°

Plan view

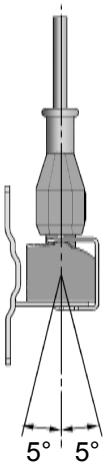


Fig 5

Chassis Installation - External Lateral Accelerometer

The EB+ STABILITY is to be mounted within distance X and Y from the centre line of the rear axle group / bogie, (includes any lift axles).

The EB+ STABILITY to be within the main Left Hand (LH) and Right Hand (RH) chassis members of the vehicle.

A: Single axle
B: Tandem axle
C: Tri-Axle

Trailer	X	Y
Semi	1.5m	1.5m
Centre-axle	1.5m	1.5m
Full	3.0m	1.5m

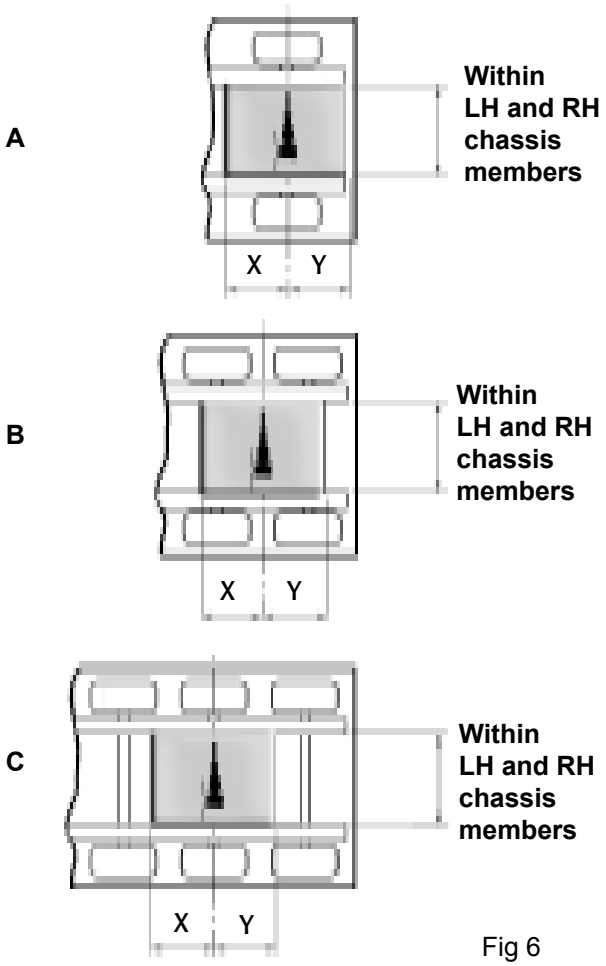


Fig 6

Position EB+ STABILITY assembly as high as possible in the chassis to provide as much protection to the assembly from direct spray and other road debris.

DO NOT mount EB+ STABILITY to deck of trailer.

Care should be taken to provide reasonable access to the EB+ STABILITY for replacement .

D= 150mm minimum
E= 1. Assembly to be above axle centre line.
2. To be as high in frame as possible.

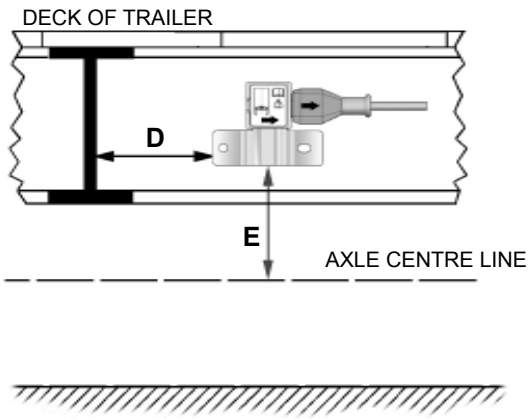


Fig 7

EB+ STABILITY MUST BE mounted directly to a rigid part of the vehicle structure.

Any additional bracket design to be as rigid as possible.

The mounting foot of the EB+ STABILITY bracket to be in full contact with the mounted surface.

Mounting bracket flatness to be not more than 0.5mm deviation from its true plane.
i.e. the surface must lie between two parallel planes 0.5mm apart.

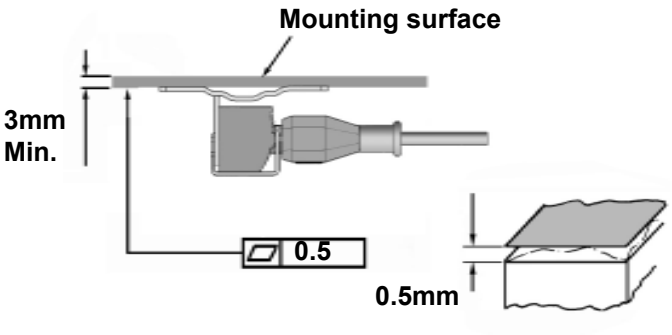


Fig 8

R13 190534

Chassis installation

Position of EB+ Gen3 assembly on Semi, Centre axle and Full Trailers

The following installation parameters are required for correct stability operation.

Roll angle : ± 3 ° (1:20)

Yaw angle : ± 5 °

The EB+ Gen3 system is to be mounted within distance X & Y from the centre line of the rear axle group / bogie (includes lift axles).

Trailer	X	Y
Semi	1.5 m	1.5 m
Centre-axle	1.5 m	1.5 m
Full	3.0 m	1.5 m

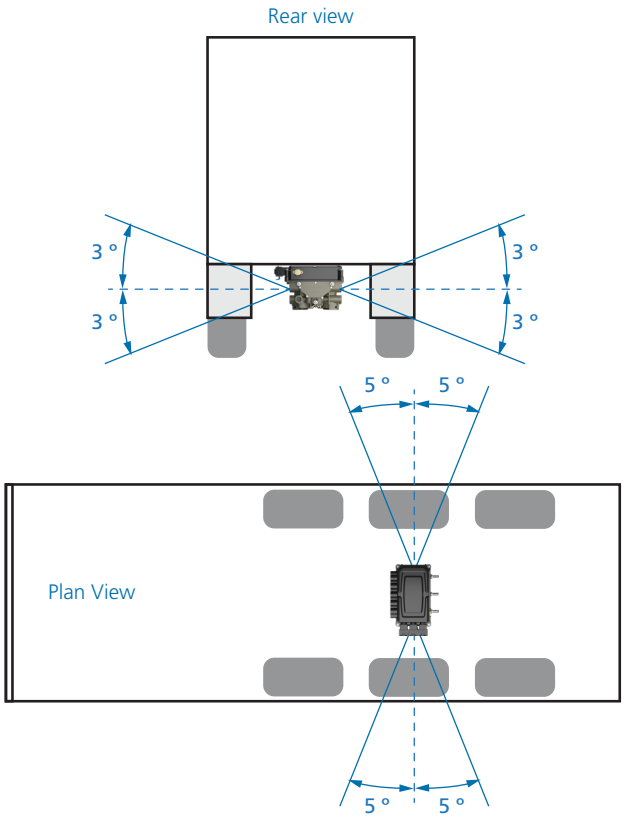
Haldex recommended position for maximum stability performance. Fitment of EB+ Gen3 outside of this area may affect the stability performance.

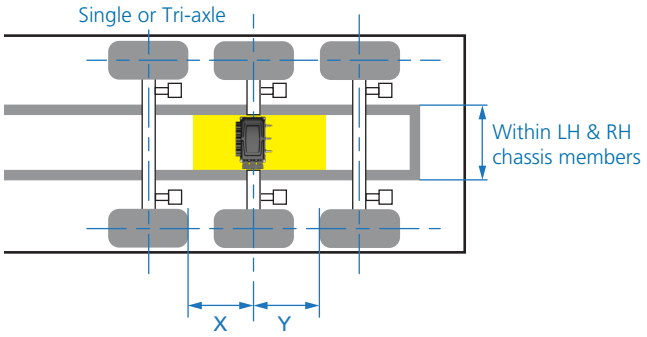
The EB+ Gen3 assembly to be within the main left hand (LH) and right hand (RH) chassis members of the vehicle.

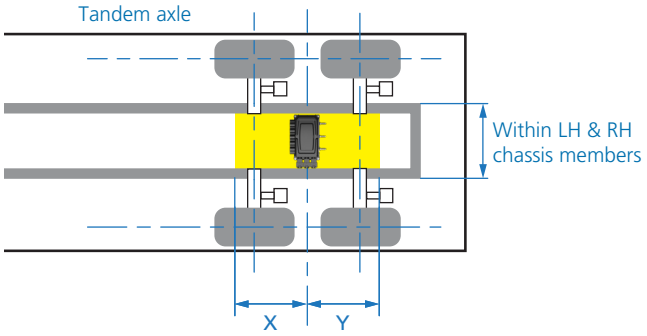
For any other applications please refer to Haldex Technical Services.

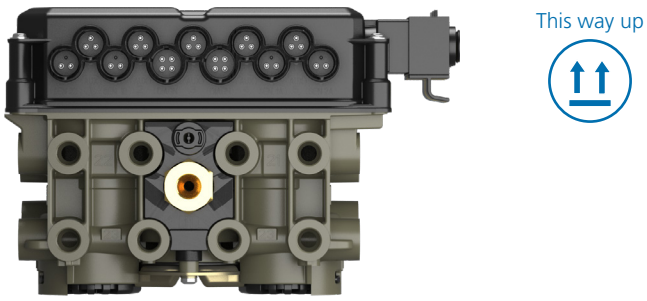
Pitch angle: assembly must be mounted vertically.

The assembly should not be in direct spray or splash water area and should be protected against high pressure cleaning.









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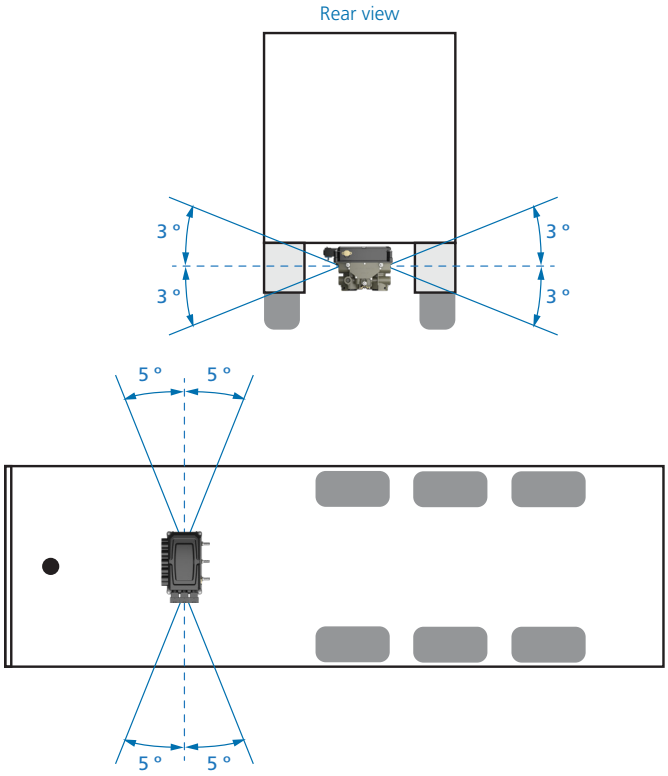
Position of EB+ Gen3 assembly on Inloader Trailers

Refer to the trailer Inloader system configuration diagrams for individual installations using 2 or 4 relay valves.

The following installation parameters are required for correct stability operation.

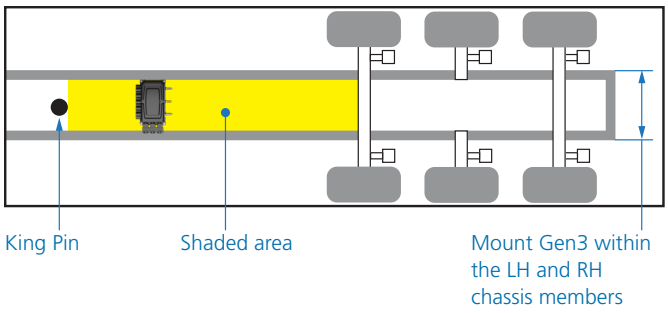
Roll angle : ± 3 ° (1:20)

Yaw angle : ± 5 °



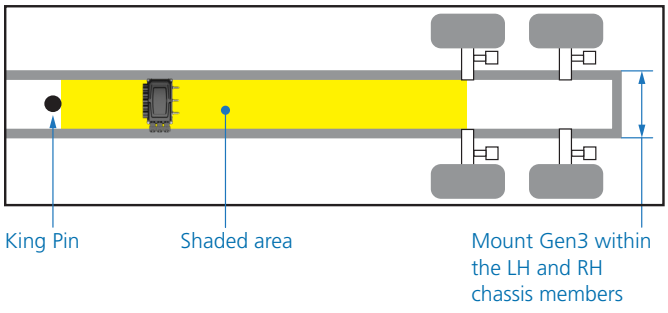
The EB+ Gen3 system is to be mounted within the distance between the trailer King Pin and the 1st axle, as shown by the shaded area.

Haldex recommended position for maximum stability performance. Fitment of EB+ Gen3 outside of this area may affect the stability performance.



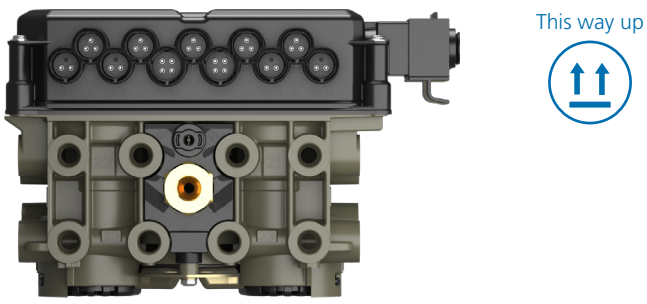
The EB+ Gen3 assembly to be within the main left hand (LH) and right hand (RH) chassis members of the vehicle.

For any other applications please refer to Haldex Technical Services.



Pitch angle: assembly must be mounted vertically.

The assembly should not be in direct spray or splash water area and should be protected against high pressure cleaning.



R13 190534

Vehicle Certification Agency

THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

COMMUNICATION CONCERNING THE ~~APPROVAL GRANTED~~ [1]/ APPROVAL EXTENDED [1]/ ~~APPROVAL REFUSED~~ [1]/ ~~APPROVAL WITHDRAWN~~ [1]/ ~~PRODUCTION DEFINITIVELY DISCONTINUED~~ [1] OF A TYPE OF ELECTRICAL/ ELECTRONIC SUB-ASSEMBLY [1] WITH REGARD TO REGULATION NO. 10.05

E11 Approval No: 10R-057673

Extension No: 05

1. Make (trade name of manufacturer): Haldex Brake Products Ltd.

2. Type and general commercial description(s):
EB+ GEN 3 Electronically controlled braking system

3. Means of identification of type, if marked on the ~~vehicle~~/component/~~separate technical unit~~: [1]
2 EB+ Gen 3 variants as follows:
823 008 XXX Standalone 2M
823 034 XXX Master Assembly 3M

3.1. Location of that marking: On the ESA

4. Category of vehicle: Not applicable

5. Name and address of manufacturer:

Haldex Brake Products Ltd.
MIRA Technology Park
Lindley
Warwickshire
CV13 6DE
United Kingdom

Vehicle Certification Agency 09-Jul-19

EAU452919

6. In the case of components and separate technical units, location and method of affixing of the approval mark: A label attached to the unit casing

7. Address(es) of assembly plant(s):

In-Tech Electronics Limited
Qihang Industrial Zone No.2,
Hao Ziang Road, Shajing
Bao An, Shenzhen
People's Republic of China

Haldex Brake Products GmbH
Mittelgewannweg
69123 Heidelberg
Germany

8. Additional information (where applicable): See appendix

9. Technical Service responsible for carrying out the tests: HORIBA MIRA Ltd.

10. Date of test report: As before and 19 June 2019

11. No. of test report: As before and 1219535#01

12. Remarks (if any): Approval to supplement 1

See appendix

13. Place: BRISTOL

14. Date: 09 JULY 2019

15. Signature:

D LAWLOR
Chief Technical and Statutory Operations Officer

16. The index to the information package lodged with the Approval Authority, which may be obtained on request, is attached.

17. Reasons for extension: Obsolescence of Solenoid and Auxiliary Driver Circuits

(1) Strike out what does not apply.

Appendix

to type-approval communication form No. E11 10R-057673 Extension 05

concerning the type-approval of an electrical/electronic sub-assembly under Regulation No. 10.05

1. Additional information:

1.1. Electrical system rated voltage: 12V or 24V ~~pos~~/neg ground (1)

1.2. This ESA can be used on any vehicle type with the following restrictions:
Negative ground vehicles only

1.2.1. Installation conditions, if any:
Fitting is to be done in accordance with Haldex installation instructions

1.3. This ESA can be used only on the following vehicle types: Not applicable

1.3.1. Installation conditions, if any: Not applicable

1.4. The specific test method(s) used and the frequency ranges covered to determine immunity were: (Please specify precise method used from Annex 9):
800 mm Stripline Method, 20 MHz to 400 MHz
Free Field Method, 400 MHz to 2000 MHz

1.5. Laboratory accredited to ISO 17025 and recognized by the Approval Authority responsible for carrying out the tests:

HORIBA MIRA Ltd
Watling Street
Nuneaton
Warwickshire
CV10 0TU
United Kingdom

2. Remarks: See Haldex GS0537, Issue 8, Dated 05/12/18

(1) Strike out what does not apply.

Document Control

Note ECU/valve assembly 823 034 001 submitted as representative of the type for EMC considerations contains electronic assembly 003 9604 19 as listed below.

ECUs for control of up to three air brake modulators

Final assembly	823 034 XXX
ECU assembly	003 9604 19 issue 1
ECU schematic	911 512 001 issue 9
PCB assembly	003 9598 19 issue 2

ECUs for control of up to two air brake modulators

Final assembly	823 008 XXX
ECU assembly	003 9602 19 issue 1
ECU schematic	911 519 001 issue 9
PCB assembly	003 9596 19 issue 2

PCB un-populated (all variants)	042 7293 09	issue 4
Wiring diagram	911 523 001	issue 1
Software	042 7291 09	
Accelerometer	042 6782 09	issue 1
Over moulding for accelerometer	815 012 000 1	issue 9

Valve Assembly Electronic Components

Apply solenoid	041 5066 09 issue 1
Hold solenoid	041 5067 09 issue 1
Dump solenoid	041 5068 09 issue 1

Left hand pressure transducer assembly	041 5064 09 issue 2
Right hand pressure transducer assembly	041 5065 09 issue 2

Accelerometer 042 6782 09 issue 1 has approvals as follows:

e11*72/245*2004/104*3819*00

10R-023819

Variants

The electronic hardware variants of the EB+ Gen 3 system are described below.

Control Assembly

The part number of the assembly is uniquely assigned according to the combination of functional mechanical features fitted within the valve body. This part number is of the form 823 YYY XXX. YYY can be any number listed in the table below. Fixed combinations of ECU hardware, mechanical and port combination variants of the pneumatic valve are manufactured that result in the part number table below. XXX can be any number 000 to 999 inclusive reflecting mechanical and port combination differences.

Final Assembly Part Number	Assembly Description
823 008 XXX	Standalone 2M
823 034 XXX	Master Assembly 3M

Slave Assembly

The only ECU variant for a EB+ Gen 3 system has assembly part number: 812 015 001

Accelerometer

This is an optional external auxiliary; part number 042 6782 09 is the variant that has a connector mounted on its body. Variants with permanently attached cables are 815 012 0XX, where XX defines the cable configuration.

CAN Repeater

This is an optional additional ECU fitted to EB+ Gen 3 installations with part number 820 020 XXX fitted to extend the physical ISO 11992 CAN communications link by 40m. The CAN repeater is used to provide EBS on extended or long trailer vehicles.

CAN Hub

This is an optional additional ECU fitted to EB+ Gen 3 installations with part number 815 057 XXX. It has similar but extended functionality compared to the CAN Repeater product in that it provides the repeater functionality for extended or long trailers but also a CAN Hub facility where a separate CAN bus needs to be created for road train situations.

Appendix 3 – List of variants covered by the approval

The following EB+ Gen 3 variants are covered by this approval:

Final Assembly Part Number	Assembly Description
823 008 XXX	Standalone 2M
823 034 XXX	Master Assembly 3M

XXX can be any number 000 to 999 inclusive.

Vehicle Certification Agency

THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

COMMUNICATION CONCERNING THE APPROVAL GRANTED [1]/ ~~APPROVAL EXTENDED~~ [1]/ ~~APPROVAL REFUSED~~ [1]/ ~~APPROVAL WITHDRAWN~~ [1]/ ~~PRODUCTION DEFINITIVELY DISCONTINUED~~ [1] OF A TYPE OF ELECTRICAL/ ELECTRONIC SUB-ASSEMBLY [1] WITH REGARD TO REGULATION NO. 10.05

E11 Approval No: E11*10R05/01*11053*00

1. Make (trade name of manufacturer): Haldex Brake Products Ltd.

2. Type and general commercial description(s): CAN Hub

3. Means of identification of type, if marked on the ~~vehicle~~/component/~~separate technical unit~~: [1]
Self-adhesive label

3.1. Location of that marking: On the front face of the product

4. Category of vehicle: Not applicable

5. Name and address of manufacturer:

Haldex Brake Products Ltd.
MIRA Technology Park
Lindley
Nuneaton
Warwickshire
CV13 6DE
United Kingdom

6. In the case of components and separate technical units, location and method of affixing of the approval mark: A label attached to the unit casing

R13 190534

EAU421166

UK Approval Authority Vehicle Certification Agency 16-Jan-20

7. Address(es) of assembly plant(s):

Integrated Micro - Electronics d.o.o. Niš
IMI 1
18205 Niška Banja, Niš,
Serbia

8. Additional information (where applicable): See Appendix

9. Technical Service responsible for carrying out the tests: HORIBA MIRA Ltd.

10. Date of test report: 11 November 2019

11. No. of test report: 1217058#01

12. Remarks (if any):

See Appendix

13. Place: BRISTOL

14. Date: 16 JANUARY 2020

15. Signature:

D LAWLOR
Chief Technical and Statutory Operations Officer

16. The index to the information package lodged with the Approval Authority, which may be obtained on request, is attached.

17. Reasons for extension: Not applicable

(1) Strike out what does not apply.

Appendix

to type-approval communication form No. E11*10R05/01*11053*00

concerning the type-approval of an electrical/electronic sub-assembly under Regulation No. 10.05

1. Additional information:

1.1. Electrical system rated voltage: 12V or 24V ~~pos~~/neg ground (1)

1.2. This ESA can be used on any vehicle type with the following restrictions:
12V or 24V negative ground vehicles only

1.2.1. Installation conditions, if any: In accordance with Haldex installation instructions

1.3. This ESA can be used only on the following vehicle types: Not applicable

1.3.1. Installation conditions, if any: Not applicable

1.4. The specific test method(s) used and the frequency ranges covered to determine immunity were: (Please specify precise method used from Annex 9):

800mm Stripline from 20MHz to 400MHz
Absorber Line Chamber from 400 MHz to 2000 MHz

1.5. Laboratory accredited to ISO 17025 and recognized by the Approval Authority responsible for carrying out the tests:

HORIBA MIRA Ltd.
Watling Street
Nuneaton
Warwickshire
CV10 0TU
United Kingdom

2. Remarks: None

(1) Strike out what does not apply.

Vehicle Certification Agency

THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

APPROVAL NUMBER: E11*10R05/01*11053*00

INFORMATION PACKAGE CONTENTS

INDEX REVISION NUMBER: Not applicable

Conformity of Production (COP) Declaration	**COP Confirmed**
Assessment Method	**ISO/TS Cert and Control Plans**
Date of Initial Clearance	**November 2019**
Date of Last Clearance	**November 2019**

Total number of sheets: 15 (Fifteen)

Reasons for Revision: Not applicable

R13 190534

Revision Date
&
Office Stamp

UK Approval Authority | Vehicle Certification Agency
16-Jan-20

Document Control

The issue levels of the relevant controlled documents are:

Complete assembly	815 057 001 issue 1
PCB assembly	003 9504 09 issue 1
PCB assembly parts list	003 9503 09 issue 1
Software drawing	042 7768 09 issue 1
Printed circuit board (unpopulated)	042 7688 09 issue 1
Assembly schematic	911 547 001 issue 1
Wiring diagram – CAN Router	911 552 001 issue 1

Notes

1. The EB+ Gen 3 2M ECU part number 823 008 001 used during the EMC assessment of the CAN Hub assembly has approval 10R-057673.
2. The remote-control line pressure transducer 815 022 xxx has approval 10R-034038.

Product Approval History

Date originally tested

Approval number

Date originally approved

First Subsequent Revision

New approval number

Date of new approval

Appendix 2 – Information Required for ECE R10.05 Annex 2B

1 **Make (trade name of manufacturer):** Haldex Brake Products Ltd.

2 **Type:** CAN Hub

3 **Means of identification of type, if marked on the component/separate technical unit:**

Self-adhesive label.

3.1 **Location of that marking:**

Label located on the front face of the product

4 **Name and address of manufacturer:**

Haldex Brake Products Limited
MIRA Technology Park
Lindley
CV13 6DE
United Kingdom

5 **In the case of components and separate technical units, location and method of affixing of the ECE type approval mark:**

A label attached to the unit casing.

6 **Address(es) of the assembly plant(s):**

Integrated Micro-Electronics d.o.o. Nis
IMI 1
18205 Niska Banja, Nis
Srbija

7 **This ESA shall be approved as a component**

8 **Restrictions of use and conditions for fitting:**

12V or 24V negative ground vehicles only.

Fitting is to be in accordance with Haldex installation instructions.

9 **Electrical system rated voltage:**

12 V or 24V, negative ground.

Appendix 3 – List of variants covered by the approval

This approval covers the following CAN Hub variants:

Final Assembly Part Number	Assembly Description
815 057 001	CAN Hub

VCA Headquarters
1 The Eastgate Office Centre
Eastgate Road
Bristol, BS5 6XX
United Kingdom

Switchboard: +44 (0) 117 951 5151
Main Fax: +44 (0) 117 952 4103
Email: enquiries@vca.gov.uk
Web: www.vca.gov.uk

THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

E11

COMMUNICATION CONCERNING THE ~~APPROVAL GRANTED~~ [2]/ APPROVAL EXTENDED [2]/ ~~APPROVAL REFUSED~~ [2]/ ~~APPROVAL WITHDRAWN~~ [2]/ ~~PRODUCTION DEFINITELY DISCONTINUED~~ [2] OF A TYPE OF ELECTRICAL/ ELECTRONIC SUB-ASSEMBLY [2] WITH REGARD TO REGULATION NO. 10.03

Approval No: 10R-033942 Extension No: 06

1. Make (trade name of manufacturer): Haldex Brake Products Ltd

2. Type and general commercial description(s): EB+ 2M GEN 2 Electronically Controlled Braking System

3. Means of identification of type, if marked on the ~~vehicle~~/component/~~separate technical unit~~ [2]: See the manufacturer's documentation GS0394 Issue 8 Appendix 3 for the applicable part number

   3.1. Location of that marking: On the ESA

4. Category of vehicle: Not applicable

5. Name and address of manufacturer:
   Haldex Brake Products Ltd
   Moons Moat Drive
   Moons Moat North
   Redditch
   Worcestershire
   B98 9HA
   United Kingdom

6. In the case of components and separate technical units, location and method of affixing of the ECE approval mark: A label attached to the unit casing

EAM235517

7. Address(es) of assembly plant(s):

MSL Circuits
Number 6-3 AV.
Parc D'Activitie Synergie
Val-De-Loire
45130 Meung Sur Loire
France

Haldex Brake Products GmbH
Mittelgewannweg 27
69123 Heidelberg
Germany

8. Additional information (where applicable): See Appendix

9. Technical Service responsible for carrying out the tests: MIRA, Nuneaton

10. Date of test report: As before and 20 April 2011

11. No. of test report: As before and Technical Review EAM235517

12. Remarks (if any): See Appendix

13. Place: Bristol

14. Date: 13 MAY 2011

15. Signature:

A. W. STENNING
Head of Technical and Quality Group

16. The index to the information package lodged with the Approval Authority, which may be obtained on request, is attached.

17. Reasons for extension: To cover
1) Additional ECU assembly part numbers for new product variants
2) Component and PCB layout changes

1/ Distinguishing number of the country which issued/extended/refused/withdrew approval (see Regulation provisions on approval).
2/ Strike out what does not apply.

Appendix to type-approval communication form No. 10R-033942 Extension 06 concerning the type-approval of an electrical/electronic sub-assembly under Regulation No. 10.03

1. Additional information:

1.1. Electrical system rated voltage: 24 V. ~~pos~~/neg ground [2]

1.2. This ESA can be used on any vehicle type with the following restrictions: 24 Negative ground vehicles only

1.2.1. Installation conditions, if any: Fitting is to be in accordance with Haldex installation instructions

1.3. This ESA can be used only on the following vehicle types: Not applicable

1.3.1. Installation conditions, if any: Not applicable

1.4. The specific test method(s) used and the frequency ranges covered to determine immunity were: (Please specify precise method used from Annex 9): 800mm stripline (20 to 1000 MHz) and absorber lined chamber (1000 to 2000 MHz)

1.5. Laboratory accredited to ISO 17025 and recognized by the Approval Authority responsible for carrying out the tests: MIRA Limited, Nuneaton, United Kingdom

2. Remarks: Haldex information document GS0394 Issue 8

2/ Strike out what does not apply.

DOCUMENT CONTROL

Note ECU/valve assembly 820 008 000 2 submitted as representative of the type for EMC considerations contains electronic assembly 003 9468 09 as listed below.

All of the following EB+ GEN2 ECUs use a rotary potting enclosure

ECUs with PremiumAux, internal accelerometer, additional auxiliaries and power output

	Haldex	BPW
ECU assembly	003 9469 09 issue 1	003 9474 09 issue 1
ECU schematic	911 497 001 issue 1	911 497 001 issue 1
PCB assembly	003 9464 09 issue 1	003 9483 09 issue 1
PCB assy parts list	003 9466 09 issue 1	003 9466 09 issue 1

ECUs with internal accelerometer, additional auxiliaries and power output

	5 auxiliaries (Haldex)	5 auxiliaries (BPW)
ECU assembly	003 9468 09 issue 1	003 9473 09 issue 1
ECU schematic	911 478 001 issue 1	911 478 001 issue 1
PCB assembly	003 9463 09 issue 2	003 9481 09 issue 1
PCB assy parts list	003 9465 09 issue 1	003 9465 09 issue 1

	3 auxiliaries (Haldex)
ECU assembly	003 9550 09 issue 1
ECU schematic	911 508 001 issue 1
PCB assembly	003 9551 09 issue 1
PCB assy parts list	003 9552 09 issue 1

ECUs with internal accelerometer but without additional auxiliaries or power output

	5 auxiliaries (Haldex)	5 auxiliaries (BPW)
ECU assembly	003 9470 09 issue 1	003 9472 09 issue 1
ECU schematic	911 498 001 issue 1	911 498 001 issue 1
PCB assembly	003 9478 09 issue 1	003 9480 09 issue 1
PCB assy parts list	003 9485 09 issue 1	003 9485 09 issue 1

	3 auxiliaries (Haldex)
ECU assembly	003 9553 09 issue 1
ECU schematic	911 509 001 issue 1
PCB assembly	003 9554 09 issue 1
PCB assy parts list	003 9555 09 issue 1

ECUs without internal accelerometer but with additional auxiliaries and power output

	5 auxiliaries (Haldex)
ECU assembly	003 9471 09 issue 1
ECU schematic	911 499 001 issue 1
PCB assembly	003 9479 09 issue 1
PCB assy parts list	003 9486 09 issue 1

	3 auxiliaries (Haldex)
ECU assembly	003 9556 09 issue 1
ECU schematic	911 510 001 issue 1
PCB assembly	003 9557 09 issue 1
PCB assy parts list	003 9558 09 issue 1

ECUs without internal accelerometer and without additional auxiliaries or power output

	5 auxiliaries (Haldex)	5 auxiliaries (BPW)
ECU assembly	003 9467 09 issue 1	003 9475 09 issue 1

ECU schematic	911 500 001 issue 1	911 500 001 issue 1
PCB assembly	003 9477 09 issue 1	003 9482 09 issue 1
PCB assy parts list	003 9484 09 issue 1	003 9484 09 issue 1
	3 auxiliaries (Haldex)	
ECU assembly	003 9559 09 issue 1	
ECU schematic	911 501 001 issue 1	
PCB assembly	003 9560 09 issue 1	
PCB assy parts list	003 9561 09 issue 1	

PCB un-populated (all variants)	042 7262 09	issue 1
Wiring diagram (Haldex variants)	911 440 001	issue 5
Wiring diagram (BPW variants)	911 473 001	issue 1
Software (all Haldex variants)	042 7210 09	
Software (all BPW variants)	042 7211 09	
Accelerometer	042 6782 09	issue 1
Accelerometer	042 6782 09	issue 2
Over moulding for accelerometer	815 012 000 1	issue 8

Valve Assembly Electronic Components

Apply solenoid	041 5047 09 issue 3
Hold solenoid	041 5049 09 issue 2
Dump solenoid	041 5048 09 issue 2

Left hand pressure transducer assembly	041 5045 09 issue 3
Right hand pressure transducer assembly	041 5046 09 issue 2

Accelerometer 042 6782 09 issue 1 has approvals as follows:

e11*72/245*2004/104*3819*00

10R-023819

APPENDIX 2 – Information Required for 2004/104/EC Annex IIB

0 **General**

0.1 **Make (trade name of manufacturer):** Haldex Brake Products Ltd.

0.2 **Type and general commercial description(s):** EB+ 2M GEN 2 Electronically Controlled Braking System

0.3 **Means of identification of type, if marked on the component/separate technical unit:**

See the manufacturer's documentation GS0394 appendix 3 for applicable part numbers

0.3.1 **Location of that marking:** On the ESA

0.5 **Name and address of manufacturer:**

Haldex Brake Products Ltd.
Moons Moat Drive,
Moons Moat North,
Redditch,
Worcestershire,
England
B98 9HA

0.7 **In the case of components and separate technical units, location and method of affixing of the EC type approval mark :**

A label attached to the unit casing.

0.8 **Address(es) of the assembly plant(s):**

MSL Circuits
No. 6-3 AV.
Parc D'Activitie Synergie
Val-De-Loire
F-45130 Meung Sur Loire
France

Haldex Brake Products GMBH
Mittelgewannweg 27
69123 Heidelberg
West Germany

1 **This ESA shall be approved as a component.**

2 **Restrictions of use and conditions for fitting:**

24V negative ground vehicles only.

Fitting is to be in accordance with Haldex installation instructions.

3 **Electrical system rated voltage:**

24V, Negative ground.

APPENDIX 3 – List of variants covered by the approval

The following EB+ Gen 2 variants are covered by this approval:

With internal accelerometer:

820 001 XXX	2S/2M	3 aux	Without additional aux
820 002 XXX	2S/2M	3 aux	With additional aux
820 003 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 004 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 005 XXX	2S/2M	3 aux	Without additional aux
820 006 XXX	2S/2M	3 aux	With additional aux
820 007 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 008 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 009 XXX	2S/2M	3 aux	Without additional aux
820 010 XXX	2S/2M	3 aux	With additional aux
820 011 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 012 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 025 1XX	2S/2M (4S/2M) – BPW	5 aux	Without additional aux
820 025 2XX	2S/2M (4S/2M) – BPW	5 aux	With additional aux
820 029 XXX	4S/2M (2S/2M) – BPW	Premium Aux	With additional aux
820 030 XXX	4S/2M (2S/2M)	Premium Aux	With additional aux

Without internal accelerometer:

820 013 XXX	2S/2M	3 aux	Without additional aux
820 014 XXX	2S/2M	3 aux	With additional aux
820 015 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 016 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 017 XXX	2S/2M	3 aux	Without additional aux
820 018 XXX	2S/2M	3 aux	With additional aux
820 019 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 020 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 021 XXX	2S/2M	3 aux	Without additional aux
820 022 XXX	2S/2M	3 aux	With additional aux
820 023 XXX	4S/2M (2S/2M)	5 aux	Without additional aux
820 024 XXX	4S/2M (2S/2M)	5 aux	With additional aux
820 025 0XX	2S/2M - BPW	5 aux	Without additional aux

External accelerometer without cable assembly 042 6782 09, with cable assembly 815 012 0XX

VCA Headquarters
1 The Eastgate Office Centre
Eastgate Road
Bristol, BS5 6XX
United Kingdom

Switchboard: +44 (0) 117 951 5151
Main Fax: +44 (0) 117 952 4103
Email: enquiries@vca.gov.uk
Web: www.vca.gov.uk

THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

E11

COMMUNICATION CONCERNING THE ~~APPROVAL GRANTED~~ (2)/ APPROVAL EXTENDED (2)/ ~~APPROVAL REFUSED~~ (2)/ ~~APPROVAL WITHDRAWN~~ (2)/ ~~PRODUCTION DEFINITELY DISCONTINUED~~ (2) OF A TYPE OF ELECTRICAL/ ELECTRONIC SUB-ASSEMBLY (2) WITH REGARD TO REGULATION NO. 10.03

Approval No: 10R-033825 Extension No: 06

1. Make (trade name of manufacturer): Haldex Brake Products Ltd

2. Type and general commercial description(s): EB + 3M Electronically Controlled Braking System

3. Means of identification of type, if marked on the ~~vehicle~~/component/~~separate technical unit~~ (2): See manufacturers documentation GS0328 issue 10 appendix 3 for applicable part numbers

   3.1. Location of that marking: On the ESA

4. Category of vehicle: Not applicable

5. Name and address of manufacturer:
   Haldex Brake Products Ltd
   Moons Moat Drive
   Moons Moat North
   Redditch
   Worcestershire
   B98 9HA
   United Kingdom

6. In the case of components and separate technical units, location and method of affixing of the ECE approval mark: A label attached to the unit casing

R13 190534

25-Jul-12
1
UK Approval Authority

7. Address(es) of assembly plant(s):

Haldex Brake Products GmbH
Mittelgewannweg 27
69123 Heidelberg
Germany

MSL Circuits
No. 6-3 AV.
Parc D'Activitie Synergie
Val-De-Loire
F-45130 Meung Sur Loire
France

8. Additional information (where applicable): See Appendix

9. Technical Service responsible for carrying out the tests: MIRA, UK Limited

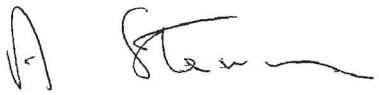
10. Date of test report: As before and 23 July 2012

11. No. of test report: As before and Technical Review EAN257377

12. Remarks (if any): See Appendix

13. Place: BRISTOL

14. Date: 25 JULY 2012

15. Signature: 

A. W. STENNING
Head of Technical and Quality Support Group

16. The index to the information package lodged with the Approval Authority, which may be obtained on request, is attached.

17. Reasons for extension: To cover addition of Slave ECU and Vale assembly

1/ Distinguishing number of the country which issued/extended/refused/withdrew approval (see Regulation provisions on approval).
2/ Strike out what does not apply.

Appendix
to type-approval communication form No. 10R-033825 Extension 06
concerning the type-approval of an electrical/electronic sub-assembly under Regulation No. 10.03

1. Additional information:

1.1. Electrical system rated voltage: 12 V or 24V ~~pos~~/neg ground (2)

1.2. This ESA can be used on any vehicle type with the following restrictions: Negative ground vehicles only

1.2.1. Installation conditions, if any: Generally 24V negative ground vehicles only with the exception of 812 015 001 and 813 012 XXX for 12V or 24V negative ground vehicles. Fitting instructions to be in accordance with Haldex installation instructions

1.3. This ESA can be used only on the following vehicle types: Not applicable

1.3.1. Installation conditions, if any: Not applicable

1.4. The specific test method(s) used and the frequency ranges covered to determine immunity were: (Please specify precise method used from Annex 9): 800 mm stripline (20 to 1000 MHz) and absorber lined chamber (1000 to 2000 MHz)

1.5. Laboratory accredited to ISO 17025 and recognized by the Approval Authority responsible for carrying out the tests: MIRA, UK Limited

2. Remarks: Haldex Information Document GS0328 Issue 10

2/ Strike out what does not apply.

DOCUMENT CONTROL (EB+ 3M Gen 1 Master and Slave ECUs)

The issue levels of the relevant controlled documents are:

System Components.	Master	24V Slave	12/24V Slave
PCB un-populated	042 7009 09 issue 2	042 6772 09 issue 2	042 6772 09 issue 2
ECU assembly	812 010 001 issue 7	812 011 001 issue 5	812 015 001 issue 1
ECU schematic	911 363 001 issue 9	911 364 001 issue 3	911 364 001 issue 3
ECU PCB assembly	003 8939 09 issue 3	003 8935 09 issue 1	003 8935 09 issue 1
PCB assy parts list	003 8940 09 issue 8	003 8943 09 issue 2	003 8943 09 issue 2
Master program code	042 6800 09		042 7291 09 or 042 7311 09
Wiring diagram	911 369 001 issue 4		911 523 001 issue 1

24V Valve Assembly Electrical Components

Apply solenoid	041 5020 09 issue 4	or	041 5031 09 issue 1*
Hold solenoid	041 5021 09 issue 4	or	041 5032 09 issue 1*
Dump solenoid	041 5022 09 issue 4	or	041 5033 09 issue 1*

12/24V Valve Assembly Electrical Components

Apply solenoid	041 5066 09 issue 1
Hold solenoid	041 5067 09 issue 1
Dump solenoid	041 5068 09 issue 1

13.5 bar abs/12.5 bar gauge pressure transducer

041 5025 09 issue 3 or
041 5030 09 issue 3 or
041 5029 09 issue 3*

9 bar abs/8 bar gauge pressure transducer

041 5024 09 issue 5
041 5027 09 issue 4
041 5028 09 issue 3*

Flexible PCB used with * 042 6876 09 issue 1

Accelerometer

042 6782 09 issue 1
042 6782 09 issue 2

Note

042 6782 09 issue 2 has approval e11*72/245*2004/104*3819*00 and 10R-023819
Overmoulding for accelerometer 815 012 000 1 issue 5

DOCUMENT CONTROL (EB+ 3M Gen 2 Master ECU/Valve Assembly)

The 3M Master ECU/valve assembly 820 026 000 2 submitted as representative of the type for EMC considerations has been manufactured using the controlled documents listed below.

ECU assembly	003 9294 09 issue 1
PCB assembly	003 9296 09 issue 1
PCB assy parts list	003 9297 09 issue 1
Software drawing	042 7021 09 issue 7
PCB un-populated	042 7104 09 issue 2
ECU schematic	911 457 001 issue 3

The same electronic assemblies, drawings and software listed above are used for both variants of 3M Master ECU 820 026 xxx and 820 027 xxx.

3M Master ECU variant 820 026 XXX

Wiring diagram 911 461 001 issue 1

3M Master ECU variant 820 027 XXX

Wiring diagram 911 467 001 issue 1

Valve Assembly Electronic Components

Apply solenoid	041 5047 09 issue 3
Hold solenoid	041 5049 09 issue 2
Dump solenoid	041 5048 09 issue 2

Left hand pressure transducer assembly

041 5045 09 issue 3

Right hand pressure transducer assembly

041 5046 09 issue 2

APPENDIX 2 – Information Required for 2009/19/EC Annex IIB

0 **General**

0.1 **Make (trade name of manufacturer):** Haldex Brake Products Ltd.

0.2 **Type and general commercial description(s):** EB+ 3M Electronically Controlled Braking System

0.3 **Means of identification of type, if marked on the component/separate technical unit:**

See the manufacturer's documentation GS0328 appendix 3 for applicable part numbers

0.3.1 **Location of that marking:** On the ESA

0.5 **Name and address of manufacturer:**

Haldex Brake Products Ltd.
Moons Moat Drive,
Moons Moat North,
Redditch,
Worcestershire,
England
B98 9HA

0.7 **In the case of components and separate technical units, location and method of affixing of the EC type approval mark :**

A label attached to the unit casing.

0.8 **Address(es) of the assembly plant(s):**

MSL Circuits
No. 6-3 AV.
Parc D'Activitie Synergie
Val-De-Loire
F-45130 Meung Sur Loire
France

Haldex Brake Products GMBH
Mittelgewannweg 27
69123 Heidelberg
West Germany

1 **This ESA shall be approved as a component.**

2 **Restrictions of use and conditions for fitting:**

Generally 24V negative ground vehicles only with the exception of 812 015 001 & 813 012 XXX for 12V or 24V negative ground vehicles.

Fitting is to be in accordance with Haldex installation instructions.

3 **Electrical system rated voltage:**

Generally 24V, Negative ground with the exception of 812 015 001 & 813 012 XXX for 12V or 24V negative ground vehicles.

APPENDIX 3 – List of Variants Covered by the Approval

The following variants are covered by this approval:

EB+ 3M Gen 1 Master 3M ECU	812 010 001
EB+ 24V Slave 3M ECU	812 011 001
EB+ 12/24V Slave 3M ECU	812 015 001
EB+ 3M Gen 1 Master Valve Assembly	813 00X 3XX
EB+ 24V Slave Valve Assy with suspension pressure transducer	813 010 XXX
EB+ 24V Slave Valve Assy without suspension pressure transducer	813 011 XXX
EB+ 12/24V Slave Valve Assy with suspension pressure transducer	813 012 XXX
EB+ 3M Gen 2 Master 3M ECU/Valve Assembly	820 026 XXX
EB+ 3M BPW ECOtronic	820 027 XXX
Accelerometer without cable assembly	042 6782 09
Accelerometer with cable assembly	815 012 0XX

Notes

1. Optional fitment of remote control line pressure transducer 815 022 XXX has approvals as follows:
   e11*72/245*2009/19*4038 and 10R-034038
2. Optional fitment of external accelerometer 042 6782 09 issue 2 has approval as follows:
   e11*72/245*2004/104*3819*00 and 10R-023819
3. Overmoulding for accelerometer 815 012 000 1 issue 5
   'X' can be any number 0-9, signifying a specific variation in mechanical configuration.

VCA Headquarters
1 The Eastgate Office Centre
Eastgate Road
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United Kingdom

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THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

E11

COMMUNICATION CONCERNING THE ~~APPROVAL GRANTED~~ (2)/ APPROVAL EXTENDED (2)/ ~~APPROVAL REFUSED~~ (2)/ ~~APPROVAL WITHDRAWN~~ (2)/ ~~PRODUCTION DEFINITELY DISCONTINUED~~ (2) OF A TYPE OF ELECTRICAL/ ELECTRONIC SUB-ASSEMBLY (2) WITH REGARD TO REGULATION NO. 10.03

Approval No: 10R-034038 Extension No: 03

1. Make (trade name of manufacturer): Haldex Brake Products Ltd

2. Type and general commercial description(s): Remote Pressure Transducer. See the manufacturer's documentation GS0399 Appendix 3 for applicable part numbers

3. Means of identification of type, if marked on the ~~vehicle/~~component/~~separate technical unit~~ (2): Self adhesive label

   3.1. Location of that marking: On the unit casing

4. Category of vehicle: Not applicable

5. Name and address of manufacturer:
   Haldex Brake Products Ltd
   Moons Moat Drive
   Moons Moat North
   Redditch
   Worcestershire
   B98 9HA
   United Kingdom

6. In the case of components and separate technical units, location and method of affixing of the ECE approval mark: A self-adhesive label attached to the unit casing

7. Address(es) of assembly plant(s): See point 5 above

R13 190534

18-Apr-11
1
UK Approval Authority

8. Additional information (where applicable): See Appendix

9. Technical Service responsible for carrying out the tests: MIRA, Nuneaton

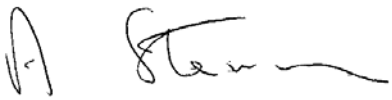
10. Date of test report: As before and 12 April 2011

11. No. of test report: As before and Technical Review EAM235513

12. Remarks (if any): See Appendix

13. Place: Bristol

14. Date: 18 APRIL 2011

15. Signature: 

A. W. STENNING
Head of Technical and Quality Group

16. The index to the information package lodged with the Approval Authority, which may be obtained on request, is attached.

17. Reasons for extension: To cover upgrade to amended level from R10.02 to R10.03

1/ Distinguishing number of the country which issued/extended/refused/withdrew approval (see Regulation provisions on approval).
2/ Strike out what does not apply.

Appendix to type-approval communication form No. 10R-034038 Extension 03 concerning the type-approval of an electrical/electronic sub-assembly under Regulation No. 10.03

1. Additional information:.

1.1. Electrical system rated voltage: 5 V. ~~pos~~/neg ground (2)

1.2. This ESA can be used on any vehicle type with the following restrictions: Negative ground vehicles only

1.2.1. Installation conditions, if any: Fitting is to be in accordance with Haldex installation instructions

1.3. This ESA can be used only on the following vehicle types: Not applicable

1.3.1. Installation conditions, if any: Not applicable

1.4. The specific test method(s) used and the frequency ranges covered to determine immunity were: (Please specify precise method used from Annex 9): 800 mm stripline 20 to 1000 MHz, absorber lined chamber 1000 to 2000 MHz

1.5. Laboratory accredited to ISO 17025 and recognized by the Approval Authority responsible for carrying out the tests: MIRA, Nuneaton, UK

2. Remarks: None

2/ Strike out what does not apply.

Document Control

The issue level for the controlled documents is

Pressure Transducer	815 022 000 2	issue 4

Appendix 2 - Information Required for 2004/104/EC Annex IIB

0 **General**

0.1 **Make (trade name of manufacturer):** Haldex Brake Products Ltd.

0.2 **Type and general commercial description(s):** Remote Pressure Transducer

0.3 **Means of identification of type, if marked on the component/separate technical unit:**

See the manufacturer's documentation GS0399 appendix 3 for part numbers

0.3.1 **Location of that marking:** On the component

0.5 **Name and address of manufacturer:**

Haldex Brake Products Ltd.
Moons Moat Drive,
Moons Moat North,
Redditch,
Worcestershire,
B98 9HA
U.K.

0.7 **In the case of components and separate technical units, location and method of affixing of the EC type approval mark :**

A label attached to the unit casing.

0.8 **Address(es) of the assembly plant(s):**

As 0.5 above

1 **This ESA shall be approved as a component.**

2 **Restrictions of use and conditions for fitting:**

Negative earth vehicles only. Fitting is to be in accordance with Haldex installation instructions.

3 **Electrical system rated voltage:**

5V D.C. regulated from the vehicle supply

Negative ground.

Appendix 3

The following variants are covered by the approval:

Pressure transducers with part numbers 815 022 X0X and 815022 X1X

Note. 'X' can be any number 0-9, signifying a specific variation in mechanical configuration.

Kraftfahrt-Bundesamt

DE-24932 Flensburg

E1

MITTEILUNG

ausgestellt von:
Kraftfahrt-Bundesamt

über die Erweiterung einer Genehmigung
eines Typs einer elektrischen/elektronischen Unterbaugruppe nach der Regelung Nr.10 einschließlich Änderung Nr. 05 Ergänzung 01

COMMUNICATION

issued by:
Kraftfahrt-Bundesamt

concerning the extension of an approval
of a type of electrical/electronic sub-assembly with regard to Regulation No.10 including amendment No 05 supplement 01

Genehmigungsnummer: **E1*10R05/01*5852*01**
Approval number:

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

2. Typ:
Type:
Drehwinkelsensor

Ausführung(en):
Version(s):
DWS_H

Handelsbezeichnung(en):
General commercial description(s):
Drehwinkelsensor

3. Merkmale zur Typidentifizierung, sofern am Bauteil vorhanden:
Means of identification of type, if marked on the component:
Artikelnummer
Item number

Genehmigungsnummer: **E1*10R05/01*5852*01**
Approval number:

3.1 Anbringungsstelle dieser Merkmale:
Location of that marking:
Auf dem Gehäusedeckel
On the housing cover

4. Klasse der Fahrzeuge:
Category of vehicle:
Entfällt
Not applicable

5. Name und Anschrift des Herstellers:
Name and address of manufacturer:
ASG Luftfahrttechnik und Sensorik GmbH
DE-69469 Weinheim

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:
Laserbeschriftung auf dem Gehäusedeckel
Laser marking on the housing cover

7. Anschrift(en) der Fertigungsstätte(n):
Address(es) of assembly plant(s):
ASG Luftfahrttechnik und Sensorik GmbH
DE-69469 Weinheim

8. Zusätzliche Angaben (gegebenenfalls):
Additional information (if any):
Siehe Anlage
See appendix

9. Für die Durchführung der Prüfungen zuständiger technischer Dienst:
Technical service responsible for carrying out the tests:
AKKA EMC GmbH
DE-71332 Waiblingen

10. Datum des Prüfprotokolls:
Date of test report:
12.08.2019

11. Nummer des Prüfprotokolls:
Number of test report:
P091403A (Stellungnahme/advisory opinon)

Genehmigungsnummer: **E1*10R05/01*5852*01**
Approval number:

12. Die Genehmigung wird **erweitert**
Approval is **extended**

13. Bemerkungen (gegebenenfalls):
Remarks (if any):
Siehe Anlage
See appendix

14. Ort: **DE-24932 Flensburg**
Place:

15. Datum: **21.08.2019**
Date:

16. Unterschrift: **Im Auftrag**
Signature:

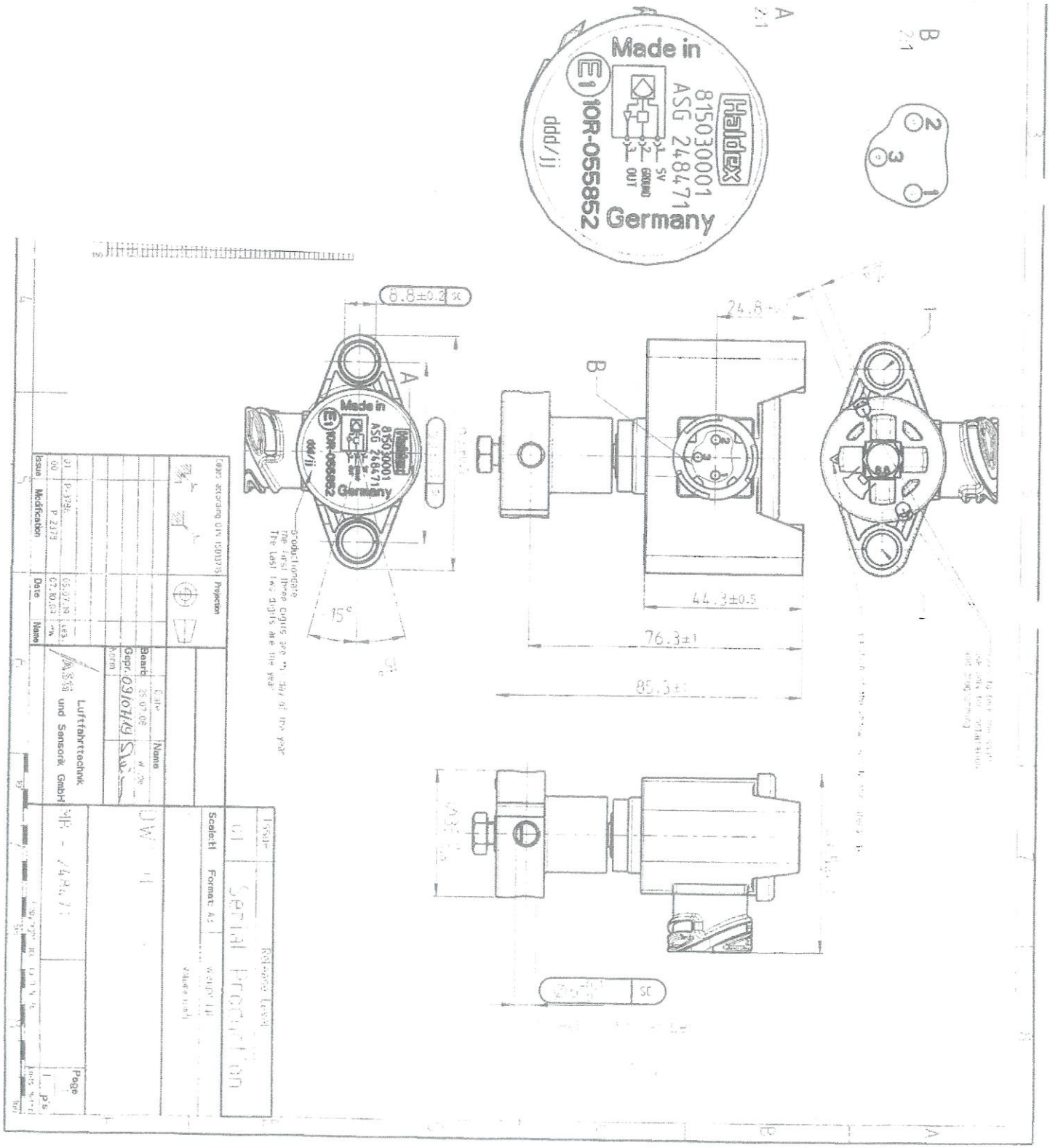
Jörg Burgkhardt

KRAFTFAHRT-BUNDESAMT 527

17. 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.

Anlagen:
Enclosures:
Gemäß Inhaltsverzeichnis
According to index

18. Grund oder Gründe für die Erweiterung der Genehmigung:
Reason(s) of extension of approval:
Anpassung an die Änderungsserie 05 der Regelung
Adaption to the 05 series of amendments of the regulation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Haldex
ddd/jj
6.8±0.2
24.8
44.3±0.5
76.3±1
85.3±1
15°
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