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OFF-HIGHWAY

OVERVIEW TECHNOLOGIES AND PRODUCTS

Edition 2 (05.2018)

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WABCO

Subject to change without notice
Publication Nr.: 815 010 217 3

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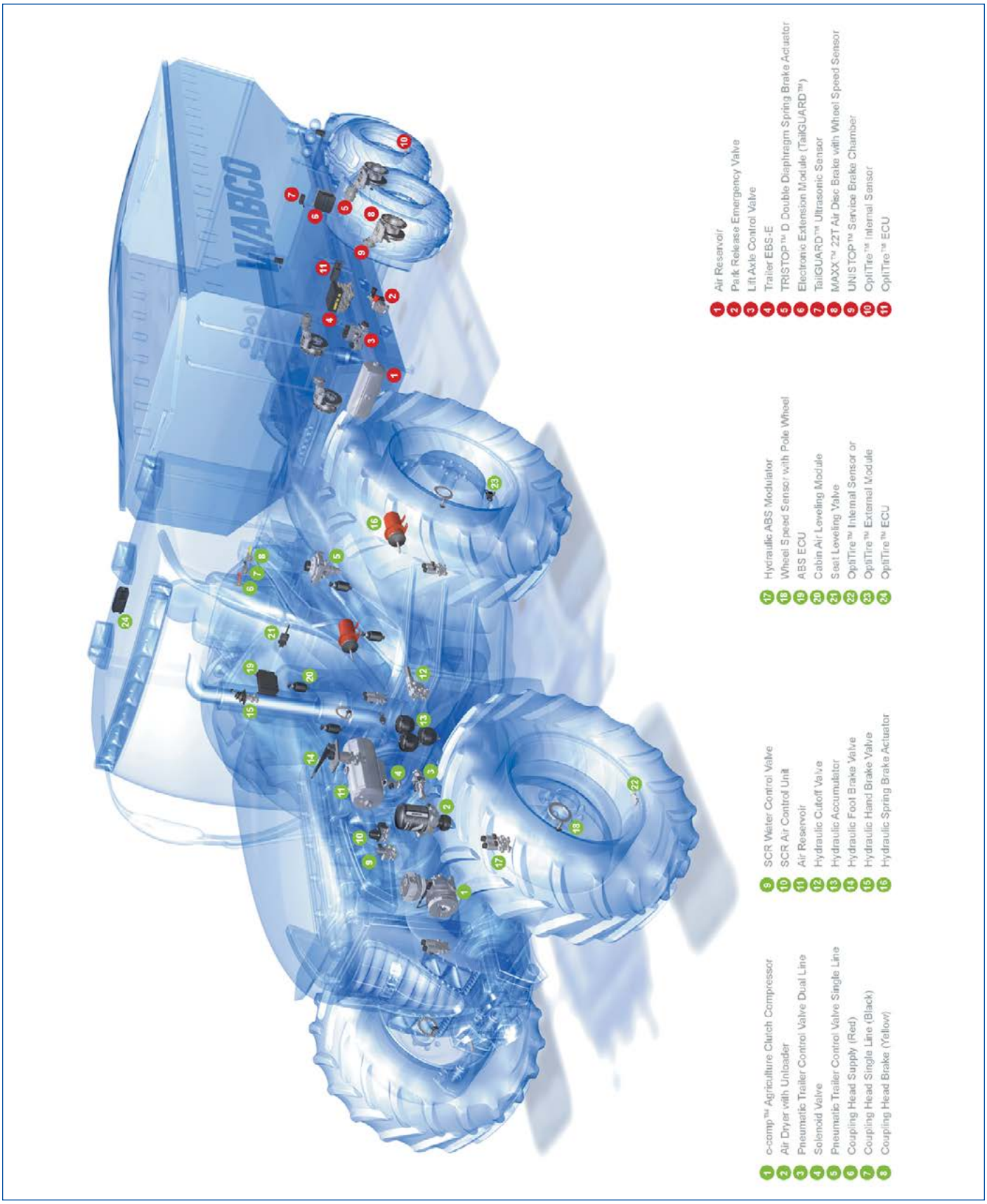
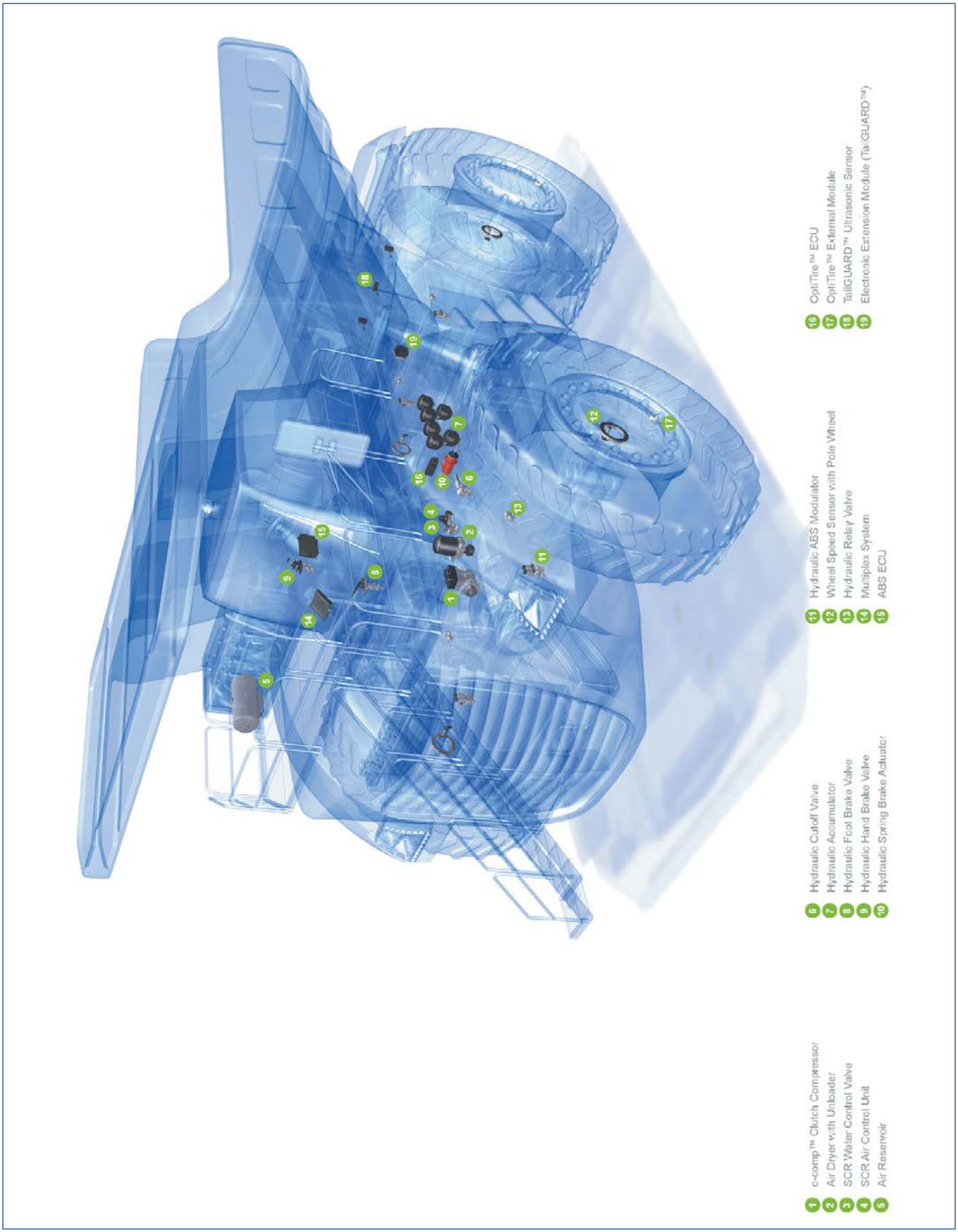
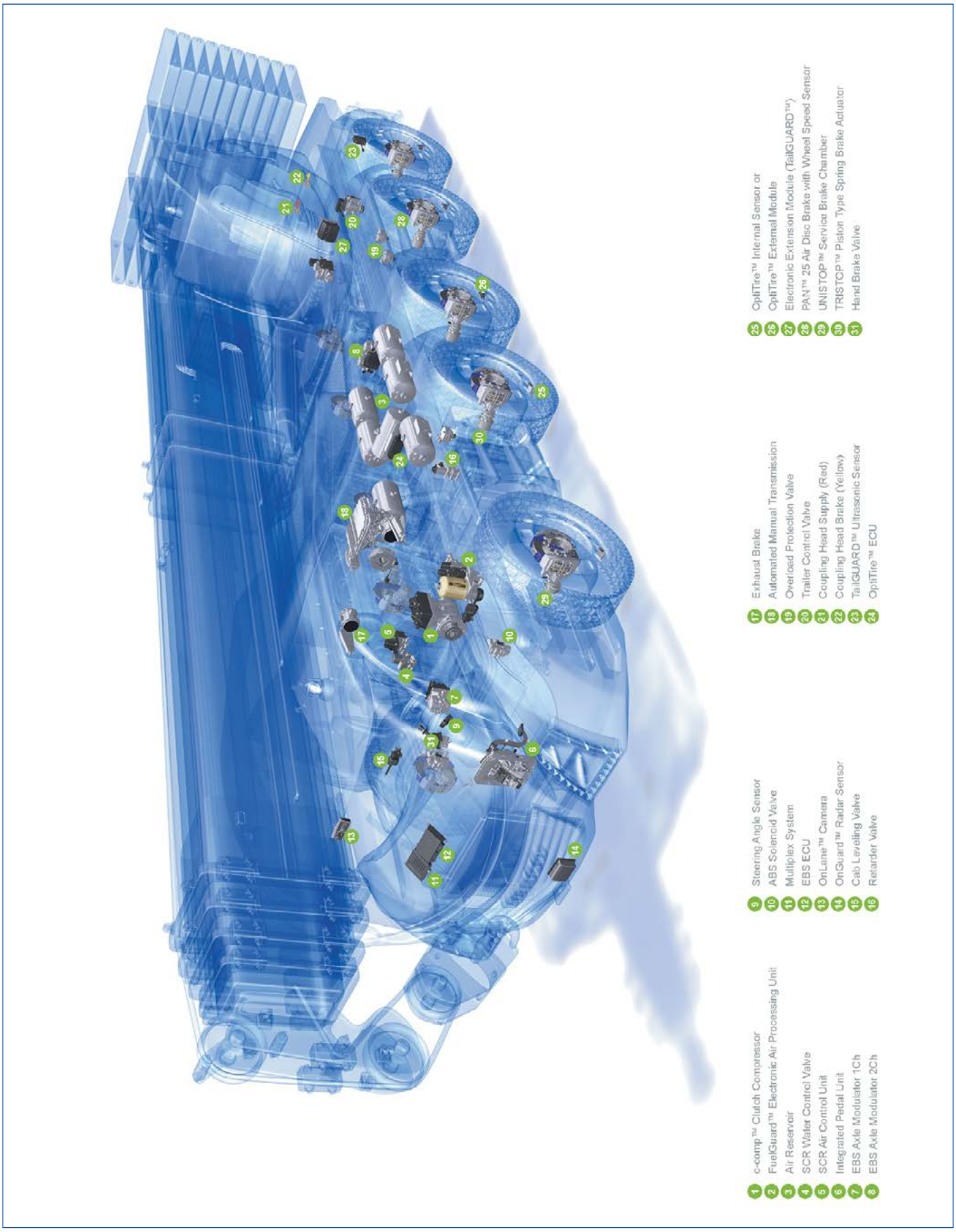
1.1 Agricultural tractor and trailer



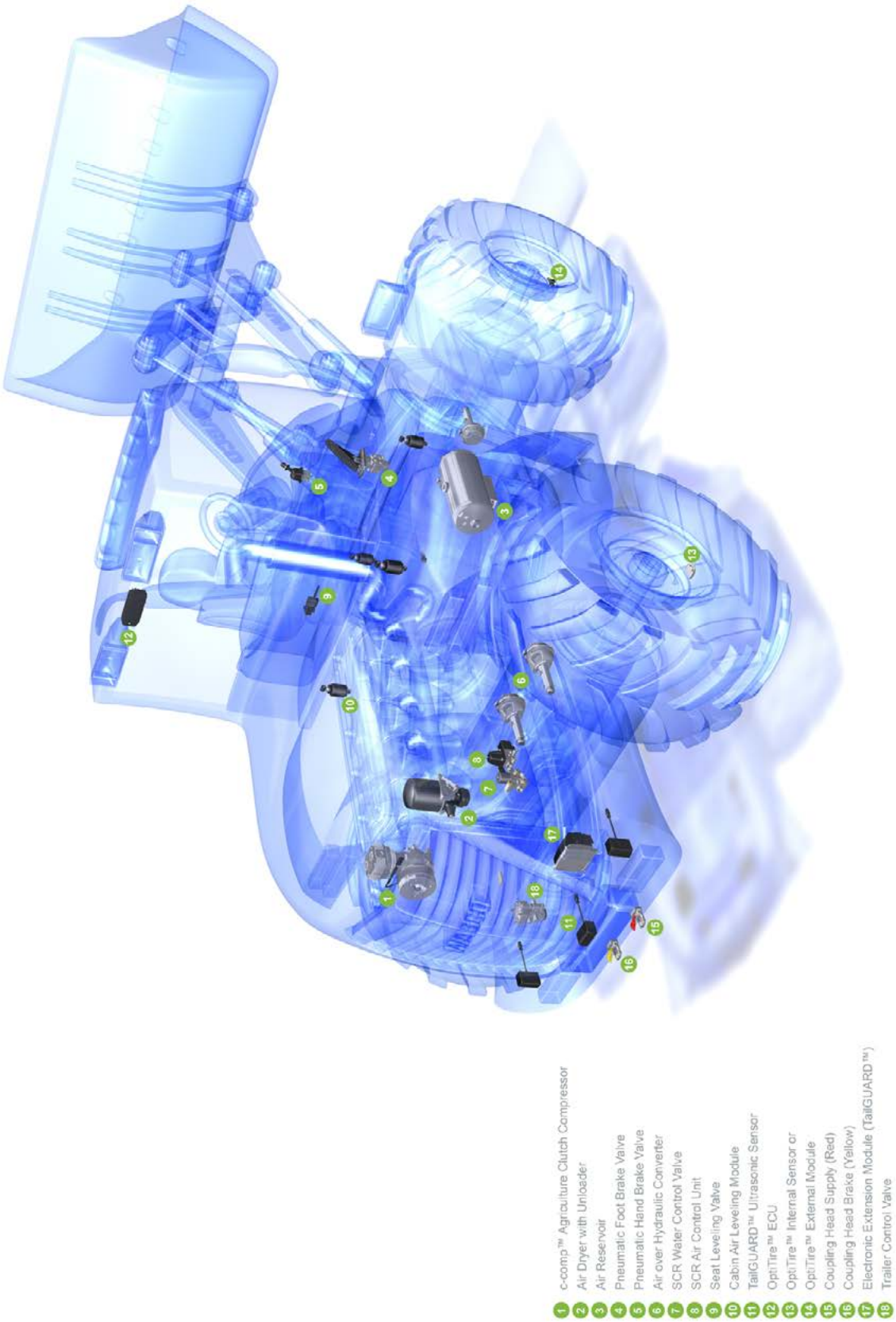
1.2 Rigid Dump Truck (RDT)



1.3 All-Terrain (AT) crane



1.4 Wheel loader



2 List of abbreviations

ABBREVIATION	MEANING
ABS	Anti-Lock Braking System
ALS	(German: Automatischer Blockierverhinderer); Automatic Anti-Lock System
ACU	Air Control Unit
AEB	Autonomous Emergency Braking System
AEBS	Advanced Emergency Braking System
LSV	Load Sensing Valve
ACC	Adaptive Cruise Control
AoH	Air Over Hydraulic
APU	Air Processing Unit
ARB	Automatic Roll Brake
ASR	(German: Antriebs-Schlupf-Regelung) Drive Slip Regulation
BVA	Brake lining wear indicator
CAN	Controller Area Network; serial bus system
C-APU	Compact Air Processing Unit
CBU	Central Brake Unit
CWS	Continuous Wear Sensor
E-APU	Electronic Air Processing Unit
EBS	Electronic Braking System
ECAS	Electronically Controlled Air Suspension
ECU	Electronic Control Unit
ELEX	Electronic Extension Module
ELM	Electronic Levelling Module; electronic air suspension module
EoL	End Of Line; end of the production line
ESC	Electronic Stability Control
eTASC	Electronic Trailer Air Suspension Control (rotary slide valve with RTR function) and ECAS function
FEM	Finite Element Method
FPB	Full Hydraulic Power Brake
GIO	Generic Input/Output
IR	Individual Regulation
ISS	Integrated Speed Switch
M-APU	Mechanical Air Processing Unit
MC	Hydraulic Master Cylinder
MIR	Modified Individual Regulation
PEM	Pneumatic Extension Module
PPM	Parts per Million
PWM	Pulse Width Modulation
PR	Power Reduction
PREV	Park Release Emergency Valve
ROP	Roll Over Protection
RSC	Roll Stability Control
RTR	Return To Ride; return to normal level (air suspension)
SAHR	Spring Applied Hydraulically Released
TASC	Trailer Air Suspension Control; rotary slide valve with RTR function
VCS	Vario-Compact-System; compactly structured ABS for trailers

3 General information

Only trained and qualified technicians may carry out work on the vehicle.

Purpose of this document

This catalogue provides an overview of WABCO's range of hydraulic, pneumatic, electro-hydraulic and electro-pneumatic products and systems.

The focus here is on applications in agricultural vehicles, construction machines, mining vehicles and all types of special vehicles – in other words, all off-highway vehicle applications.

The Off-Highway catalogue shows an extract from our product range. You will find more information about our products on the internet in our WABCO online product catalogue INFORM.

Copyright and trademark notice

Technical documents

– Open the WABCO INFORM online product catalogue: http://inform.wabco-auto.com
– Search for documents by entering the document number.

The WABCO online product catalogue INFORM provides you with convenient access to the complete technical documentation.

All documents are available in PDF format. Please contact your WABCO partner for printed versions.

Please note that the publications are not always available in all language versions.

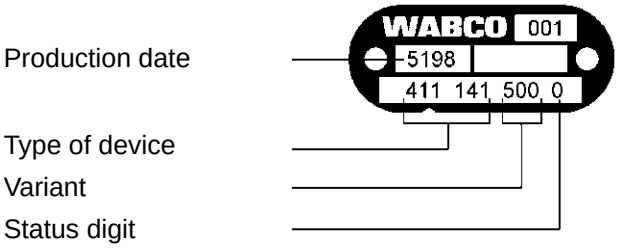
DOCUMENT TITLE	DOCUMENT NUMBER
FPB™ – Hydraulic Pump Accumulator Braking Systems	815 XX0 044 3
Air brake systems – Agriculture and forestry - Product catalogue	815 XX0 082 3
Air brake systems – Agriculture and forestry – Maintenance, Testing & Troubleshooting	815 XX0 083 3
Air brake systems – Agriculture and forestry - Product catalogue	815 XX0 084 3
TEBS E system description	815 XX0 093 3

DOCUMENT TITLE	DOCUMENT NUMBER
OnLane™ Lane departure warning system – Installation manual	815 XX0 197 3
OnLane™ Lane departure warning system – Driver information	815 XX0 202 3
TailGUARD™ for truck and bus applications – System description	815 XX0 211 3
Virtual All-Terrain (AT) crane with legend (poster DIN A1)	820 XX0 096 3
Virtual Rigid Dump Truck with legend (poster DIN A1)	820 XX0 097 3
Virtual tractor and trailer with legend (poster DIN A1)	820 XX0 098 3
Virtual Rigid Dump Truck with legend (poster DIN A1)	820 XX0 099 3
OnGuardACTIVE™	820 XX0 083 3

*Language code XX: 01 = English, 02 = German, 03 = French, 04 = Spanish, 05 = Italian, 06 = Dutch, 07 = Swedish, 08 = Russian, 09 = Polish, 10 = Croatian, 11 = Romanian, 12 = Hungarian, 13 = Portuguese (Portugal), 14 = Turkish, 15 = Czech, 16 = Chinese, 17 = Korean, 18 = Japanese, 19 = Hebrew, 20 = Greek, 21 = Arabic, 24 = Danish, 25 = Lithuanian, 26 = Norwegian, 27 = Slovenian, 28 = Finnish, 29 = Estonian, 30 = Latvian, 31 = Bulgarian, 32 = Slovakian, 34 = Portuguese (Brazil), 35 = Macedonian, 36 = Albanian, 97 = German/English 98 = multilingual, 99 = non-verbal

Structure of the WABCO product number

WABCO product numbers consist of 10 digits.



0 = New device (complete device), black/silver
1 = New device (subassembly)
2 = Repair set or subassembly
4 = Individual part
7 = Replacement part, red/silver
R = Reman product, green/silver

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- Regular audits of suppliers
- Exhaustive end-of-line tests
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- Find the right product
- Diagnosis support
- Training
- System support
- Order management

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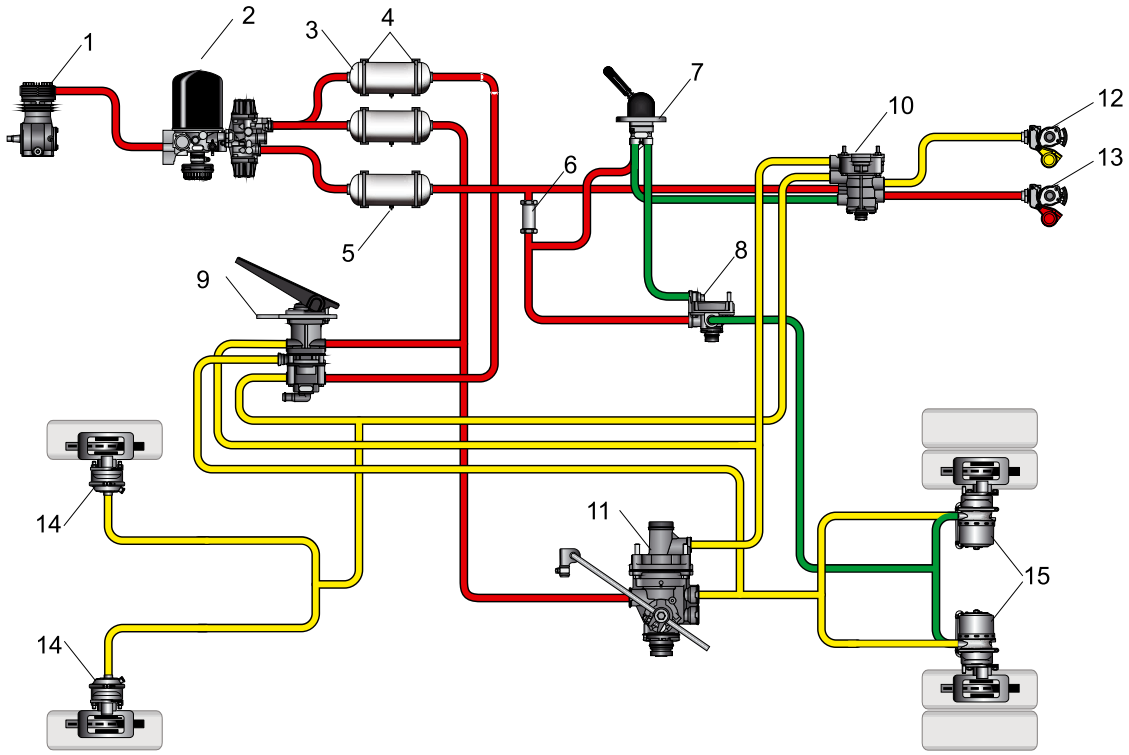
Notes

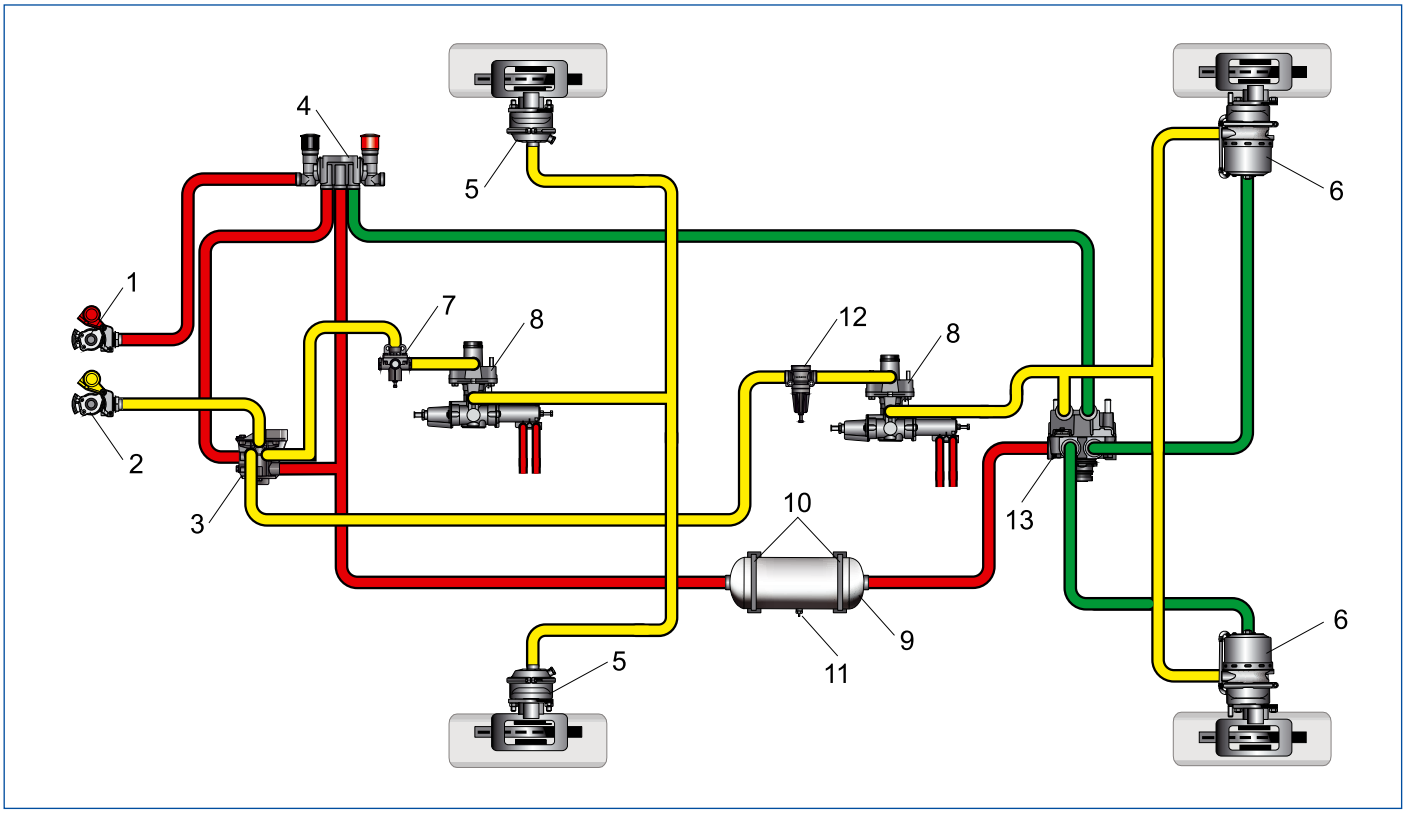
4 Schematic diagram

4.1 Conventional air brake systems – towing vehicle



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Air Processing Unit (APU)	932 500 XXX 0	49
3	Air reservoir	950 XXX XXX 0	52
4	Clamping band	451 999 XXX 2	53
5	Drain valve	934 30X XXX 0	53
6	Check valve	434 014 XXX 0	63
7	Hand brake valve	961 72X XXX 0	60
8	Relay valve	973 006 XXX 0	62
9	Foot brake valve with pedal actuation	461 31X XXX 0	56
10	Trailer control valve	973 009 XXX 0	66
11	LSV controller (mechanical)	475 710 XXX 0	61
12	Coupling head "brake" (yellow)	952 200 XXX 0	68
13	Coupling head "supply" (red)	952 200 XXX 0	68
14	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
15	TRISTOP™ spring chamber brake cylinder	925 37X XXX 0	137

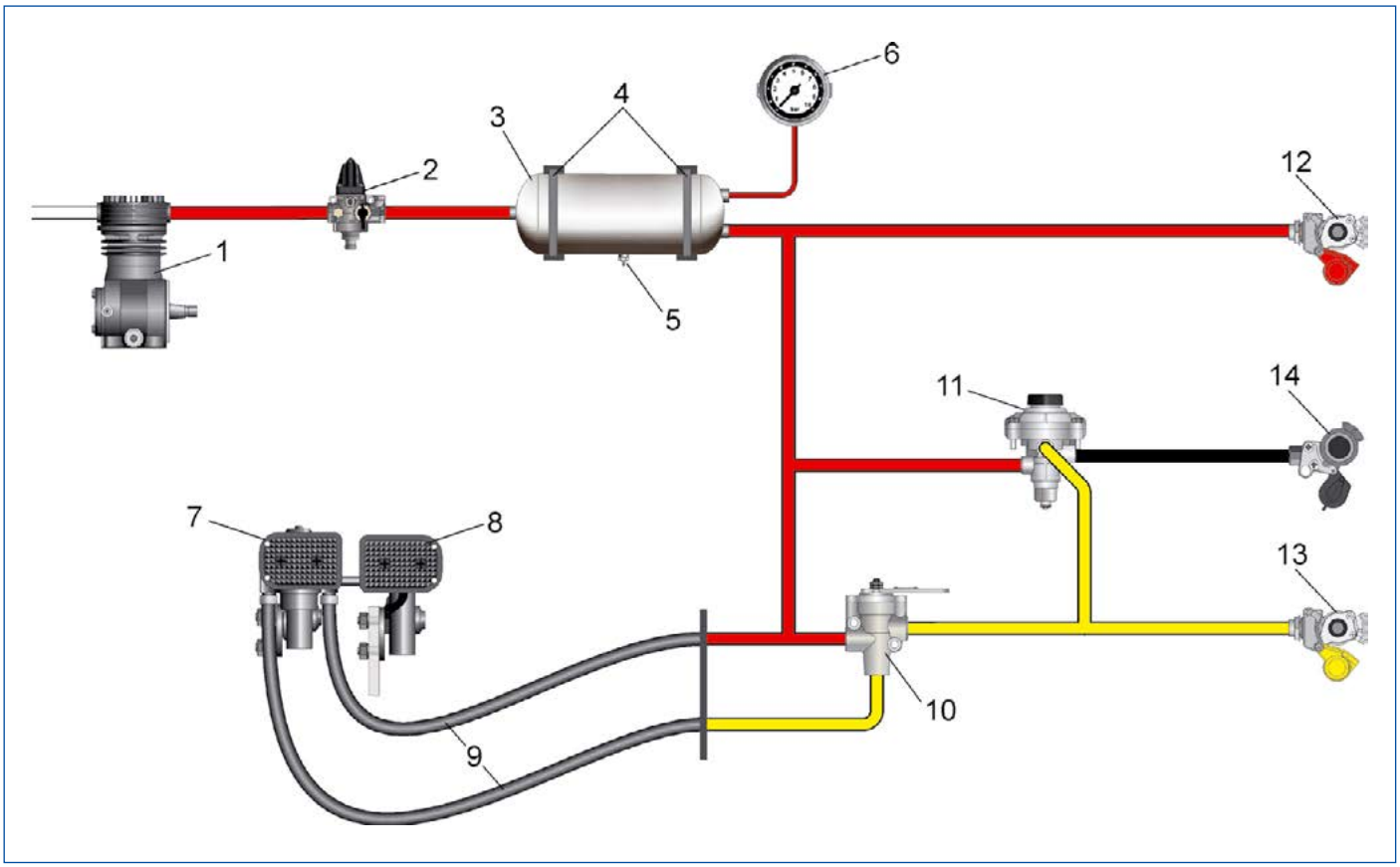
4.2 Conventional air brake systems – trailer



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve	971 002 XXX 0	73
4	Trailer release valve (double release valve)	963 001 XXX 0	80
5	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
6	TRISTOP™ spring chamber brake cylinder	925 37X XXX 0	137
7	Pressure ratio valve (also: adjuster valve)	975 001 XXX 0	75
8	LSV controller (pneumatic)	475 71X XXX 0	61
9	Air reservoir	950 XXX XXX 0	52
10	Clamping band	451 999 XXX 2	53
11	Drain valve	934 30X XXX 0	53
12	Pressure limiting valve	475 010 XXX 0 475 015 XXX 0	74 74
13	Overload protection relay valve	973 011 XXX 0	62

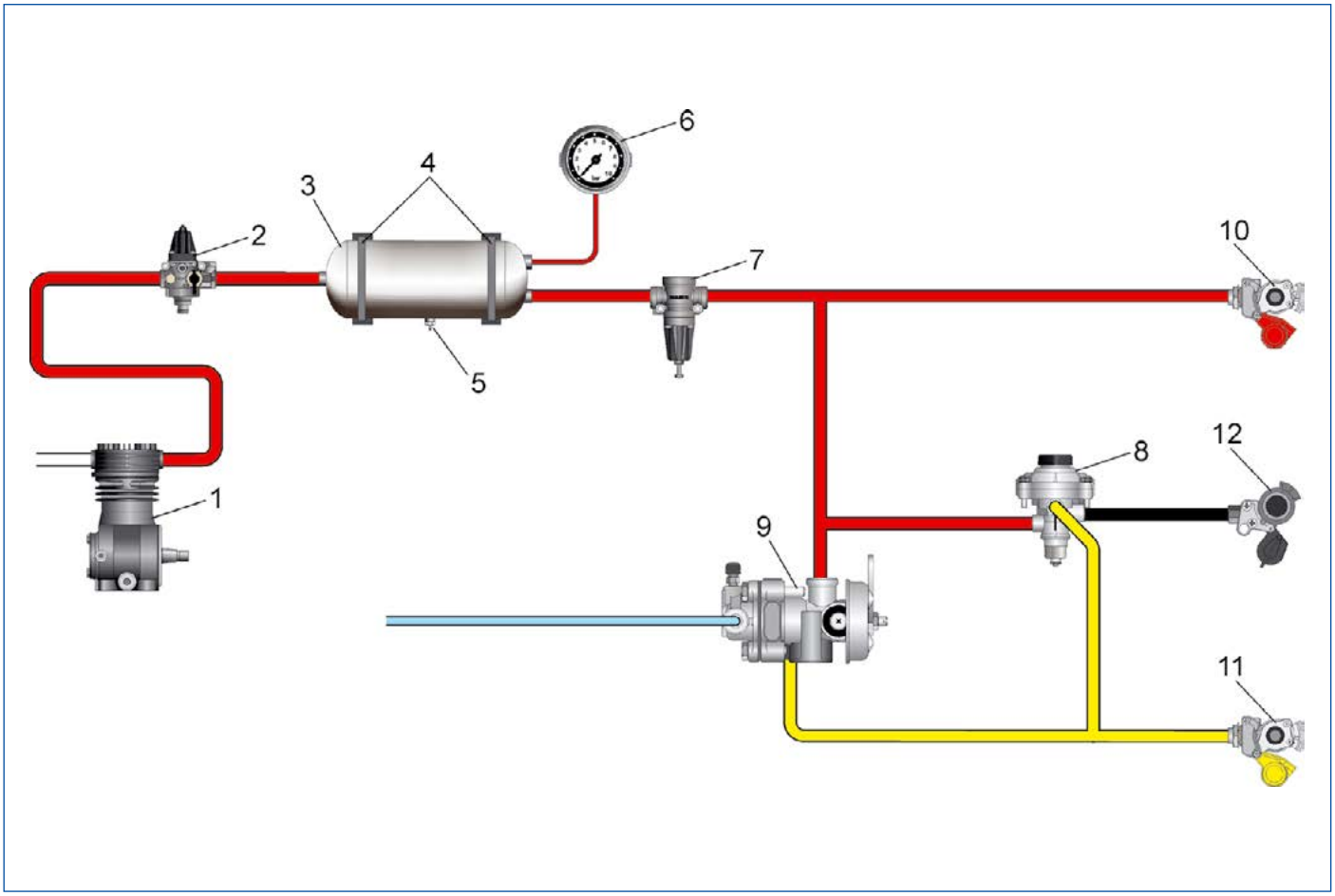
4.3 Compressed air generating systems (agricultural and forestry vehicles)

Normal pressure – single and dual lines with pedal valve



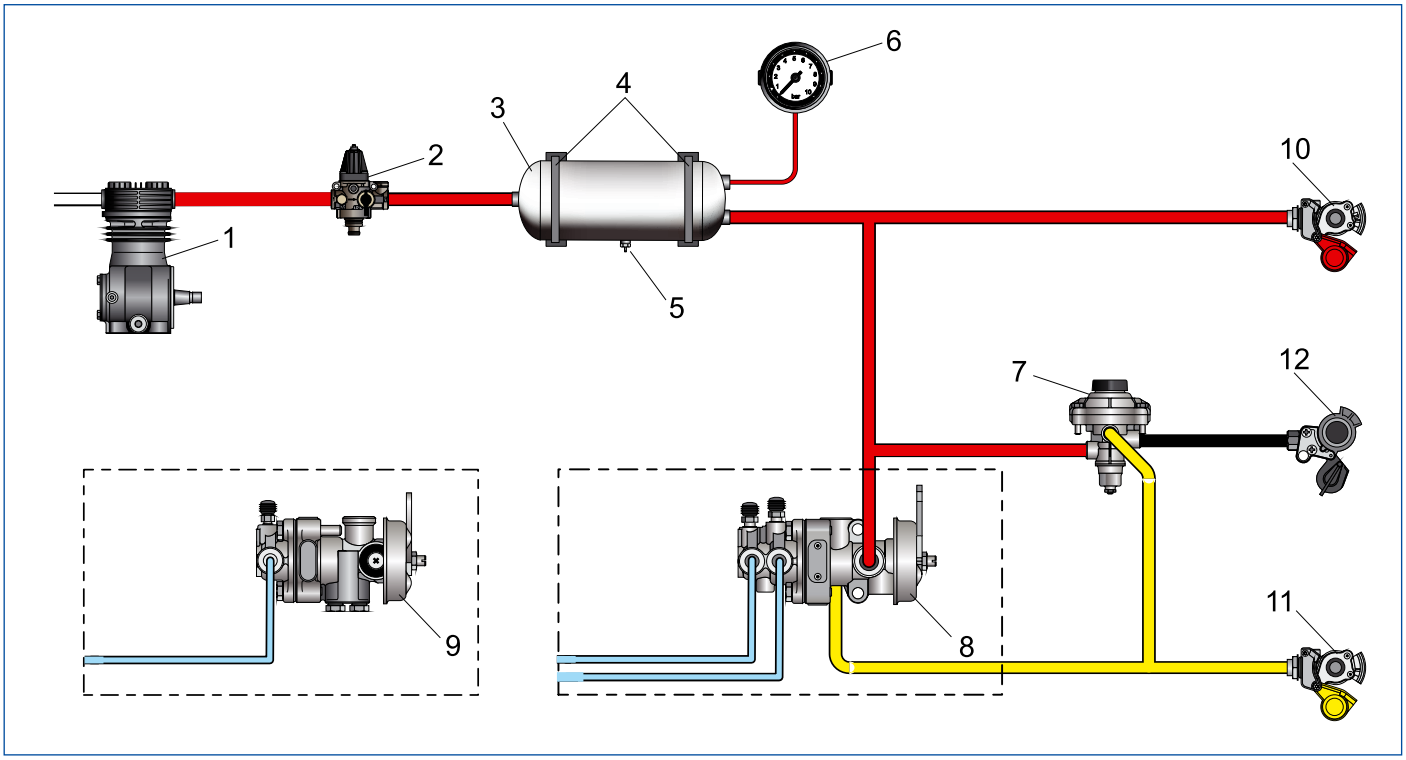
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Unloader valve	975 303 XXX 0	56
3	Air reservoir (20 litres)	950 XXX XXX 0	52
4	Clamping band	451 999 XXX 2	53
5	Drain valve	934 300 XXX 0	53
6	Pressure gauge	453 002 XXX 0	54
7	Trailer control valve (power-operated)	961 106 XXX 0	67
8	Compensator actuation	–	not part of WABCO's scope of supply
9	Fabric hose	828 876 XXX 6	–
10	Hand brake valve	461 700 XXX 0	60
11	Trailer control valve (single line)	471 200 XXX 0	66
12	Coupling head "supply" (red)	952 200 XXX 0	68
13	Coupling head "brake" (yellow)	952 200 XXX 0	68
14	Coupling head "single line" (black)	452 300 XXX 0	68

High pressure – combined single and dual line system hydraulically actuated



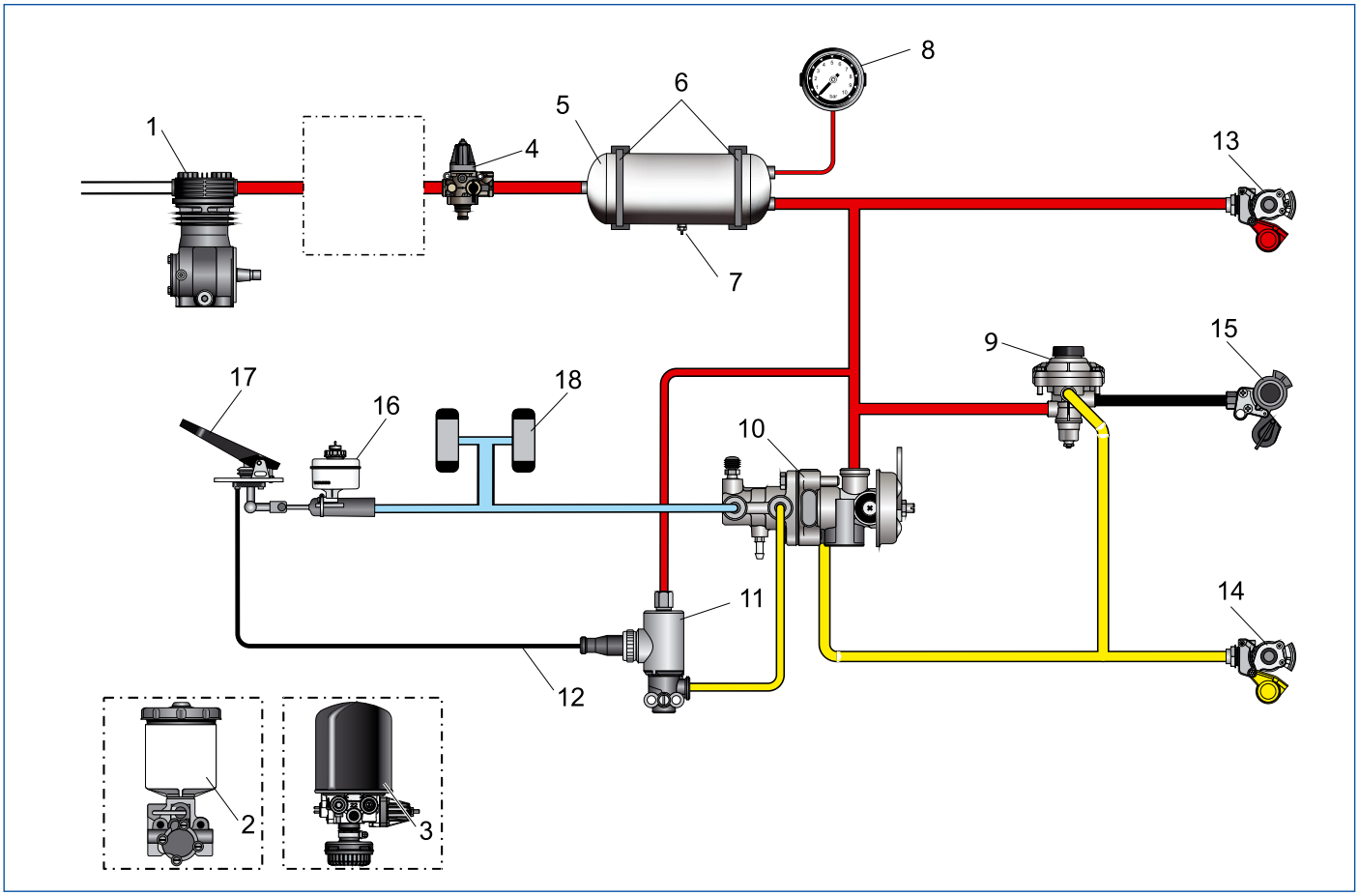
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Unloader valve	975 303 XXX 0	56
3	Air reservoir (20 litres)	950 XXX XXX 0	52
4	Clamping band	451 999 XXX 2	53
5	Drain valve (automatic) Drain valve	934 301 XXX 0 934 300 XXX 0	53 53
6	Pressure gauge	453 011 XXX 0	54
7	Pressure limiting valve	475 010 XXX 0 475 015 XXX 0	65
8	Trailer control valve (single line)	471 200 1XX 0 471 200 0XX 0	66 66
9	Trailer control valve	470 015 XXX 0	162
10	Coupling head "supply" (red)	952 200 XXX 0	68
11	Coupling head "brake" (yellow)	952 200 XXX 0	68
12	Coupling head "single line" (black)	452 300 XXX 0	68

Normal pressure – combined single and dual line system hydraulically actuated



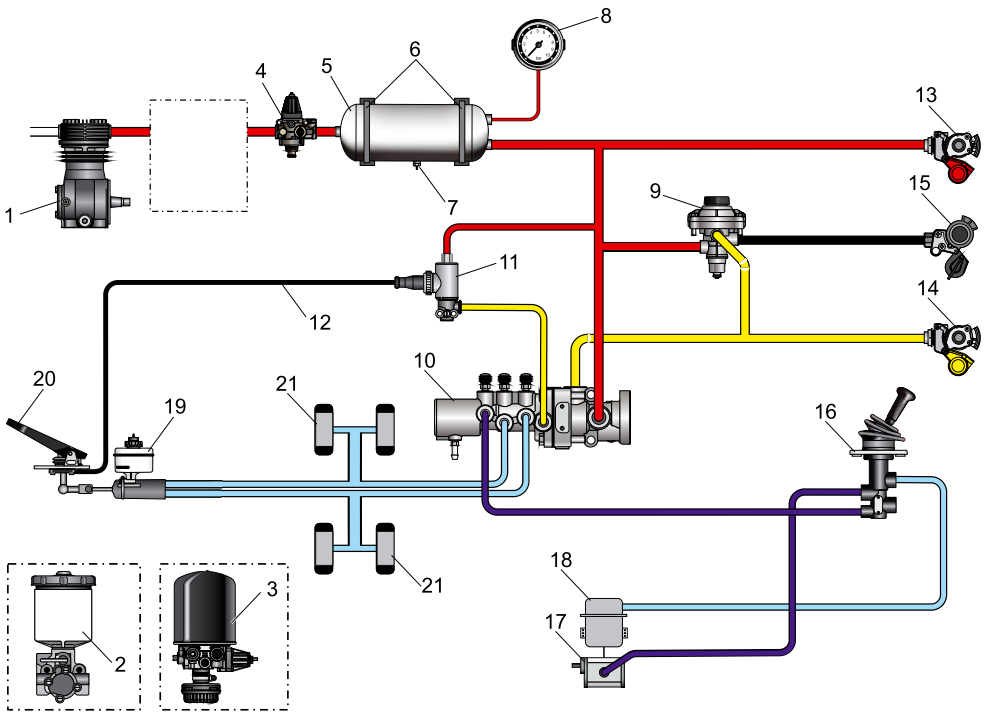
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Unloader valve	975 303 XXX 0	56
3	Air reservoir (20 litres)	950 XXX XXX 0	52
4	Clamping band	451 999 XXX 2	53
5	Drain valve	934 300 XXX 0	53
6	Pressure gauge	453 002 XXX 0	54
7	Trailer control valve (single line)	471 200 XXX 0	66
8	Trailer control valve (alternative to **9**), 2-circuit	470 015 2XX 0	162
9	Trailer control valve (alternative to **8**), 1-circuit	470 015 0XX 0	162
10	Coupling head "supply" (red)	952 200 XXX 0	68
11	Coupling head "brake" (yellow)	952 200 XXX 0	68
12	Coupling head "single line" (black)	452 300 XXX 0	68

Combined single and dual line system, hydraulically actuated, pneumatic pilot operation



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Anti-freeze pump	932 002 XXX 0	46
3	Air dryer	432 410 XXX 0	48
4	Unloader valve	975 303 XXX 0	56
5	Air reservoir (20 litres)	950 XXX XXX 0	52
6	Clamping band	451 999 XXX 2	53
7	Drain valve	934 300 XXX 0	53
8	Pressure gauge	453 002 XXX 0	54
9	Trailer control valve (single line)	471 200 XXX 0	66
10	Trailer control valve	470 015 XXX 0	162
11	Solenoid valve	472 170 XXX 0	198
12	Cable for solenoid valve	894 600 451 2	▸ see overviews "Cables", 202
13	Coupling head "supply" (red)	952 200 XXX 0	68
14	Coupling head "brake" (yellow)	952 200 XXX 0	68
15	Coupling head "single line" (black)	452 300 XXX 0	68
16	Hydraulic master cylinder	468 XXX XXX 0	142
17	Foot brake valve with pedal actuation	461 31X XXX 0	56
18	Wheel brake cylinder	–	–

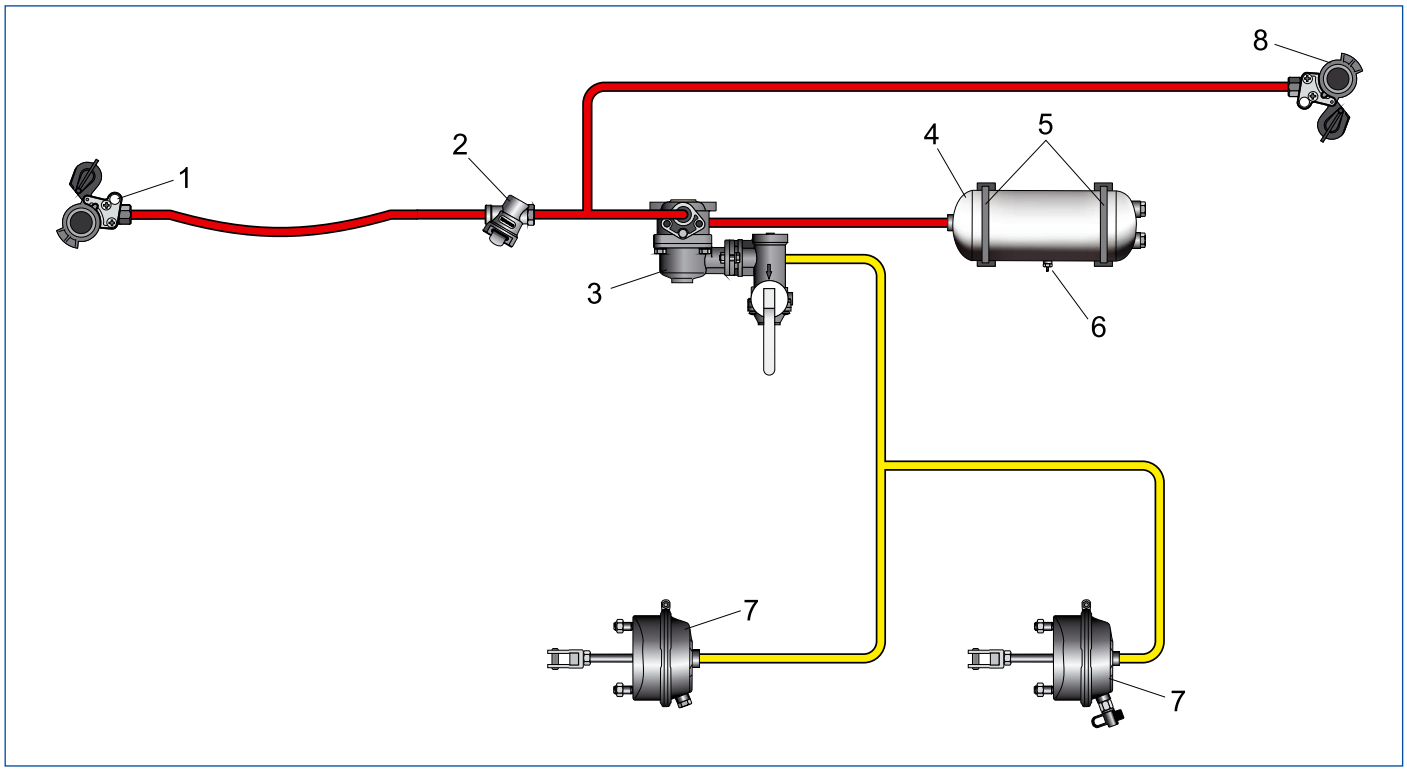
Combined single and dual line system, hydraulically actuated, pneumatic pilot operation, hydraulic park brake system



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Anti-freeze pump	932 002 XXX 0	46
3	Air dryer	432 410 XXX 0	48
4	Unloader valve	975 303 XXX 0	56
5	Air reservoir (20 litres)	950 XXX XXX 0	52
6	Clamping band	451 999 XXX 2	53
7	Drain valve	934 300 XXX 0	53
8	Pressure gauge	453 002 XXX 0	54
9	Trailer control valve (single line)	471 200 XXX 0	66
10	Trailer control valve (dual line)	470 015 XXX 0	162
11	Solenoid valve	472 XXX XXX 0	64
12	Cable for solenoid valve	894 600 451 2	▸ see overviews "Cables", 202
13	Coupling head "supply" (red)	952 200 XXX 0	68
14	Coupling head "brake" (yellow)	952 200 XXX 0	68
15	Coupling head "single line" (black)	452 300 XXX 0	68
16	Hand brake valve	467 410 XXX 0	158
17	Pump	–	in the vehicle
18	Tank	–	in the vehicle
19	Hydraulic master cylinder	468 XXX XXX 0	142
20	Foot brake valve with pedal actuation	461 31X XXX 0	56
21	Wheel brake cylinder	–	–

4.4 Single line air brake system (agricultural or forestry trailers)

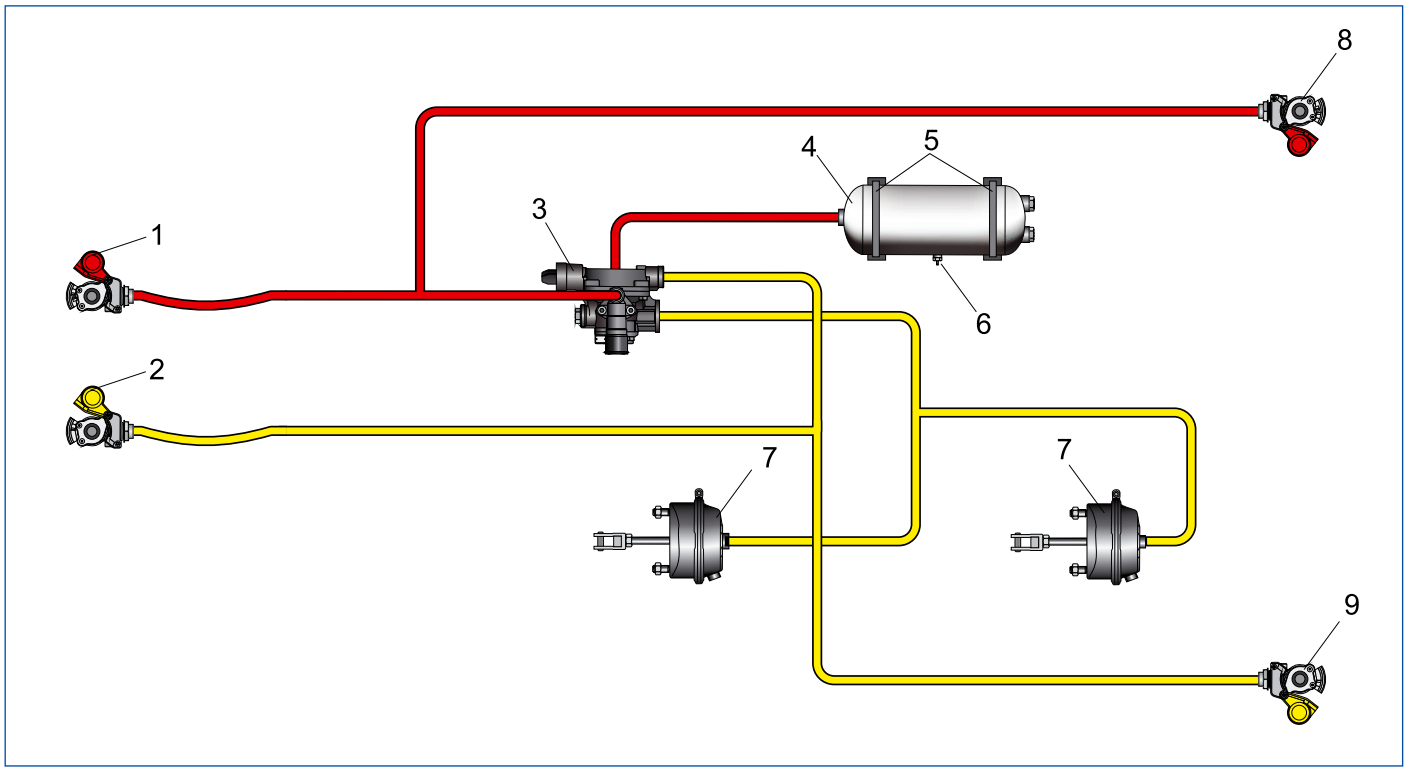
Single line braking system for 2-axle trailers or central axle trailers



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head "single line" (black)	452 201 XXX 0	81
2	Line filter	435 500 XXX 0	72
3	Trailer brake valve with release valve	471 003 XXX 0	74
4	Air reservoir	950 XXX XXX 0	52
5	Clamping band	451 999 XXX 2	53
6	Drain valve	934 300 XXX 0	53
7	UNISTOP™ diaphragm brake cylinder Piston cylinder	423 XXX XXX 0 921 XXX XXX 0	135 138
8	Coupling head "single line" (black)	452 300 XXX 0	81

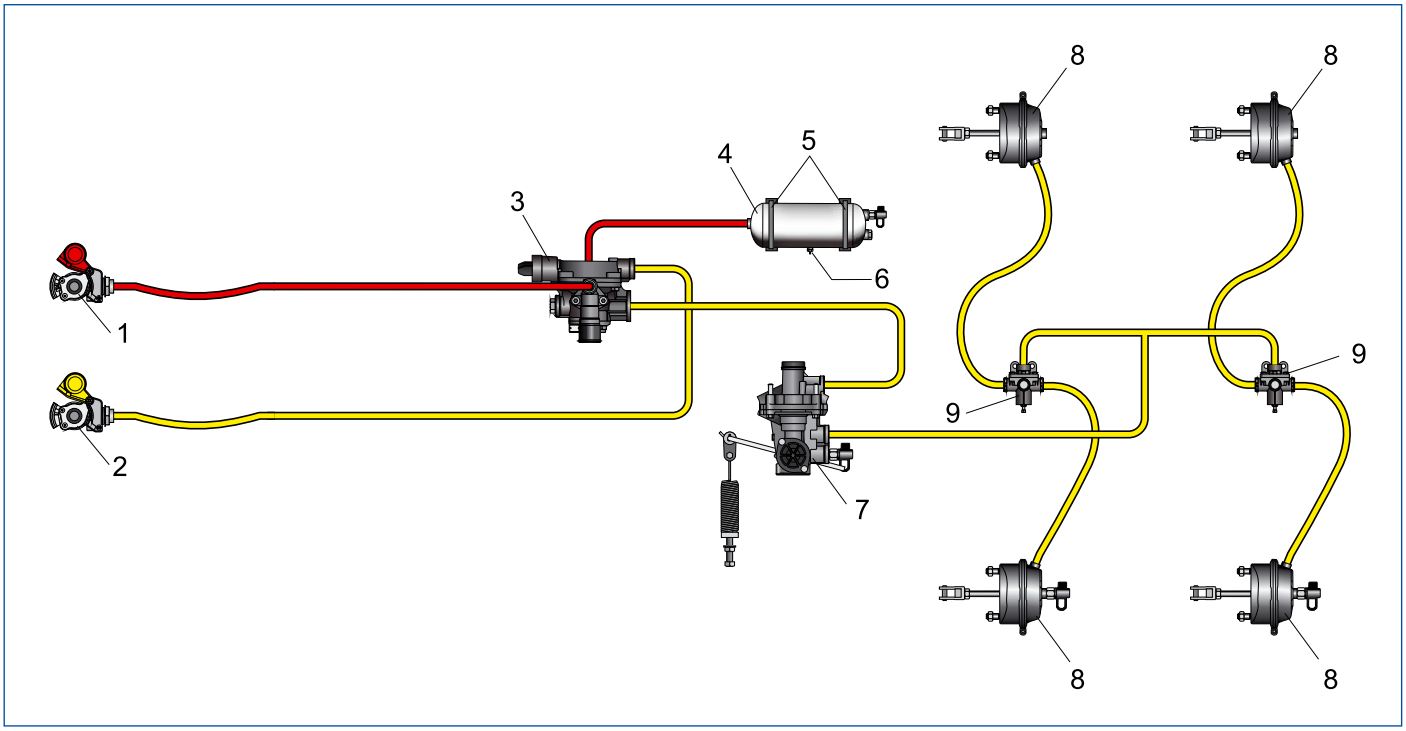
4.5 Dual line air brake system (agricultural or forestry trailers)

Dual line braking system for 2-axle trailers or central axle trailers



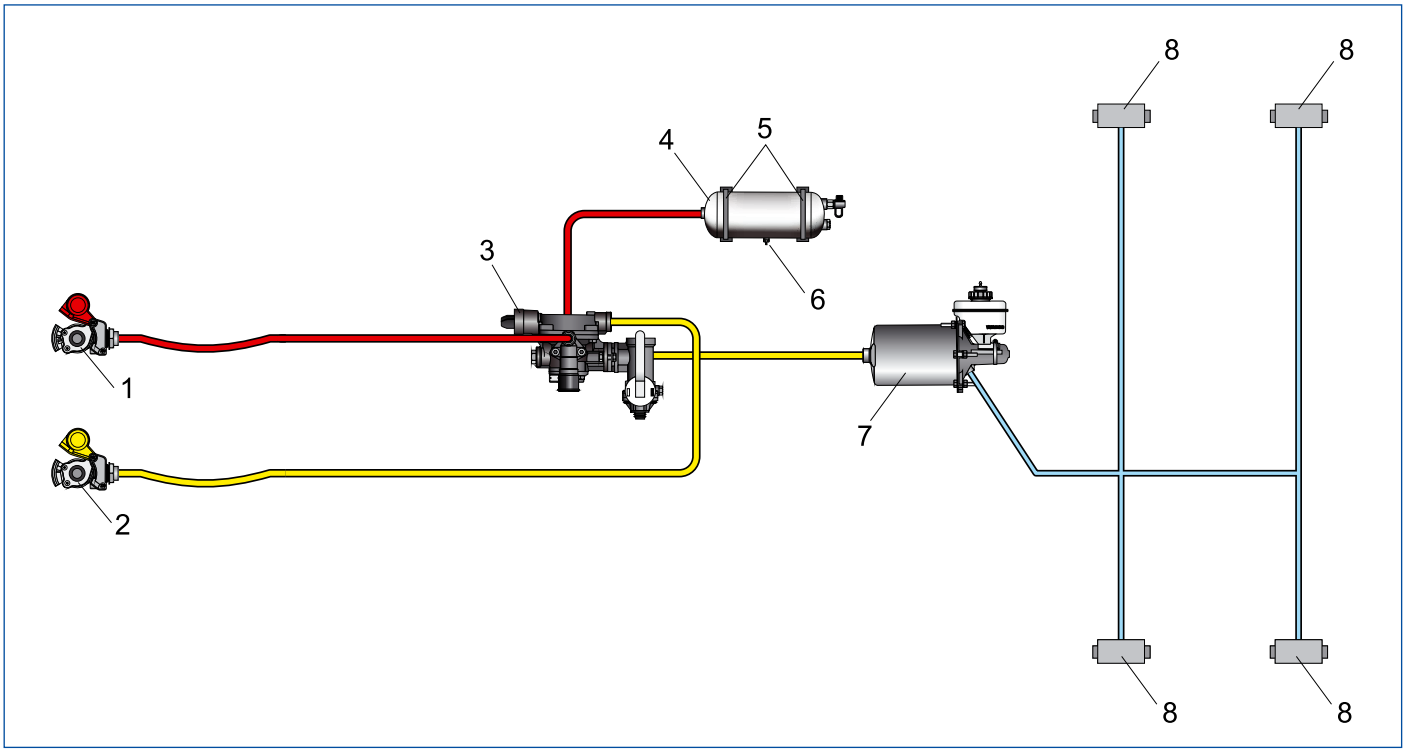
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve with load-sensing valve (dual line)	971 002 XXX 0	73
4	Air reservoir	950 XXX XXX 0	52
5	Clamping band	451 999 XXX 2	53
6	Drain valve	934 300 XXX 0	53
7	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
8	Coupling head "supply" (red)	952 200 XXX 0	68
9	Coupling head "brake" (yellow)	952 200 XXX 0	68

Dual line braking system for central axle trailers with LSV control, mechanically suspended



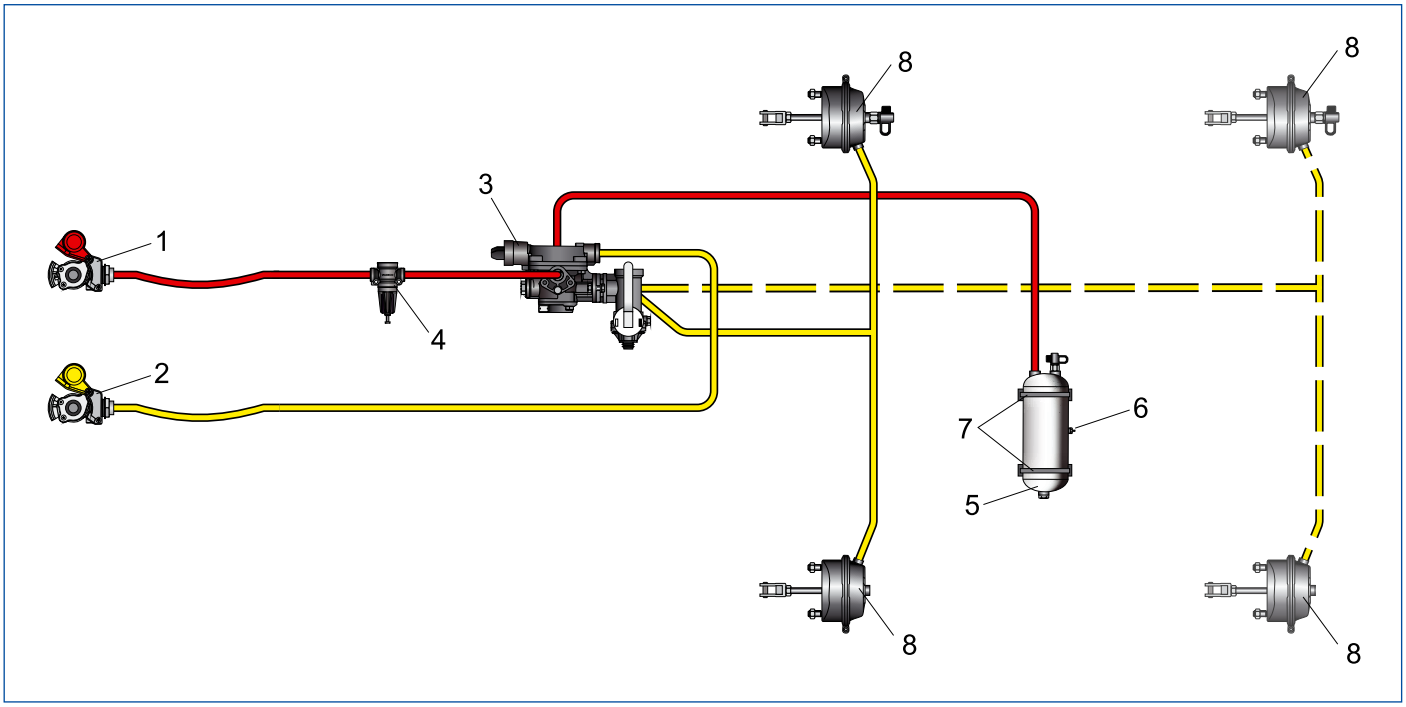
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve with load-sensing valve (dual line)	971 002 XXX 0	73
4	Air reservoir	950 XXX XXX 0	52
5	Clamping band	451 999 XXX 2	53
6	Drain valve	934 300 XXX 0	53
7	LSV controller, mechanical	475 713 XXX 0	77
8	UNISTOP™ diaphragm brake cylinder Piston cylinder	423 XXX XXX 0 921 XXX XXX 0	135 138
9	Pressure ratio valve (also: adjuster valve) (optional, use according to requirements)	975 001 XXX 0	75

Pneumatic/hydraulic dual line braking system for 2 axle trailers or central axle trailers with release valve and load sensing valve



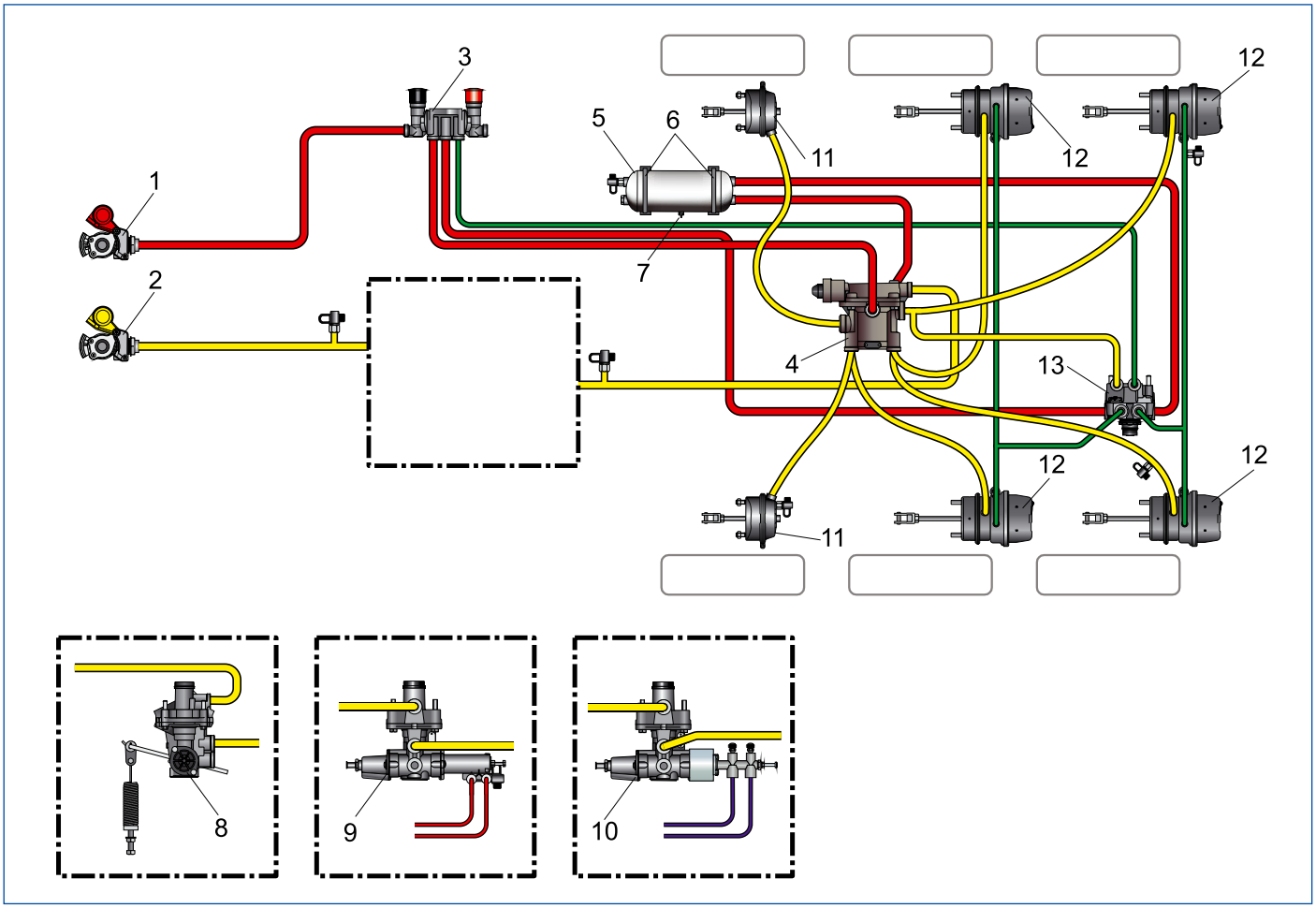
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve with load-sensing valve and release valve	971 002 XXX 0	73
4	Air reservoir	950 XXX XXX 0	52
5	Clamping band	451 999 XXX 2	53
6	Drain valve	934 300 XXX 0	53
7	Compact unit	921 399 XXX 0	–
8	Brake cylinder	–	in the vehicle

Conversion from single to dual line air brake system for 2-axle trailers



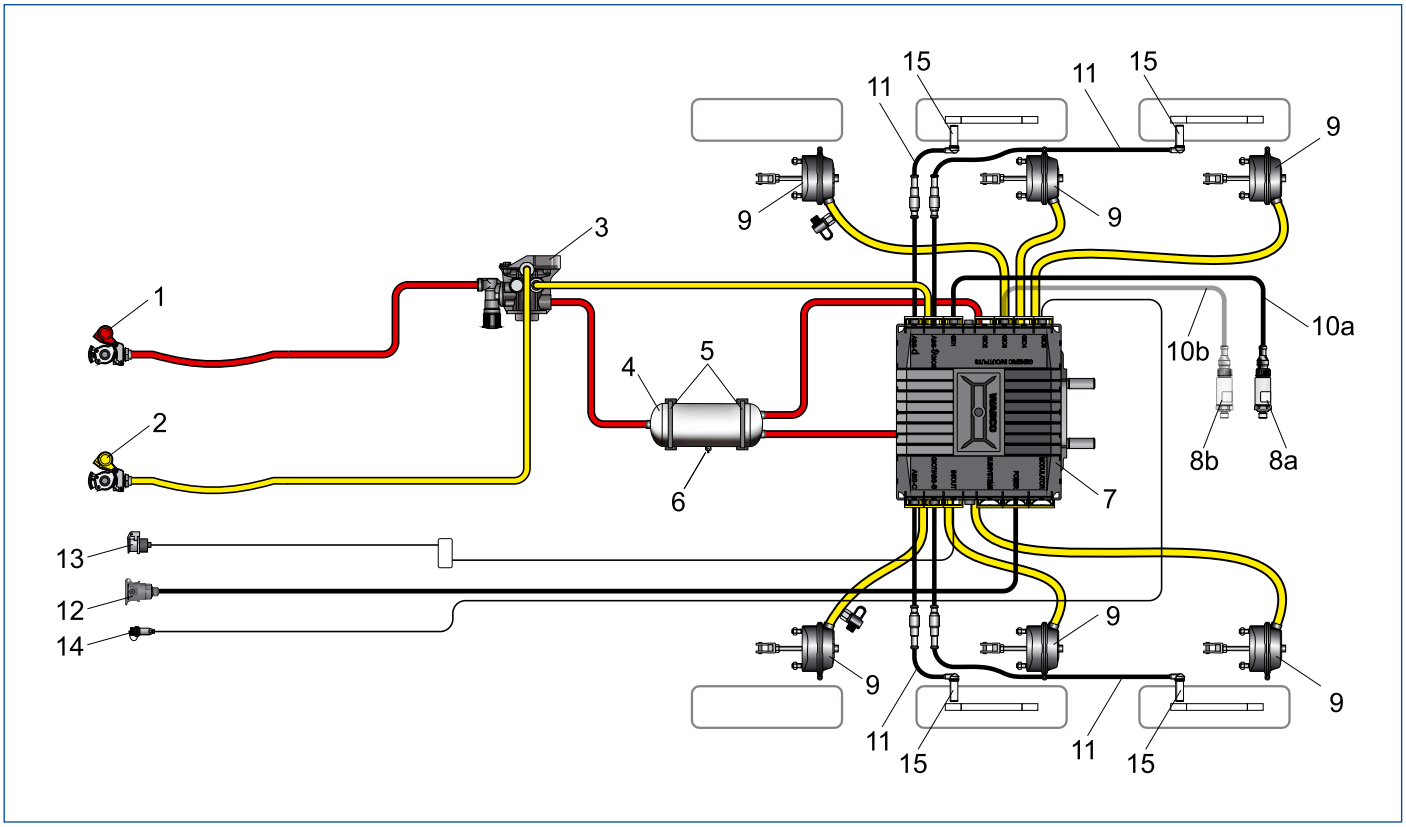
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve with load-sensing valve and release valve	971 002 XXX 0	73
4	Pressure limiting valve	475 010 XXX 0	74
5	Drain valve	934 300 XXX 0	53
6	Air reservoir	950 XXX XXX 0	52
7	Clamping band	451 999 XXX 2	53
8	UNISTOP™ diaphragm brake cylinders (when converting)	–	in the vehicle

Dual line air brake system for 3-axle central axle trailers, LSV controller, optionally mechanical /air / hydraulic suspension



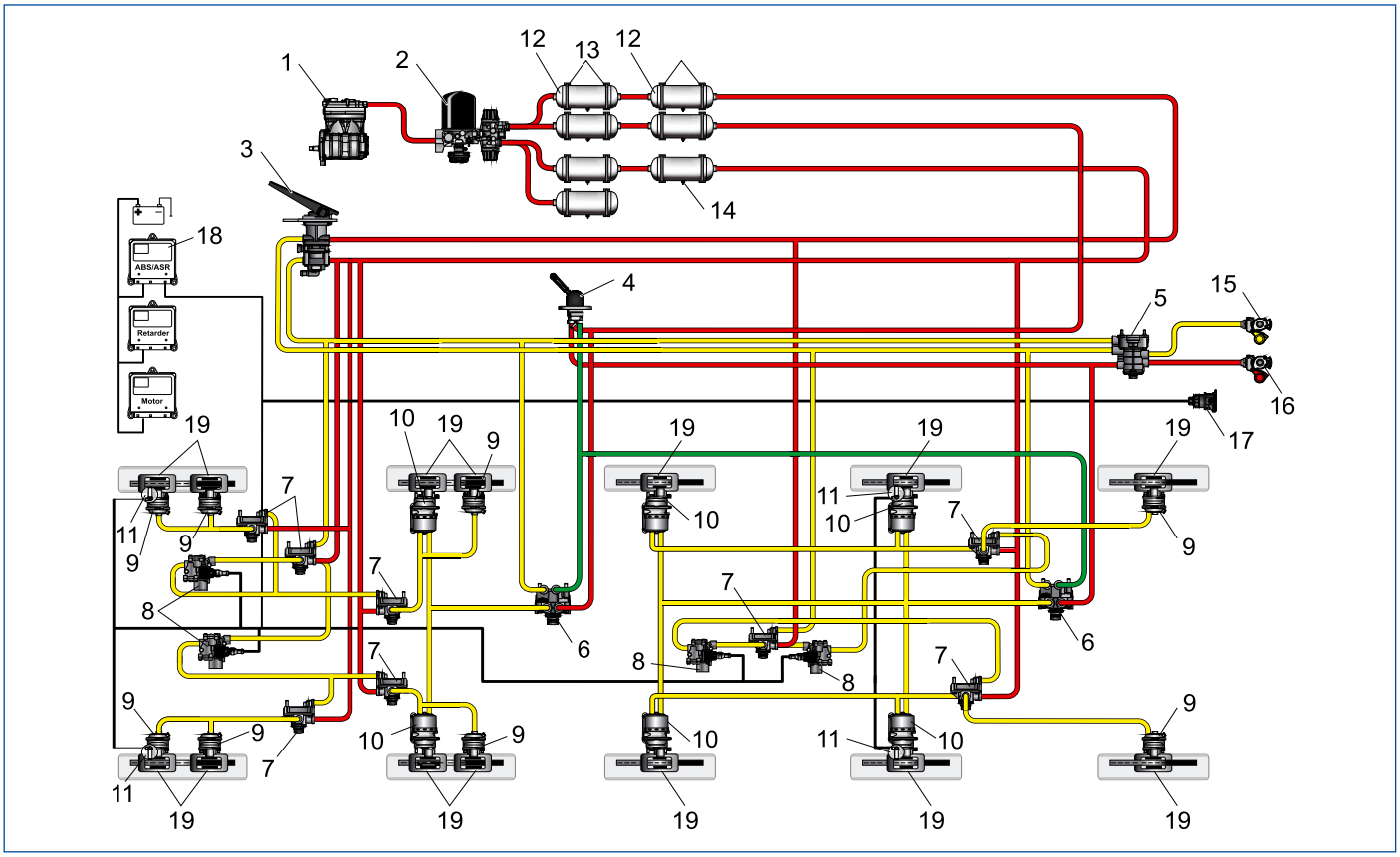
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer release valve (double release valve)	963 001 XXX 0	80
4	Trailer brake valve	971 002 XXX 0	73
5	Air reservoir	950 XXX XXX 0	52
6	Clamping band	451 999 XXX 2	53
7	Drain valve	934 300 XXX 0	53
8	LSV controller, mechanical	475 713 XXX 0	77
9	LSV controller, pneumatic	475 714 XXX 0	77
10	LSV controller, hydraulic	475 714 XXX 0	77
11	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
12	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
13	Overload protection relay valve	973 011 XXX 0	62

Trailer EBS E for 3-axle central axle trailer, 4S/2M or 2S/2M, Multi-Voltage Modulator



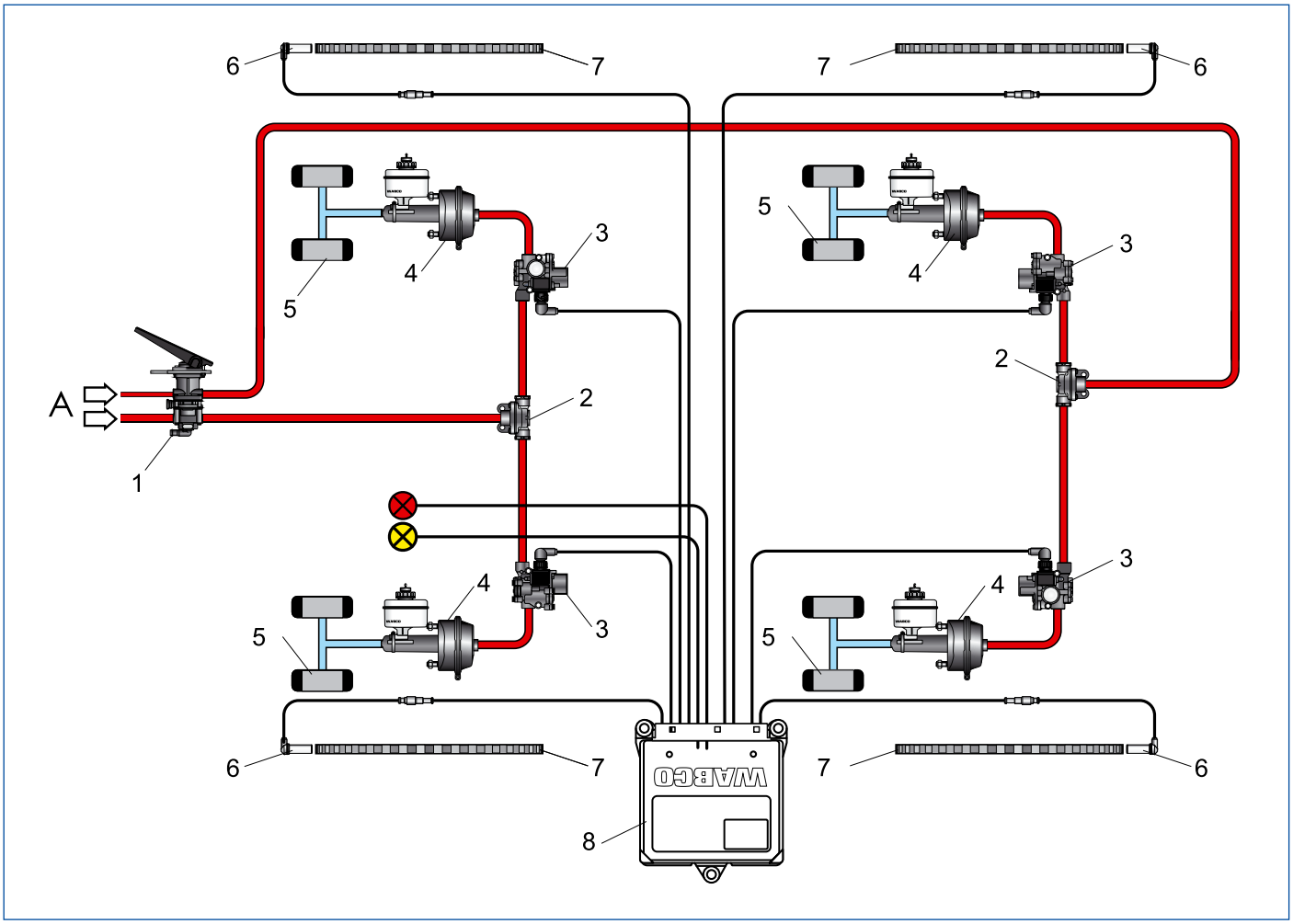
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Trailer brake valve with release valve	971 002 XXX 0	73
4	Air reservoir	950 XXX XXX 0	52
5	Clamping band	451 999 XXX 2	53
6	Drain valve	934 300 XXX 0	53
7	Trailer EBS E modulator	480 102 XXX 0	123
8a **8b**	Pressure sensor hydraulic oil Pressure sensor hydraulic oil (optional, TEBS E2 or higher)	– –	not part of WABCO's scope of supply
9	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
10a **10b**	Cable pressure sensor Cable pressure sensor (optional, TEBS E2 or higher)	449 812 XXX 0 449 812 XXX 0	▸ see overviews "Cables", 202
11	Extension cable sensor	449 723 XXX 0	▸ see overviews "Cables", 202
12	Supply cable	449 173 XXX 0	
13	24N cable	449 349 XXX 0	
14	Diagnostic cable (optional, only with TEBS E Premium modulator)	449 611 XXX 0	
15	Wheel speed sensor	441 032 XXX 0	49

4.6 Example of 5-axle crane ABS braking system



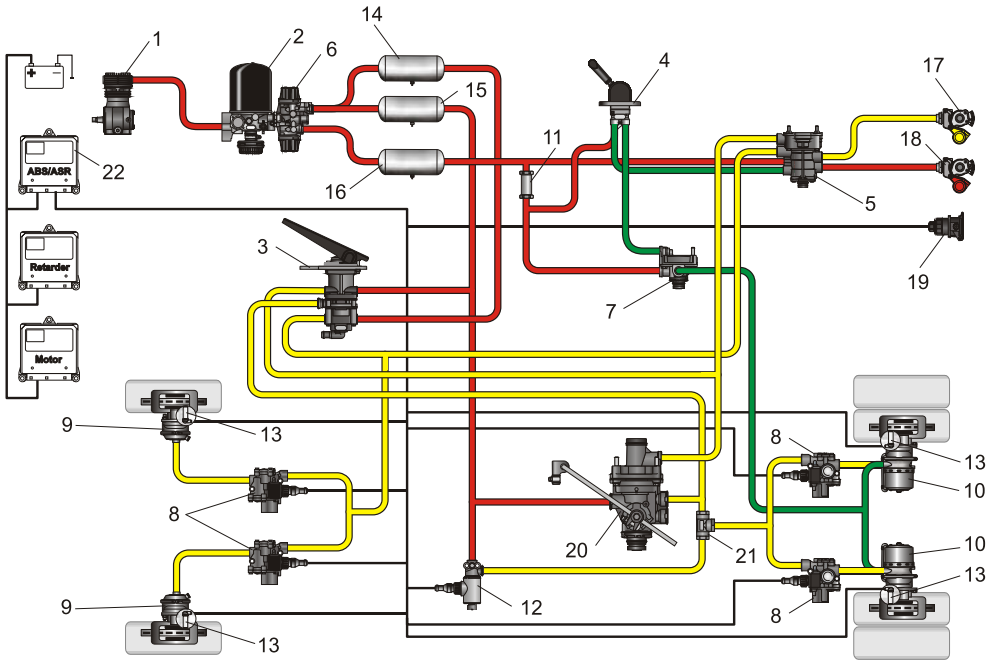
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	911 5XX XXX 0	42
2	Air Processing Unit (APU)	932 500 XXX 0	49
3	Foot brake valve with pedal actuation	461 31X XXX 0	56
4	Hand brake valve	961 72X XXX 0	60
5	Trailer control valve	973 009 XXX 0	66
6	Overload protection relay valve	973 011 XXX 0	62
7	Relay valve	973 011 XXX 0	62
8	ABS solenoid valve	472 195 XXX 0	117
9	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
10	TRISTOP™ spring chamber brake cylinder	925 37X XXX 0	137
11	Wheel speed sensor	441 032 XXX 0	49
12	Air reservoir	950 XXX XXX 0	52
13	Drain valve	934 30X XXX 0	53
14	Clamping band	451 999 XXX 2	53
15	Coupling head "brake" (yellow)	952 200 XXX 0	68
16	Coupling head "supply" (red)	952 200 XXX 0	68
17	Power supply via ISO 7638	–	–
18	ECU "ABS E"	446 003 XX0 0	89
19	PAN™25	40 250 XXX	132

4.7 Example of Air-over-Hydraulic (AoH) braking system with ABS



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
A	Air quality	–	–
1	Foot brake valve with pedal actuation	461 31X XXX 0	56
2	Quick release valve	973 500 XXX 0	79
3	ABS solenoid valve	472 195 XXX 0	117
4	AoH converter	–	139
5	Wheel brake cylinder	–	–
6	Wheel speed sensor	441 032 XXX 0	49
7	Pole wheel	–	–
8	ECU "ABS E"	446 003 XXX 0	89

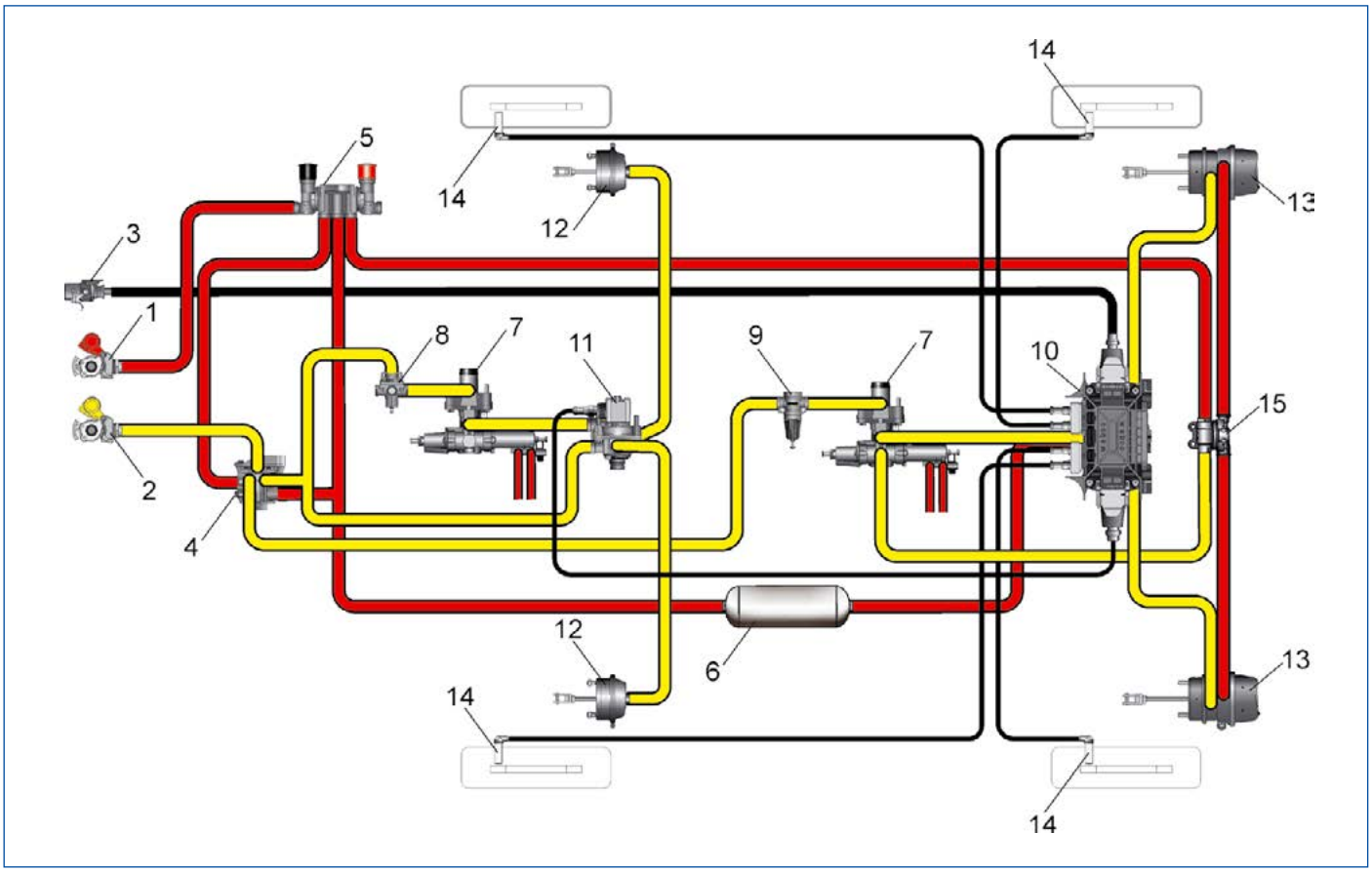
4.8 EC Air Brake System with ABS and ASR fitted (towing vehicle)



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 1XX XXX 0	42
2	Air dryer with combined unloader valve	432 410 XXX 0	48
3	Foot brake valve with pedal actuation	461 31X XXX 0	56
4	Hand brake valve	961 72X XXX 0	60
5	Trailer control valve	973 009 XXX 0	66
6	Multi-circuit protection valve	934 7XX XXX 0	57
7	Overload protection relay valve	973 011 XXX 0	62
8	ABS solenoid valve	472 195 XXX 0	117
9	UNISTOP™ diaphragm brake cylinder front axle	423 XXX XXX 0	135
10	TRISTOP™ spring chamber brake cylinder rear axle	925 XXX XXX 0	137
11	Check valve	434 014 XXX 0	63
12	ASR solenoid valve	472 XXX XXX 0	–
13	Wheel speed sensor	441 032 XXX 0	49
14	Air reservoir circuit 2	950 XXX XXX 0	52
15	Air reservoir circuit 1	950 XXX XXX 0	52
16	Air reservoir circuit 3	950 XXX XXX 0	52
17	Coupling head "supply" (red)	952 200 XXX 0	68
18	Coupling head "brake" (yellow)	952 200 XXX 0	68
19	ABS trailer plug connection	–	–
20	LSV controller	475 7XX XXX 0	61
21	2 way directional control valve	434 208 XXX 0	92
22	ECU "ABS"	446 XXX XXX 0	89

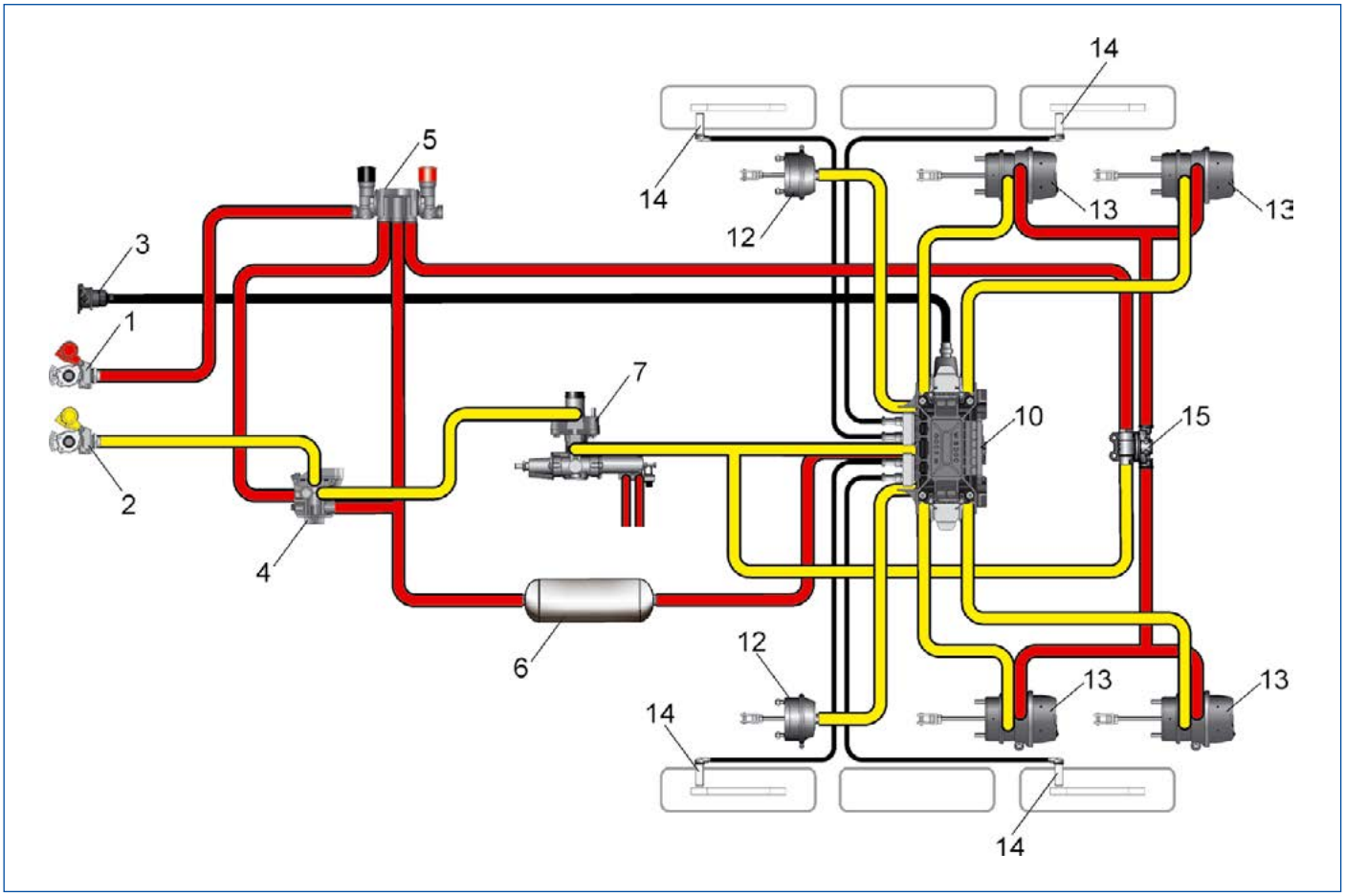
4.9 Pneumatic anti-lock system ABS (towed vehicle)

EC air brake system with ABS (4S/3M) in the drawbar trailer



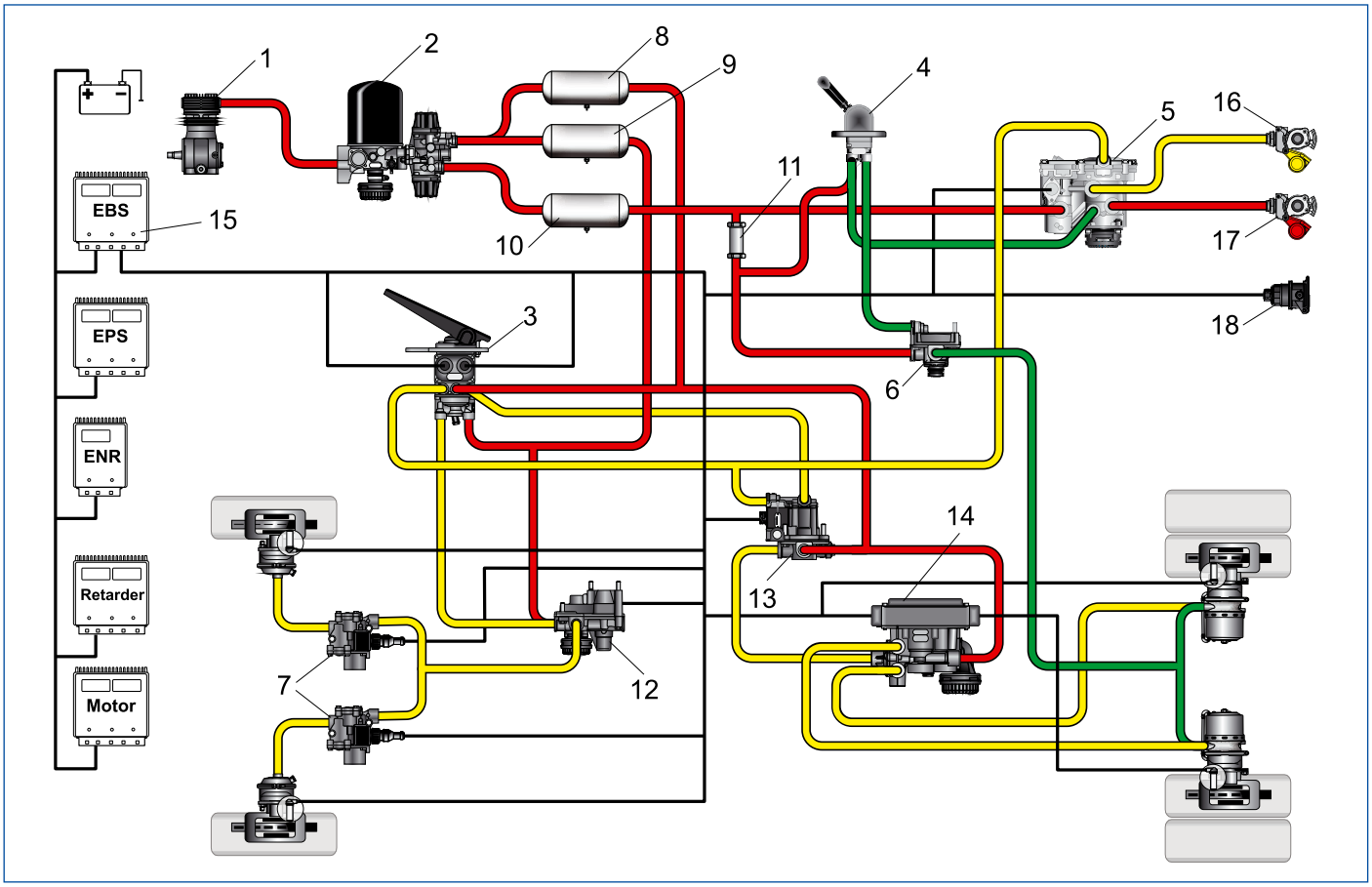
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	ABS trailer plug connection	–	–
4	Trailer brake valve	971 002 XXX 0	73
5	Trailer release valve (double release valve)	963 001 XXX 0	80
6	Air reservoir	950 XXX XXX 0	52
7	LSV controller	475 71X XXX 0	77
8	Pressure ratio valve	975 001 XXX 0	75
9	Pressure limiting valve	475 010 XXX 0 475 015 XXX 0	74 74
10	VCS-ABS ECU with ABS boxer relay valve	4XX XXX XXX 0	99
11	ABS relay valve "steering axle"	472 195 XXX 0	126
12	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
13	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
14	Wheel speed sensor	441 032 XXX 0	49
15	2 way directional control valve	434 208 XXX 0	92

EC air brake system with ABS (4S/2M) in the semitrailer



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	ABS trailer plug connection	–	–
4	Trailer brake valve	971 002 XXX 0	73
5	Trailer release valve (double release valve)	963 001 XXX 0	80
6	Air reservoir	950 XXX XXX 0	52
7	LSV controller	475 71X XXX 0	77
12	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
13	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
14	Wheel speed sensor	441 032 XXX 0	49
15	2 way directional control valve	434 208 XXX 0	92

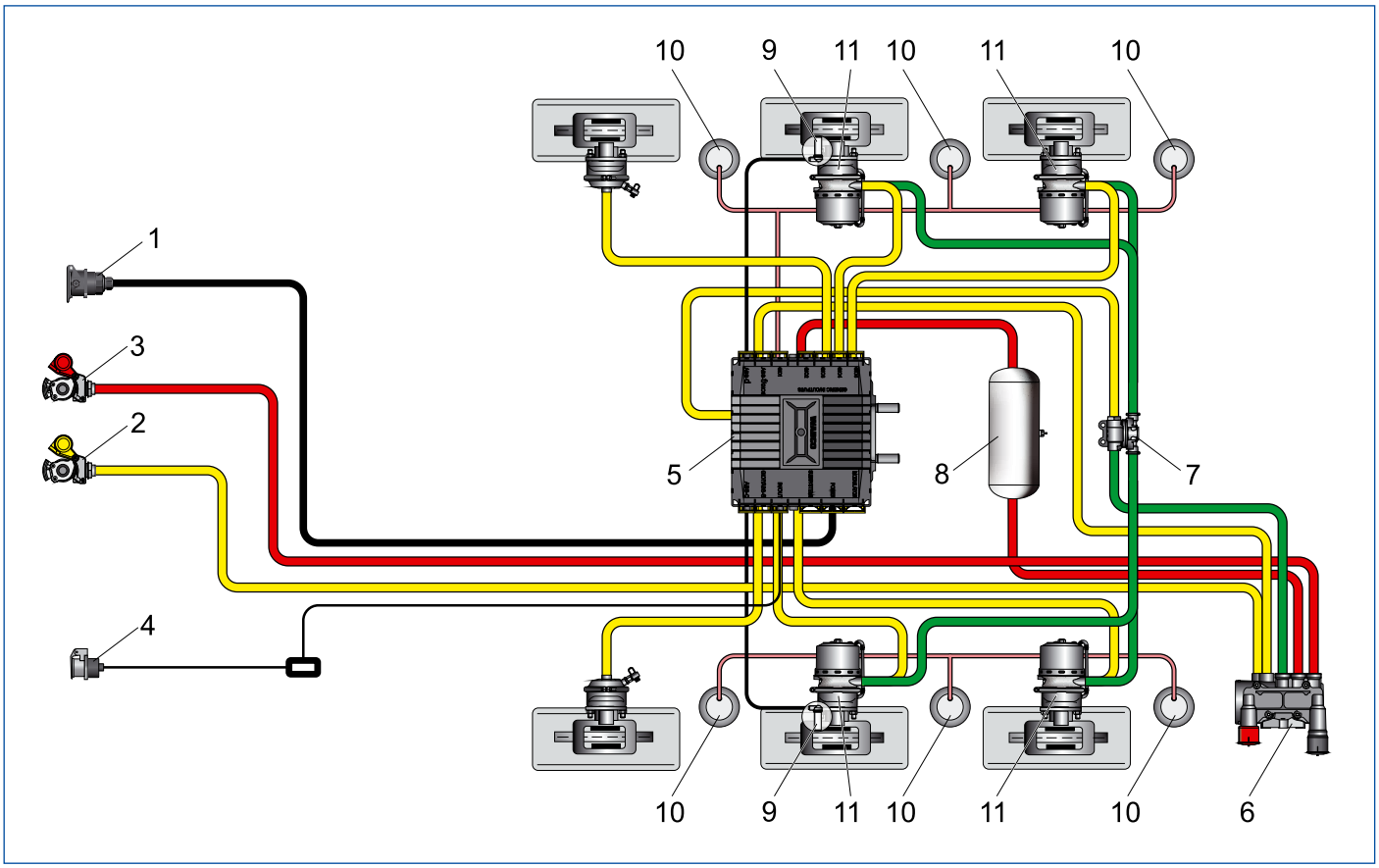
4.10 Electronic braking system EBS (towing vehicle)



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Air Processing Unit (APU)	932 500 XXX 0	49
3	Brake signal transmitter	480 003 XXX 0	109
4	Hand brake valve	961 72X XXX 0	60
5	Trailer control valve	973 009 XXX 0	66
6	Overload protection relay valve	973 011 XXX 0	62
7	ABS solenoid valve	472 195 XXX 0	117
8	Air reservoir circuit 2	950 XXX XXX 0	52
9	Air reservoir circuit 1	950 XXX XXX 0	52
10	Air reservoir circuit 3	950 XXX XXX 0	52
11	2 way directional control valve	434 208 XXX 0	92
12	Proportional relay valve	480 202 XXX 0	111
13	Backup valve rear axle	480 205 XXX 0	113
14	(Axle) modulator	480 10X XXX 0	114
15	EBS central module	446 135 XXX 0	110
16	Coupling head "brake" (yellow)	952 200 XXX 0	68
17	Coupling head "supply" (red)	952 200 XXX 0	68
18	Power supply via ISO 7638	–	–

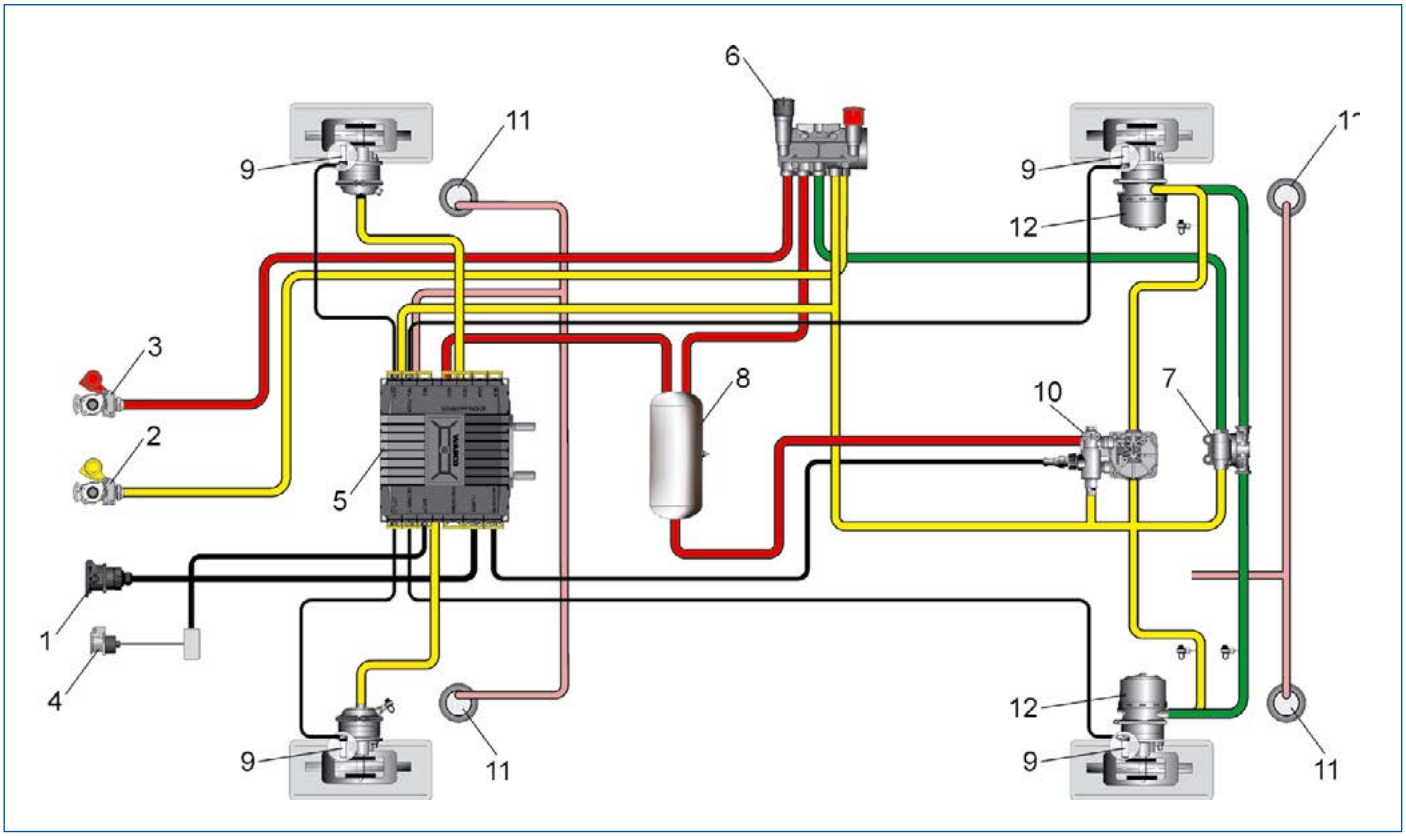
4.11 Electronic braking system EBS (towed vehicle)

Trailer EBS E – 2S/2M system for standard semitrailers



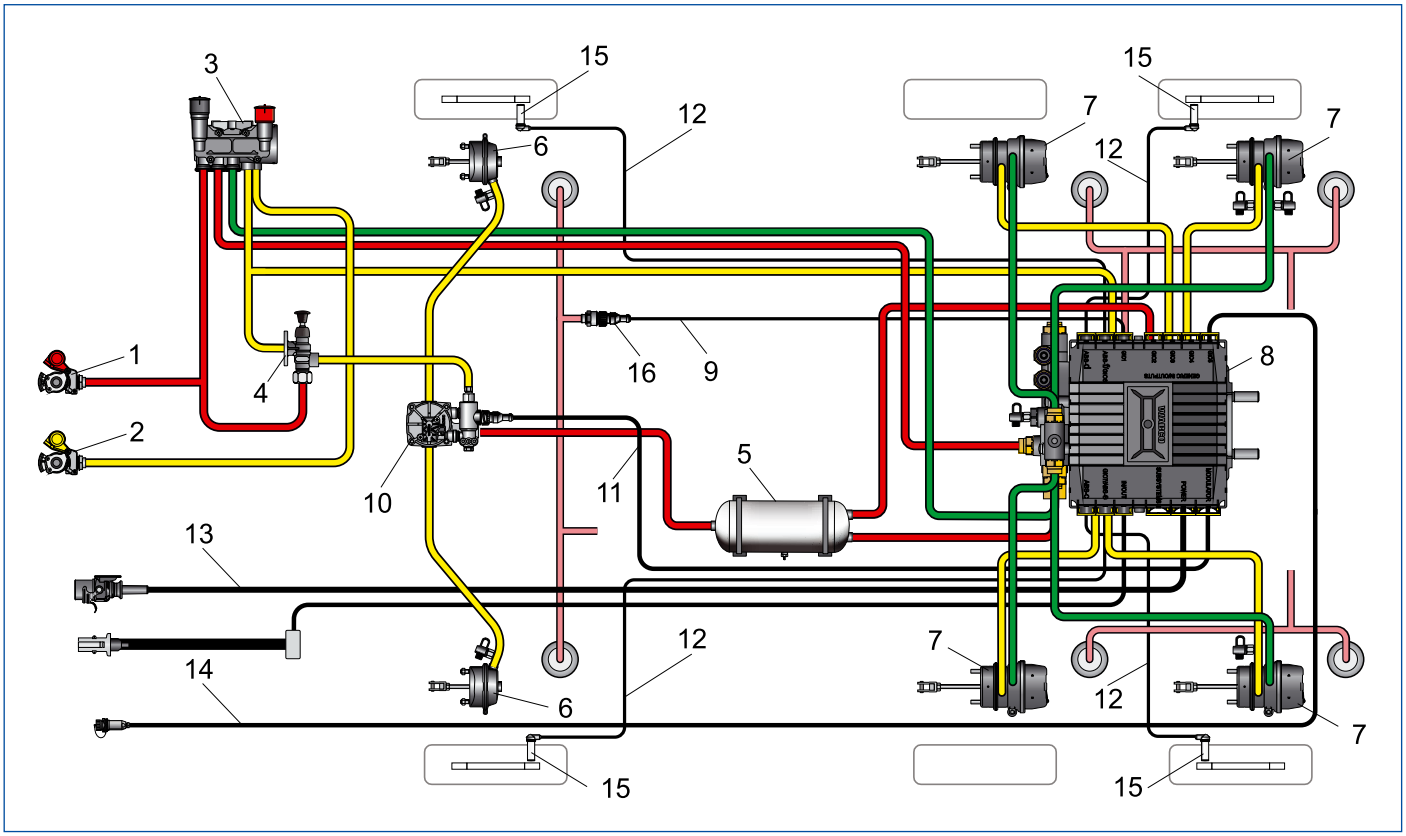
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Power supply via ISO 7638	–	▸ see overviews "Cables", 202
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Coupling head with filter "supply" (red)	952 201 XXX 0	68
4	Stop light supply 24N via ISO 1185 (optional)	–	▸ see overviews "Cables", 202
5	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
6	Park release emergency valve (PREV)	971 002 XXX 0	127
7	Overload protection relay valve	973 011 XXX 0	62
8	Air reservoir of the service brake system	950 XXX XXX 0	52
9	Wheel speed sensor	441 032 XXX 0	49
10	Support bellow	–	–
11	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137

Trailer EBS E – 4S/3M system for standard drawbar trailers with conventional air suspension



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Power supply via ISO 7638	–	–
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Coupling head with filter "supply" (red)	952 201 XXX 0	68
4	Stop light supply 24N via ISO 1185 (optional)	–	▸ see overviews "Cables", 202
5	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
6	Park release emergency valve (PREV)	971 002 XXX 0	127
7	Overload protection relay valve	973 011 XXX 0	62
8	Air reservoir of the service brake system	950 XXX XXX 0	52
9	Wheel speed sensor	441 032 XXX 0	49
10	EBS relay valve (3rd modulator; for controlling the 2nd axle)	480 207 XXX 0	126
11	Support bellow	–	–
12	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137

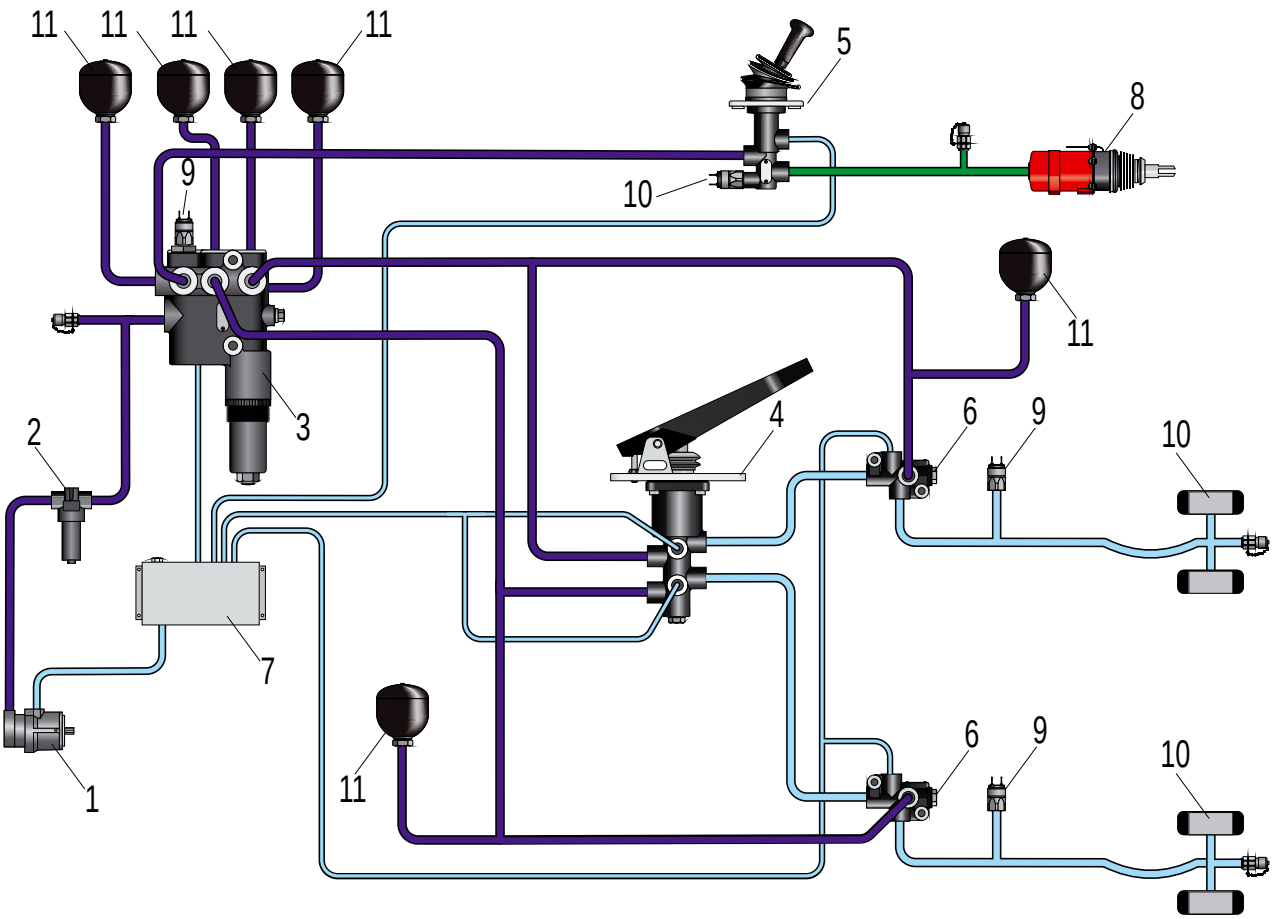
Trailer EBS E – 4S/3M system for 3-axle drawbar trailers with conventional air suspension



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Park release emergency valve (PREV)	971 002 XXX 0	127
4	Trailer release valve	963 00X XXX 0	80
5	Air reservoir of the service brake system	950 XXX XXX 0	52
6	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
7	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
8	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
9	Cable to the pressure sensor	441 040 013 0	▸ see overviews "Cables", 202
10	EBS relay valve (3rd modulator; for controlling the 2nd axle)	480 207 XXX 0	126
12	Extension cable for sensor	449 723 XXX 0	▸ see overviews "Cables", 202
13	24N cable	449 349 XXX 0	▸ see overviews "Cables", 202
14	Supply cable	449 273 XXX 0	▸ see overviews "Cables", 202
15	Wheel speed sensor	441 032 XXX 0	49
16	Pressure sensor	441 040 XXX 0	176

4.12 Full Hydraulic Power Brake (FPB™)

2-circuit with relay valve and park brake circuit



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Pump	in the vehicle	–
2	Pressure filter	in the vehicle	–
3	Cutoff valve	477 397 XXX 0	146
4	Brake valve	467 406 XXX 0	149
5	Hand brake valve	467 410 XXX 0	158
6	Relay valve	477 411 XXX 0	159
7	Hydraulic tank	in the vehicle	–
8	Spring brake cylinder	427 001 XXX 0	160
9	Pressure switch	441 014 XXX 0	157
10	Wheel brake cylinder	in the vehicle	–
11	Accumulator	458 501 XXX 0	156

5 Air management

5.1 Compressors

Vehicle data / Technical data

- Number of cylinders: One or two cylinders
- Fastening: Foot or flange fixation
- Drive: V-belt or gear drive
- Operating pressure: Operated by normal or high pressure
- Cooling: air-, water- or oil-cooled
- Type of lubrication: Pressure lubrication or splash lubrication with pressure oil connection or manual refilling
- Drive shaft: with or without drive shaft for auxiliary units (e.g. hydraulic pump for hydro-steering)

PRODUCT FAMILY	FIGURE	DESCRIPTION
912 XXX XXX 0		c-comp™ ■ Integrated multi-disk clutch in the compressor ■ Pneumatic control and actuation of the clutch analogously to the current Power Reduction (PR) system ■ Significant fuel savings due to full decoupling during idling phases ■ Clean air and reduced maintenance costs ■ Reduced noise emissions and greater driving comfort
411 141 XXX 0		c-comp™ Agriculture ■ Developed and adapted for agricultural applications ■ One-cylinder pedestal-type compressor (159 cm³) with belt drive, electrically operated clutch (12 V) ■ Fuel consumption significantly improved during idling phase ■ Completely disengaged compressor during the idling phase also reduces noise emission ■ Efficient solution for off-highway applications where the compressor is only used to a limited extent ■ Clean air and reduced maintenance costs
912 518 XXX 0		d-comp™ ■ The system pressure is reached in two compression stages: 1st stage up to 4 bar / 60 psi 2nd stage to more than 12.5 bar / 180 psi ■ Intensive cooling between the two stages ■ Clean air and high efficiency for a long life and high customer satisfaction ■ Significant reduction in oil transfer and exhaust gas temperatures

PRODUCT FAMILY	FIGURE	DESCRIPTION
913 500 XXX 0		e-comp™ ■ Operation is completely independent of the vehicle engine ■ Stand-alone system with compressor, electric motor, oil supply and oil pump ■ Variable compressor speeds between 0 and 2500 rotations per minute ■ Ideal solution for off-highway vehicles or trucks and buses with hybrid or fully electric drive trains
912 210 XXX 0		h-comp™ ■ Addition to the compressor range by a version with 100 mm piston ■ 3 designs are available: Grey cast iron, aluminium with bushing and full aluminium ■ Grey cast iron version: More than 30 % weight saving compared to a two-cylinder compressor with comparable output ■ Aluminium version with bushing: Additional weight saving of 20 % compared to the grey cast iron version ■ Full aluminium version: The innovative design without bushing allows further weight and cost savings ■ Less oil transfer and oil decomposition ■ Clean air and reduced maintenance costs
9XX XXX XXX 0		t-comp™ ■ High durability and clean air in two-stage compression ■ Advantages due to use of air from the turbocharger as the first compression stage ■ Turbopressure as multiplier for the air supply
9XX XXX XXX 0		m-comp™ Modular compressor with multiple options: ■ The Power Reduction function provides significant potential for saving fuel during idling phases ■ The Temperature Reduction function enables a significant reduction in cylinder head and exhaust air temperatures ■ The shaft permits operation of additional units downstream of the compressor ■ The crank housing of aluminium helps to reduce the overall weight significantly ■ The water-cooled valve plate and the crank housing reduce oil transfer and deposition of oil carbon

Purpose

Compressors generate the compressed air required for the sum of all compressed air consumers in a vehicle.

WABCO compressors significantly reduce the power consumption during idling phases if they area equipped with the optional Power Reduction (PR) function, which is integrated in the cylinder head.

Numerous different compressor variants mean that WABCO has the suitable solution for virtually any application.

5.2 Pedestal-type compressors

411 141 XXX 0

Purpose

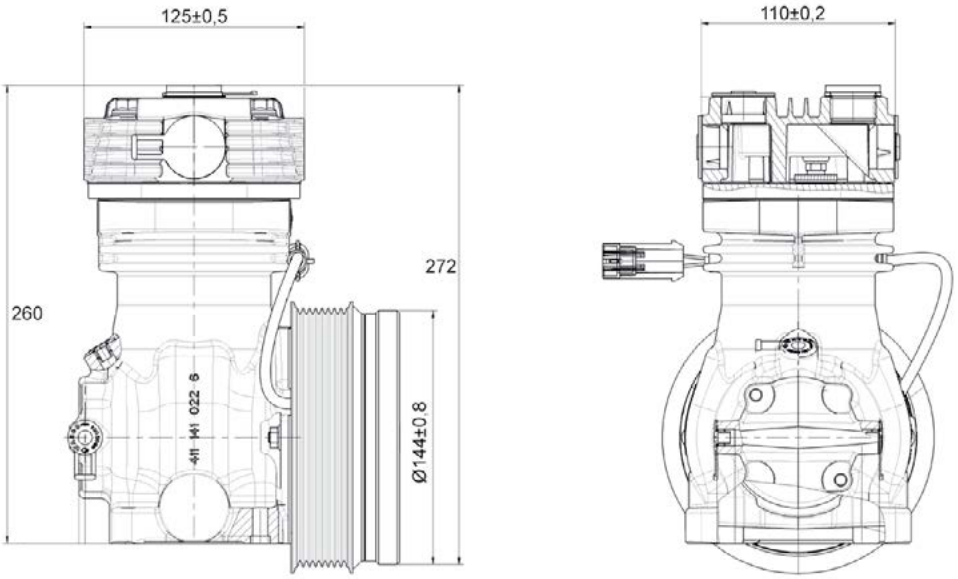
Generating compressed air in vehicles.

The compressor is designed as a single-stage piston compressor and its major parts are as follows: Monoblock housing, lamellar valve, valve plate, air-cooled cylinder head. Further a crankshaft on two composite plain bearings. The drive sealed with a shaft seal, a connecting rod with a composite plain bearing, pistons with piston rings.

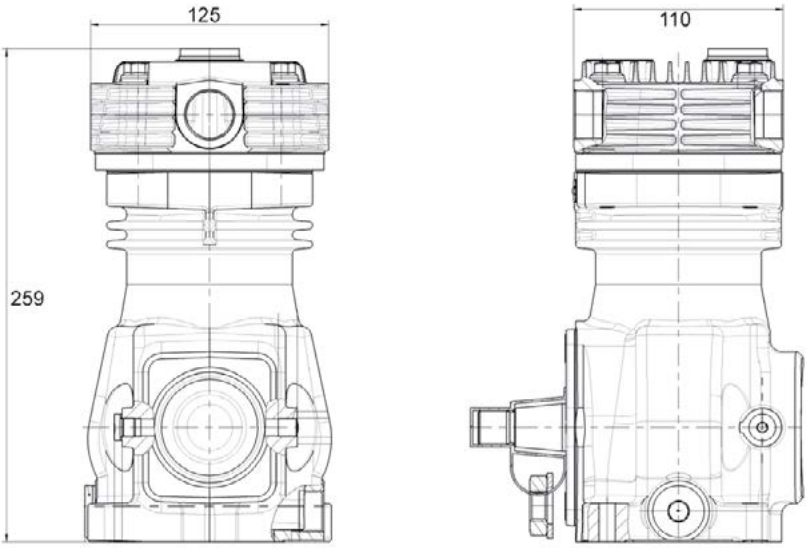
Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 411 141 XXX 0			
Bore diameter [mm]	75		
Stroke [mm]	34	36	
Displacement [cm^3]	150	159	
Maximum operating speed [RPM]	2600	3000	
Maximum operating pressure	8 bar	8.5	18
Type of lubrication	Splash lubrication (refilled manually)	Pressure lubrication	
Cooling air	≤ 8 bar 4 m/s, > 8 bar 6 m/s		
Flow rate at maximum operating speed and maximum operating pressure [litres]	180	280	180
Weight [kg]	6.4	8.8 kg	

Installation dimensions – Example for pressure lubrication / air cooling / electrical decoupling



Installation dimensions – Example for pressure lubrication / air cooling



5.3 Air management (electronic / mechanical)

5.3.1 Anti-freeze pump

932 002 XXX 0

Purpose

To automatically inject anti-freeze fluid into the braking system to prevent icing in pipes and downstream components.

Technical data

EXAMPLE OF VARIANT FOR PRODUCT FAMILY 932 002 XXX 0	
Maximum operating pressure [bar]	18
Flow rate per pulse [cm^3]	0.2
Anti-freeze	WABCOTHYL™
Thermal range of application [°C]	-40 to +80
Medium temperature [°C]	-40 to +150
Maximum air admission temperature [°C]	+130
Activation pressure [bar]	≥ 6
Nominal width [mm]	Ø 15
Direction of flow	Optional
Weight [kg]	0.5

5.3.2 WABCOTHYL

Design types

830 702 XXX 0

Purpose

Anti-freeze

Technical data

Available container types: 1, 10, 30 or 200 litres

5.3.3 Single-chamber and dual-chamber air dryer

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
432 410 XXX 0 (with unloader valve) 432 420 XXX 0 (without unloader valve)		■ Removes humidity from the compressed air provided by the compressor ■ An integrated single-chamber unloader valve is responsible for regeneration in single-chamber air dryers ■ The alternating regeneration of the two cartridges in dual-chamber air dryers is controlled electronically by means of a solenoid valve ■ Optionally available with heater and unloader valve ■ Compact design permits installation even in small installation spaces ■ Robust, cost-efficient design based on tried and tested components
432 431 XXX 0 (without unloader valve) 432 433 XXX 0 (with unloader valve)		

Purpose

Air dryers can be fitted in all air compression systems. The purpose of the air dryer is to reduce the amount of water vapour in the compressed air. This is achieved by cold-generated absorption drying.

This procedure conducts the compressed air from the compressor over a granulate that can absorb the water vapour contained in the air. The granulates are regenerated by backwashing them with previously dried air.

Advantage of the dual chamber principle

With the single chamber air dryer, the regeneration process takes place only during the idling phase of the compressor. In a dual chamber air dryer, this process is controlled by a solenoid valve with an integrated timer. This procedure ensures that the absorbency of the granulates is maintained even when the compressor works more or less continuously. Dual chamber air dryers are usually used in vehicles with higher air consumption.

5.3.3.1 Air Processing Unit (APU)

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
932 501 XXX 0		C-APU (Compact Air Processing Unit) ■ Integrates the functions of air dryer, multi-circuit protection valve as well as the optional pressure limiting valve ■ Regeneration within the unit or regenerated air from a separate regeneration reservoir ■ Integrated double pressure sensor as an option ■ An installation length reduced by 30 % as compared to conventional APUs ■ Cost savings due to less complex installation ■ Reduced maintenance costs thanks to innovative solutions that extend the cartridge's service life ■ Pressure limiter for controlling two different pressure levels, optional
932 500 XXX 0		M-APU (Mechanical Air Processing Unit) ■ Integrates the function of an air dryer and a multi-circuit protection valve ■ 2 optional pressure limiting valves ■ System regeneration or regenerated air from a separate regeneration tank ■ Optionally integrated double pressure sensor ■ Innovative cartridge solutions permit longer maintenance intervals ■ With two pressure limiters it is possible to control up to 3 pressure levels

Purpose

The proven air processing units from WABCO control the conveying times of the compressors and the regeneration of the cartridge by means of a mechanical unloader valve.

In this respect there are different solutions with functions such as air dryer and four-circuit protection valve as well as highly integrated solutions that provide numerous connections, pressure sensors and pressure limiting valves as options.

5.3.4 Cartridge

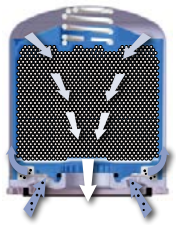
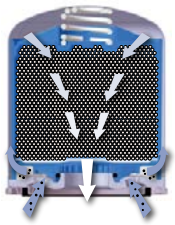
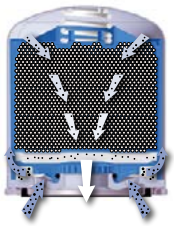
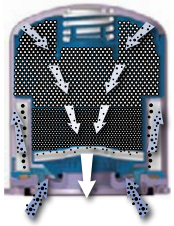
Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
432 41X XXX X		Recycling cartridge ■ WABCO premium desiccant ■ Recycling cartridge with up to 30 % recycled desiccant ■ Available for almost all air dryers with screw-on cartridges ■ Protects the entire compressed air system against humidity ■ Desiccant withstands even the toughest challenges ■ Permits maintenance intervals of 2 years under normal conditions of application
432 410 XXX X		Standard cartridge ■ WABCO premium desiccant ■ Available for almost all air dryers with screw-on cartridges ■ Protects the entire compressed air system against humidity ■ Desiccant withstands even the toughest challenges ■ Permits maintenance intervals of 2 years under normal conditions of application
432 901 XXX X		Air System Protector ■ WABCO premium desiccant ■ Oil coalescence filter ■ Lower repair costs thanks to improved protection against corrosion and frost damage as well as oil deposits in valves of the compressed air system ■ Desiccant withstands even the toughest challenges ■ Permits maintenance intervals of 2 years under normal conditions of application
432 410 XXX X		Air System ProtectorPLUS ■ Unique combination of oil coalescence filter up- and downstream of the desiccant ■ The cartridge can hold more desiccant thanks to a modified design ■ With two different desiccants ■ A service life extended by 50 % with a recommended replacement interval of 3 years under normal conditions of application ■ Almost 100 % separation of all substances such as oil and carbon reaching the air dryer reduce repair costs ■ Innovative design increases the reliability of the air brake system, particularly in vehicles with high air demand

Purpose

Protects the air brake system against contamination and damage due to oil, moisture and aerosols.

Technical data

CARTRIDGE TYPE	RECYCLING CARTRIDGE	STANDARD CARTRIDGE	AIR SYSTEM PROTECTOR	AIR SYSTEM PROTECTOR^{PLUS}
Function: Drying phase				
Filter Recommended service interval	Water filter (recycling: with up to 30 % recycled premium desiccant) up to 2 years system protection	Water filter up to 2 years system protection	1. Water filter 2. Oil and aerosol filter up to 2 years system protection	1. Oil filter 2. Water filter 3. Aerosol filter Up to 3 years system protection
Drying performance	++	++	++	++
Oil separation			+	++
Aerosol separation			+	++
Vehicle air consumption	low	low	medium	high
M 39x1.5; 13 bar	432 410 XXX 7	432 410 XXX 2	432 901 XXX 2	432 410 XXX 2
M 39x1.5; 13 bar			432 901 XXX 2	
M 41x1.5; 13 bar			432 901 XXX 2	
M 42x1.5; 13 bar		432 410 XXX 2		
G 1¼"; 13 bar	432 415 XXX 7			
G 1¼" Width over flats 30; 13 bar		432 410 XXX 2	432 901 XXX 2	

5.3.5 Air reservoir

Design types

950 XXX XXX 0

- Steel variants with a volume of up to 100 l and a diameter of 396 mm
- Aluminium variants with a volume of up to 60 l and a diameter of 396 mm

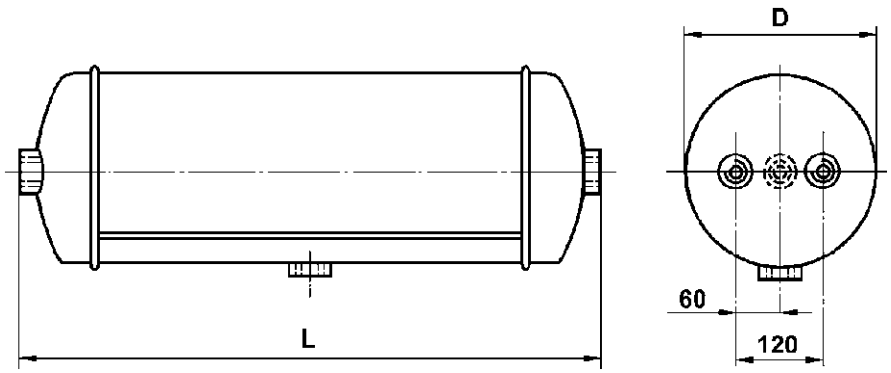
Purpose

Stores the compressed air supplied by the compressor

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 950 XXX XXX 0												
Content [litres]	10	15	20		30	40		60			80	100
L [mm]	368	527	691	495	709	927	758	1108	893	580	750	915
D [mm]	206			246			276		323	396		
In accordance with 87/404/EEC & EN286-2	yes											
Maximum operating pressure [bar]	15.5						14.5		12.5			
Weight [kg]	4.7	6.3	7.9	7.2	10.0	12.7	11.5	16.2	15.2	16.3	20.5	24.5

Installation dimensions



5.3.5.1 Clamping band

451 999 XXX 2

Purpose

Fastening the air reservoir

Technical data

The clamping bands are available for the following air reservoir diameters:
206 mm, 246 mm, 276 mm, 310 mm, 396 mm

5.3.5.2 Drain valve

Design types

934 300 XXX 0 (manual)

934 301 XXX 0 (automatic)

Purpose

To drain condensation from the air reservoir and, if necessary, to vent the compressed air lines and reservoirs.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 934 30X XXX 0		
Design	manual	automatic
Maximum operating pressure [bar]	20	
Permissible medium	Air, water, mineral oil	
Corresponds to standard	DIN 74292	

5.3.5.3 Pressure gauge

Design types

453 002 XXX 0

453 011 XXX 0

Purpose

Single air pressure metre with lighting for monitoring the pressure in the air reservoirs.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 453 0XX XXX 0		
Maximum operating pressure [bar]	10	25
Display range [bar]	0 to 10	0 to 25
Display tolerance [bar]	± 0.1	± 0.2
Dial	Off-white with black lettering	White with black lettering
Pointer	black	
Cover	Glass	
Edge ring	Chrome-plated	
Light connection [V]	12	–
Thermal range of application [°C]	-25 to + 65	-20 to +50
Weight [kg]	0.2	0.26

Notes

6 Brakes and brake systems

6.1 Pneumatic braking system

Products and systems that are exclusively actuated and controlled using the medium of air.

6.1.1 Conventional components (towing vehicle)

6.1.1.1 Unloader valve

975 303 XXX 0

Purpose

Automatic control of the operating pressure in an air brake system and ensuring that pipes and valves are free of contamination. Depending on the variant used, it also serves to control a downstream anti-freeze pump or single chamber air dryer.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 975 303 XXX 0					
Maximum operating pressure [bar]	25				
Medium temperature [°C]	-40 to +150				
Ambient temperature [°C]	-40 to +100				
Tire valve	no	yes			
Cut-off pressure [bar]	8.1 ±0.2	7.8 ±0.2	7.3 ±0.2	8.1 ±0.2	14 ±0.3
Operating range [bar]	0.6 +0.4				1 +1.5
Port 22	yes				
Opening pressure of integrated safety valve [bar]	12 +2				20 +1/-2

6.1.1.2 Multi-circuit protection valve

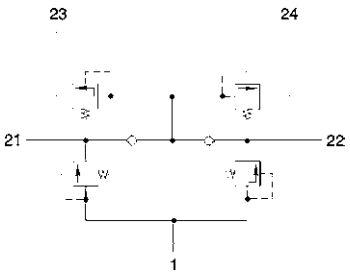
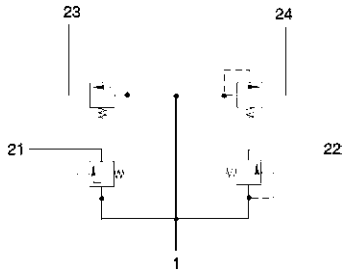
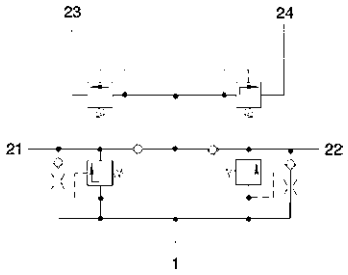
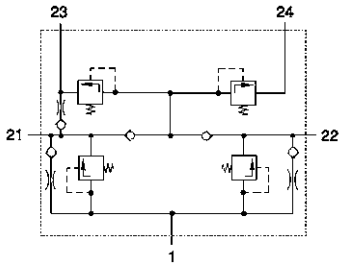
Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
934 702 XXX 0		Four-circuit safety valve ■ With limited return flow in serial or parallel arrangement, with or without a bypass.
934 702 XXX 0		Four-circuit safety valve ■ With limited return flow in serial or parallel arrangement, with or without a bypass. ■ Delivery with 5 or 7 connections.
934 705 XXX 0		Four-circuit safety valve ■ In serial connection. ■ With one or two integrated pressure limiting units and check valves for circuits (3) and (4), as well as electronic pressure sensors for circuits (1) and (2). ■ Direct connection via a screw flange with air dryer 932 400 to the compact Air Processing Unit (APU). ■ To comply with regulation 98/12/EC, some variants are equipped with a "bleed-back function".
934 714 XXX 0		Four-circuit safety valve ■ In serial connection. ■ To comply with regulation 98/12/EC, some variants are equipped with a "bleed-back function".

Purpose

Distributes the braking pressure to the different braking circuits and secures the pressures in the intact braking circuits in the event that one or several braking circuits in a multi-circuit air brake system fail.

Terminology

FIGURE	DESCRIPTION
	Series connection ■ This means that the ancillary consumers (circuits 3 and 4) are switched downstream of the primary consumers (circuits 1 and 2). No return flow is possible from the ancillary consumers to the primary consumers.
	Parallel switching ■ In a parallel arrangement, all circuits are connected with each other. This means that a limited return flow from the ancillary consumers to the primary consumers is possible.
	Bypasses ■ Even if a circuit has failed and the whole of the system is pressureless, a bypass allows those circuits which have not failed to be filled even if the compressor is working at a slow speed. They are often used in circuit 1 and 2. At valve variants in parallel arrangement bypasses in circuit 3 and 4 can also be used.
	Bleed-back function ■ The parking brake circuit 3 is connected to air circuit 1 via a throttled check valve. If the service brake circuit 1 fails, circuit 3 is vented too, to fulfil the requirements according to 98/12/EC.
	Opening pressure ■ Pressure that is required to open the circuits.
	Closing pressure ■ Pressure (stabilising pressure) that triggers shutting down the failed circuit. Limited Return Flow: This allows the pressure of any combined circuits to be balanced up to the closing pressure.

6.1.1.3 Towing vehicle brake valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
461 315 XXX 0		Dual circuit foot brake valve ■ Tappet-actuated. ■ Control via pedal block with brake pedal.
461 317 XXX 0		Dual circuit foot brake valve ■ Treadle-actuated.
461 318 XXX 0		Dual circuit foot brake valve ■ With treadle actuation and integrated electrical endurance brake control. ■ Depending on variant: Equipped with three electrical switches or a proximity switch.
461 319 XXX 0		Dual circuit foot brake valve ■ With tappet actuation and an integrated laden/unladen valve for the second braking circuit. ■ Pressure reduction ratio for the laden/unladen valve is 1.5:1, 2:1 or 2.7:1, depending on the variant. ■ Control via the brake pedal.
461 324 XXX 0		Dual circuit foot brake valve ■ With treadle actuation and integrated, stepped, pilot valve for pneumatically controlled retarders.

Purpose

Dual circuit brake valves are responsible for sensitive, stepped air intake and outlet of the towing vehicle's brake cylinders. In addition, they also control the trailer control valve (if installed).

The brake valves are supplied with tappet, treadle or lever actuation. Both braking circuits are installed one underneath the other.

If one circuit fails, the other circuit remains unaffected.

Some design types have additional functions (for load-sensing control of the front axle or for upstream actuating of endurance brake systems such as retarders).

6.1.1.4 Hand brake valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
961 722 XXX 0		Hand brake valve ■ Supplied with and without control position. ■ Both hand brake valves have the same function.
961 723 XXX 0		
961 722 26X 0		Hand brake valve ■ With two independent compressed air supply circuits and integrated emergency release system / pipe rupture safeguard.
461 700 XXX 0		Hand brake valve ■ For dual line braking system. ■ Direct, non-graduated pressurising of the braking system's pilot line for the trailer in connection with the mechanical tractor park brake.

Purpose

Hand brake valves, which when actuated work on the basis of venting, are used with linkage-free auxiliary and parking brake systems. Their function is to adjustably vent the connected TRISTOP™ or spring brake actuators.

In trailer train operation, the hand brake valve simultaneously controls the trailer control valve. Depending on the variant, the device is equipped with an additional control position for the trailer.

Dual circuit variants with integrated emergency release system / pipe rupture safeguard are often used for buses.

6.1.1.5 Automatic Load Sensing Valve (LSV)

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
475 710 XXX 0		■ Automatic control of the braking force depending on the spring deflection and thus the load status of the vehicle. ■ The integrated relay valve ensures quick pressurising and venting of the brake cylinders.
475 711 XXX 0		■ Automatic control of the braking force of air brake cylinders on air suspended axles relative to the air suspension bellow pressure and thus the load status of the vehicle.
475 720 XXX 0		■ Automatic control of the braking force depending on the spring deflection and thus the load status of the vehicle. ■ The integrated relay valve ensures quick pressurising and venting of the brake cylinders.
475 721 XXX 0		■ Automatic control of the braking force depending on the bellows pressure and thus on the load status of the vehicle. ■ The integrated relay valve ensures quick pressurising and venting of the brake cylinders.

Purpose

Automatic load sensing valves have the task of adjusting the braking pressure on an axle (or possibly several axles in trailers) relative to the respective load status. With properly designed braking forces, and assuming a dry road surface, this prevents locking of the wheels when the vehicle is unladen or partially laden.

In mechanically suspended vehicles, regulation is relative to the spring deflection.

6.1.1.6 Relay valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
973 001 XXX 0		Relay valve for service brake or spring-type actuator.
973 006 XXX 0		Relay valve - plastic type. ■ This valve can only be used for controlling the spring-loaded portion of the TRISTOP™ spring brake actuator.
973 011 XXX 0		Relay valve ■ Relay valve for service brake or spring-type actuator. ■ Replaces 973 001.
973 011 2XX 0		■ Relay valve with overload protection ■ For spring chamber brake, with integrated pressure reduction from port (42) to (2). ■ Replaces 473 017.
473 017 XXX 0		■ Relay valve with overload protection (older variant) for spring-type actuator.

Purpose

The purpose of the relay valves is to shorten the response and pressure build-up times within a braking process by pressurising the brake cylinders more rapidly. At the same time, relay valves act as quick-release valves when the brakes are released.

It is advisable to install relay valves if the total volume of the brake cylinders to be pressurised exceeds 4.5 litres.

Relay valves with overload protection are designed to prevent braking force addition when the service and parking brake systems are actuated at the same time, thereby effectively protecting the mechanical transmission parts against excessive strain. For the area of the auxiliary and parking brake systems, this valve acts as a relay valve.

6.1.1.7 Check valve

434 014 XXX 0

Purpose

To protect the pressurised lines against unintentional venting.

Technical data

EXAMPLE OF VARIANT FOR PRODUCT FAMILY 434 014 XXX 0	
Maximum operating pressure [bar]	20
Nominal width [mm]	Ø 8
Thermal range of application [°C]	-40 to +80
Weight [kg]	0.17

6.1.1.8 3/2 solenoid valve

Design types

472 XXX XXX 0 (venting)	472 XXX XXX 0 (venting)	472 XXX XXX 0 (pressurising)	472 XXX XXX 0 (pressurising)	472 XXX XXX 0 (pressurising)
				

Purpose

3/2 solenoid valve (venting): To vent an air line when current is supplied to the solenoid
3/2 solenoid valve (pressurising): To pressurise an air line when current is supplied to the solenoid.

! You will find connecting cable in the WABCO cable overview ▸ see chapter "10 Accessories" on page 202.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 472 XXX XXX 0 (VENTING)		
Maximum operating pressure [bar]	8	< 13
Nominal width [mm]	Charging: Ø 2.6 Venting: Ø 2.2	Charging: Ø 4 Venting: Ø 4
Nominal current [A]	at 10.8 V = 0.33 at 28.8 V = 0.87	1.41
Switch-on duration [%]	100	
Thermal range of application [°C]	-40 to +70	-40 to +80
Weight [kg]	0.6	0.5

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 472 XXX XXX 0 (PRESSURISING)			
Connector	–	Kostal M 27x1	DIN bayonet
Maximum operating pressure [bar]	8	10.2	
Nominal width [mm]	Ø 2.2	Ø 4	
Nominal current [A]	at 12 V = 0.33 at 24 V = 0.65	1.41	
Switch-on duration [%]	100		
Thermal range of application [°C]	-40 to +70	-40 to +80	
Weight [kg]	0.5		

6.1.1.9 Pressure limiting valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
475 015 XXX 0		Pressure limiting valve with integrated safety valve. ■ It is available in numerous variants with different limiting and safety valve pressures.
475 010 XXX 0		Pressure limiting valve with mounting flange. ■ The valve can be fastened directly to the flange facing of the trailer brake valve. ■ The pressure is set by means of the adjusting screw at the bottom of the valve.
475 010 3XX 0		Pressure limiting valve ■ This valve has been developed as the successor for 475 010 0XX 0. ■ The pressure is set by means of the adjusting screw at the bottom of the valve.

Purpose

Pressure limiting valves are used to limit the initial pressure for the downstream components to the value set by means of the adjusting screw. Pressure limiting valves are used in both motor vehicles and trailers.

On air suspended vehicles, the valve is fitted upstream of the quadruple-circuit protection valve if the unloader valve's cut-off pressure lies above the operating pressure of the braking system.

In trailer braking systems, a pressure limiting valve is often used on the rear axle of trailers to prevent locking of the rear wheels when dynamic axle loads are transferred rapidly during the braking process.

6.1.1.10 Trailer control valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
973 002 XXX 0		Trailer control valve with 2/2-way valve in truck and tractor variants.
973 008 XXX 0		Trailer control valve with integrated 2/2-way valve and proportional pressure reduction. ■ This variant is used in trucks as well as tractor units whose service brake system operates with 10 bar.
973 009 XXX 0		Trailer control valve with integrated 2/2-way valve. ■ This type can be used both in trucks and tractor units.
471 200 XXX 0		Trailer control valve for controlling the single line trailer braking system and for limiting the applied pressure to 5.2 bar.
480 202 XXX 0		Trailer control valve with pulse width modulation control

Purpose

Trailer control valves are used for sensitive and stepped control of the trailer brake in trucks and tractors – with or without predominance. They are actuated via two circuits of the service brake system and one circuit of the auxiliary and parking brake system. In the case of articulated buses, a trailer control valve (without 2/2-way valve) is often used for dual circuit control of the service brake system for axle 3.

6.1.1.11 Trailer control valve (power-operated)

961 106 XXX 0

Purpose

To control the trailer's dual line braking system in connection with the mechanical or hydraulic foot brake of agricultural tractors of any make or size.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 961 106 XXX 0	
Maximum operating pressure [bar]	10
Thermal range of application [°C]	-40 to + 80
Nominal width [mm]	Ø 7
Weight (without compensator actuation) [kg]	1.2
Weight (with compensator actuation) [kg]	2.17

6.1.1.12 Coupling heads

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
Dual line coupling heads		
952 200 XXX 0		■ Coupling head for the supply line with a red cover. ■ For trailers (without valve).
952 200 XXX 0		■ Automatic coupling head for the supply line with two connections and a red cover.
952 200 XXX 0		■ Automatic coupling head for the supply line with one connection and a red cover. ■ For towing vehicles (with valve).
952 200 XXX 0		■ Coupling head for the control line with a yellow cover. ■ For trailers (without valve).
952 200 XXX 0		■ Automatic coupling head for the control line with one connection and a yellow cover. ■ For towing vehicles (with valve).
Single line coupling heads		
452 300 XXX 0		■ Coupling head for the supply line, which is also the control line, and black cover. ■ For towing vehicles (with valve).

PRODUCT FAMILY	FIGURE	DESCRIPTION
452 201 XXX 0		■ Coupling head for the supply line, which is also the control line, and black cover. ■ For trailers (without valve).
Coupling head with integrated filter		
952 201 XXX 0		■ Coupling head for the supply line with a red cover. ■ For trailers (without valve). ■ With integrated filter
952 201 XXX 0		■ Coupling head for the control line with a yellow cover. ■ For trailers (without valve). ■ With integrated filter

Purpose

Coupling heads are required on the supply and control lines between the towing vehicle and its trailer. Their purpose is to connect both lines with a built-in safeguard against cross-coupling. Coupling heads in the towing vehicle have a valve.

! Coupling heads of the older 452 200 series can be connected to coupling heads of the 952 200 series without any problem.

6.1.1.13 Duo-Matic coupling heads

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
For articulated trains		
452 802 XXX 0		■ Vehicle parts with integrated closing valves. ■ Mounted to the rear of the truck.
452 804 XXX 0		■ Trailer part without closing valves. ■ Fitted to the hoses of the supply and control line of the (drawbar) trailer.
For semitrailer units		
452 805 XXX 0		■ Vehicle parts with integrated closing valves. ■ Fitted to the Susie-lines of the semitrailer-tractor.
452 803 XXX 0		■ Semitrailer parts without closing valves. ■ Fitted on the front of the trailer.

Purpose

Duo-Matic quick couplings connect the air brake system (supply and control lines) of the truck or the semitrailer tractor to the braking system of the trailer or the semitrailer with only one coupling process.

Notes

6.1.2 Conventional components (towed vehicle)

6.1.2.1 Line filter

432 500 XXX 0

Purpose

Protecting the compressed-air brake system from contamination.

Technical data

EXAMPLE OF VARIANT FOR PRODUCT FAMILY 432 500 XXX 0	
Maximum operating pressure [bar]	20
Free passage	12 mm = 1.13 cm^2
Pore size of filter [µm]	80 to 140
Thermal range of application [°C]	-40 to +80
Weight [kg]	0.5

6.1.2.2 Trailer brake valve (single/dual line)

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
Introduction		
471 003 XXX 0		Trailer brake valve (single line)
Two-line		
971 002 XXX 0		Trailer brake valve with adjustable predominance. ■ The predominance is maintained over the entire braking range up to full braking. ■ With 2 connections for the brake cylinders. ■ The device has a flange in one of its two outputs for connecting a park brake-power regulator or pressure limiting valve directly.
971 002 XXX 0		Trailer brake valve with adjustable predominance. ■ With 6 connections for the brake cylinders. ■ The device can be switched as a relay valve in semitrailers.
971 002 XXX 0		Trailer brake valve with adjustable predominance, but without flange for a manual brake power regulator. ■ With 3 connections for the brake cylinders. ■ The device can replace 971 200 150 0.

Purpose

Trailer brake valves are used within the trailer braking system. They are each controlled from the towing vehicle by means of a trailer control valve.

The function of trailer brake valves is to brake the trailer sensitively stepped relative to the pressure in the trailer brake line.

They initiate automatic braking of the trailer if the trailer breaks away or the supply line is separated.

Predominance can be adjusted in accordance with compatibility band.

6.1.2.3 Pressure limiting valve

Design types

475 010 3XX 0

475 010 0XX 0

475 015 XXX 0

Purpose

To limit the output pressure to a preset level.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 475 010 0XX 0				
Output pressure p_2 [bar]	7.0 +0.3	5.3 +0.3	6.0 -0.3	1.8 +0.3
Output pressure [bar] with input pressure p_1 = ...	10.0	7.5		8.0
Setting range [bar]	6.0 to 9.0	1.5 to 6.0	6.0 to 7.5	1.5 to 6.0
Maximum operating pressure [bar]	20 bar			
Thermal range of application [°C]	-40 to +80			

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 475 015 XXX 0				
Output pressure p_2 [bar]	7.0 +0.3	5.3 +0.3	6.0 -0.3	1.8 +0.3
Output pressure [bar] with input pressure p_1 = ...	10.0	7.5		8.0
Setting range [bar]	6.0 to 9.0	1.5 to 6.0	6.0 to 7.5	1.5 to 6.0
Maximum operating pressure [bar]	20 bar			
Thermal range of application [°C]	-40 to +80			

6.1.2.4 Pressure ratio valve (adjuster valve)

975 001 XXX 0

Purpose

To reduce the braking force of the axle to be adapted during partial brake applications and rapid exhausting of brake cylinders.

Trailers being operated in mountainous regions and frequently covering downhill journeys always show increased wear on the brake linings of the front wheels because the arrangement of the larger front wheel brake cylinders required for stopping will cause excess braking on the front axle. By using the pressure ratio valve, the braking force on the front axle is reduced to the extent that both axles are braked evenly; this does not, however, in any way impair the brake force during full braking.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 975 001 XXX 0			
Set to [bar]	0.7 ± 0.1	1 ± 0.1	0.5 ± 0.1
Setting range [bar]	0.3 to 1.1		
Nominal width [mm]	12		
Maximum operating pressure [bar]	10		
Thermal range of application [°C]	-40 to +80		
Weight [kg]	0.65	0.55	

6.1.2.5 Manually operated load sensing valve

475 604 XXX 0

Purpose

Manually operated load sensing valves are used within the trailer's braking system (if no automatic LSV is installed). They are usually connected to the trailer brake valve by means of a mounted flange. Their task is to manually adjust the deceleration to the respective load status of the trailer. In this process, the load sensing valve limits the braking pressure output from the trailer brake valve to a defined value.

! In Austria and the Czech Republic, only manual control devices without a release position are permitted. In these instances, the release function is to be installed with a separate release valve 963 001 012 0 / 963 001 013 0.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 475 604 XXX 0		
Setting range: Release [bar]	0	
Setting range: Unladen [bar]	0.8 to 2.2	1.4 to 2.8
Setting range: 1/2 load [bar]	2.8 to 3.7	3.4 to 4.3
Setting range: Laden	System pressure	
Range "Unladen" set to: [bar]	1.6 -0.2	3.4 -0.2
Range "1/2 load" set to: [bar]	2.1 -0.2	4.0 -0.2
Thermal range of application [°C]	-40 to +80	

6.1.2.6 Automatic Load Sensing Valve (LSV)

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
475 712 XXX 0		LSV controller with integrated trailer brake valve for leaf-spring type semitrailers.
475 713 XXX 0		Static LSV for mechanical suspension vehicles (single-axles/axle assemblies) without EBS.
475 714 XXX 0		Static LSV controller for air-suspension vehicles without EBS.
475 714 60X 0		LSV controller for hydraulic control
475 715 XXX 0		Static LSV controller with integrated trailer brake valve for air-suspension semitrailers with multiple axles without Trailer EBS.

Purpose

Automatic load sensing valves have the task of adjusting the braking pressure on an axle (or possibly several axles) relative to the respective load status. With properly designed braking forces, and assuming a dry road surface, this prevents locking of the wheels when the vehicle is unladen or partially laden.

In mechanically suspended vehicles, regulation is relative to the spring deflection.

! The LSV controller must always be configured for the respective trailer!

6.1.2.7 Relay valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
973 001 XXX 0		Relay valve ■ Relay valve for service brake or spring-type actuator.
973 006 XXX 0		Relay valve ■ Plastic type. ■ This valve can only be used for controlling the spring-loaded portion of the TRISTOP™ spring brake actuator.
973 011 XXX 0		Relay valve ■ Relay valve for service brake or spring-type actuator. ■ Replaces 973 001.
973 011 2XX 0		Relay valve ■ With overload protection ■ For spring chamber brake, with integrated pressure reduction from port (42) to (2). ■ Replaces 473 017.
473 017 XXX 0		Relay valve ■ With overload protection (older variant) for spring chambers.

Purpose

The purpose of the relay valves is to shorten the response and pressure build-up times within a braking process by pressurising the brake cylinders more rapidly. At the same time, relay valves act as quick-release valves when the brakes are released.

It is advisable to install relay valves if the total volume of the brake cylinders to be pressurised exceeds 4.5 litres.

Relay valves with overload protection are designed to prevent braking force addition when the service and parking brake systems are actuated at the same time, thereby effectively protecting the mechanical transmission parts against excessive strain. For the area of the auxiliary and parking brake systems, this valve acts as a relay valve.

6.1.2.8 Quick release valve (rapid bleeder valve)

973 500 XXX 0

Purpose

The purpose of these valves is to accelerate the venting process of the brake cylinders or the pilot lines when the brakes are released. Some variants (with thread at venting port 3) could be used as 2 way directional control valve.

The use of quick-release valves is recommended wherever the brake cylinder or pilot lines to be vented exceed a length of 7 metres.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 973 500 XXX 0		
Maximum operating pressure [bar]	10	12
Opening pressure of integrated safety valve [bar]	12 +2	
Nominal width [mm]	Ø 14	
Permissible medium	Air	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	0.3	

6.1.2.9 Trailer release valve

Design types

963 001 XXX 0

963 006 XXX 0

Purpose

Trailer release valves are used within the braking system of drawbar trailers and semi-trailers.

Release valves allow manual release of the trailer's braking system, or the front axle brake cylinders only, when the trailer is not attached to its tractor, allowing the vehicle or the drawbar to be moved. They are also used in spring-type parking brake systems to release and actuate the parking brake system.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 963 XXX XXX 0					
Maximum operating pressure [bar]	8.5				
Minimum nominal width [mm] 1-1 => 2	–	Ø 8			
Minimum nominal width [mm] 1-2 => 2	–	Ø 6			
Port threads	M 16x1.5 - 13 deep		M 22x1.5 - 13 deep	M 16x1.5 - 13 deep	
Colour of the actuation button	2 heads: black/red	black		red	green
Permissible medium	Air				
Thermal range of application [°C]	-40 to +80				
Weight [kg]	0.73	0.13	0.21	0.15	

6.1.2.10 Coupling heads

Further information and details, ▸ see chapter "6.1.1.12 Coupling heads" on page 68.

Design types

PRODUCT FAMILY	DESCRIPTION
952 200 XXX 0	Dual line coupling head (supply, red cover)
952 200 XXX 0	Dual line coupling head (brake, yellow cover)
452 201 XXX 0	Single line coupling head (black cover)

Purpose

Coupling heads are required on the supply and control lines between trailer and towing vehicle. Their purpose is to connect both lines with a built-in safeguard against cross-coupling. Coupling heads in towed vehicles have a pin to eject the valve in the towing vehicle coupling head.

6.1.2.11 Duo-Matic quick coupling

Further information and details, ▸ see chapter "6.1.1.13 Duo-Matic coupling heads" on page 70.

Design types

PRODUCT FAMILY	DESCRIPTION
452 803 XXX 0	■ Semitrailer parts without closing valves. ■ Installation: on the front of the semitrailer.
452 804 XXX 0	■ Trailer part without closing valves. ■ Installation: to the hoses of the supply and control line of the (drawbar) trailer.

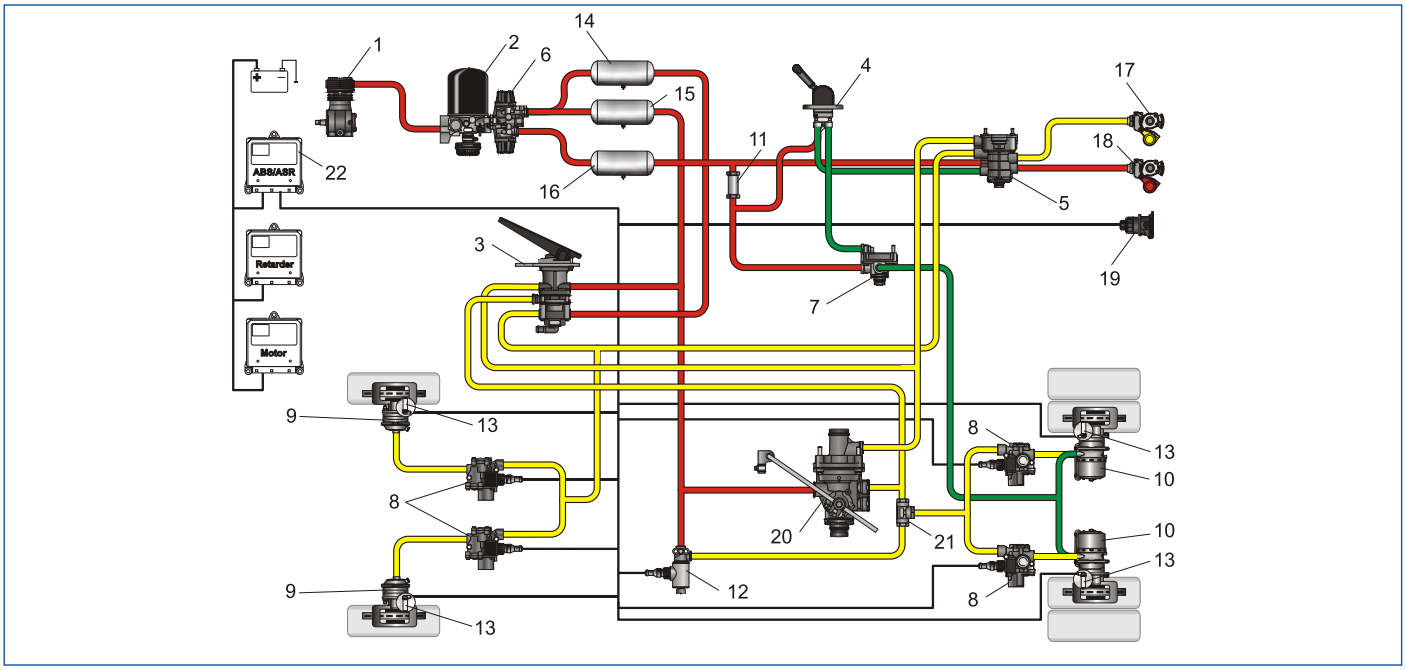
Purpose

Connect the air brake system of the motor vehicle with the braking system of the trailer.

With Duo-Matic quick couplings, trailer vehicles can be coupled quicker and more securely than with standard couplings.

6.1.3 Pneumatic anti-lock system ABS (towing vehicle)

EC Air Brake System with ABS and ASR fitted (towing vehicle)



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 1XX XXX 0	42
2	Air dryer with combined unloader valve	432 410 XXX 0	48
3	Foot brake valve with pedal actuation	461 31X XXX 0	56
4	Hand brake valve	961 72X XXX 0	60
5	Trailer control valve	973 009 XXX 0	66
6	Multi-circuit protection valve	934 7XX XXX 0	57
7	Overload protection relay valve	973 011 XXX 0	62
8	ABS solenoid valve	472 195 XXX 0	117
9	UNISTOP™ diaphragm brake cylinder front axle	423 XXX XXX 0	135
10	TRISTOP™ spring chamber brake cylinder rear axle	925 XXX XXX 0	137
11	Check valve	434 014 XXX 0	63
12	ASR solenoid valve	472 XXX XXX 0	–
13	Wheel speed sensor	441 032 XXX 0	49
14	Air reservoir circuit 2	950 XXX XXX 0	52
15	Air reservoir circuit 1	950 XXX XXX 0	52
16	Air reservoir circuit 3	950 XXX XXX 0	52
17	Coupling head "supply" (red)	952 200 XXX 0	68
18	Coupling head "brake" (yellow)	952 200 XXX 0	68
19	ABS trailer plug connection	–	–
20	LSV controller	475 7XX XXX 0	61
21	2 way directional control valve	434 208 XXX 0	92
22	ECU "ABS"	446 XXX XXX 0	89

Anti-Lock Braking System (ABS)

Why ABS?

Anti-lock brake systems (ABS) - generally also referred to as anti-lock systems (ALS) - are designed to prevent the vehicle wheels from locking as a result of the service brake being applied with too much force, especially on slippery road surfaces. The idea is to maintain cornering forces on braked wheels to ensure that the vehicle or vehicle combination retains its driving stability and manoeuvrability as far as physically possible. The available power transmission or grip between tires and carriageway should also be utilised as far as possible to minimise the braking distance and maximise vehicle deceleration.

Although today commercial vehicle brakes are designed to a very high technical standard, braking on slippery roads often results in potentially dangerous situations. During full or even partial braking on a slippery roads, it may no longer be possible to transmit all of the brake force onto the road due to the low coefficients of friction between the tires and the carriageway. The braking force is excessive and the wheels lock. When the wheels are locked, they no longer have any traction on the road surface and can thus transmit hardly any cornering forces (steering and tracking forces).

This often has dangerous consequences:

- The vehicle becomes unsteerable.
- The vehicle breaks away in spite of countersteering and starts to swerve.
- The braking distance is significantly increased.
- Tractor-trailer combinations or semitrailer trains may break away or jackknife.

LSV effects

On dry roads today's load sensing valves (LSV) alone are often capable of preventing the wheels from locking if the vehicle is unladen; they also help the driver to effectively grade the braking process on wet road surfaces, but they are unable to prevent locking as such (no slip monitoring). The are also unable to counteract any overreactions of the driver or any variances in frictional or adhesion coefficients which may apply to different sides or axles of the vehicle (µ-split road surfaces).

Benefits of ABS

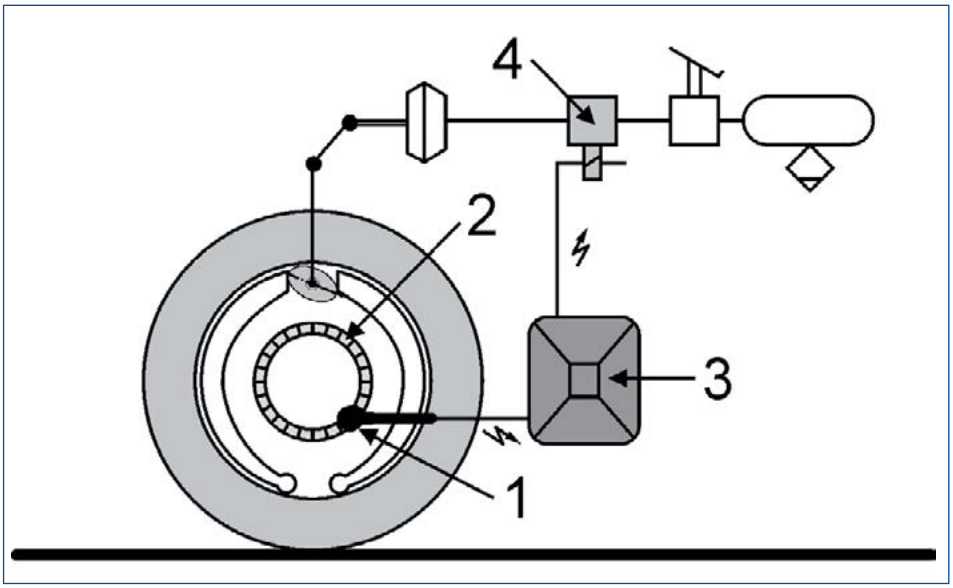
- Guarantees stable braking characteristics on all road surfaces
- Maintains steerability and, as a rule, shortens the braking distance
- Prevents jackknifing of vehicle combinations
- Reduces tire wear
- Meets requirements of future EU directives beyond 2016

Limits of ABS

Although ABS is an effective safety device, it can not override the limits defined by driving physics.

Even a vehicle fitted with ABS will become uncontrollable if driven too fast around a corner. So ABS is not a licence for a maladjusted style of driving or failure to observe the correct safety distance.

Layout of a pneumatic ABS control circuit



LEGEND			
1	Sensor	**2**	Pole wheel
3	ECU	**4**	Solenoid control valve

Operation

The fixed sensor connected to the axle continuously picks up the rotary movement of the wheel by means of the pole wheel. The electrical pulses generated within the sensor are transmitted to the electronic control unit (ECU) which uses them to compute the wheel speed.

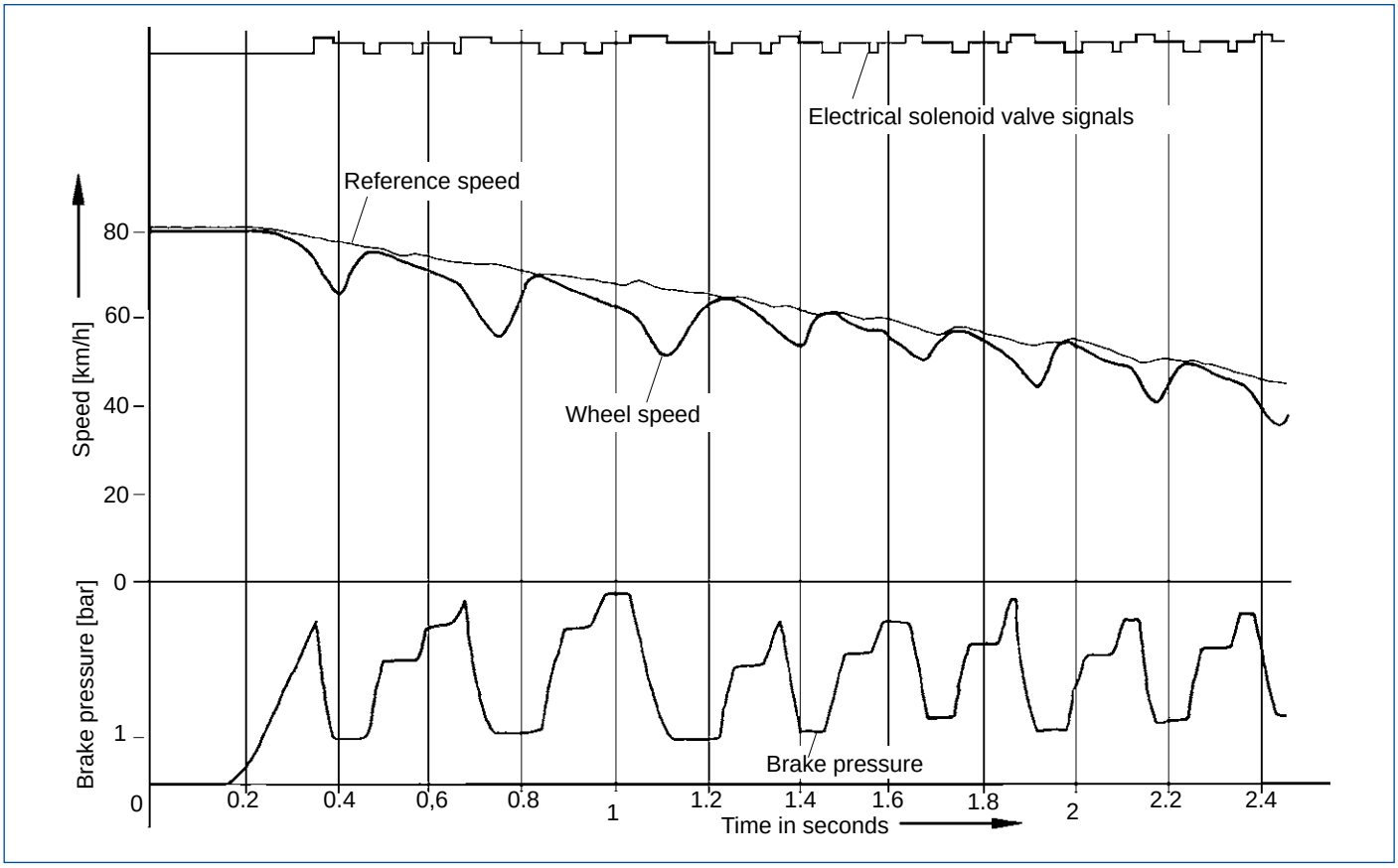
At the same time, the ECU uses a certain mode to determine a reference speed that is close to the vehicle speed, which is not actually measured.

Using all this information, the electronic control unit continuously calculates the wheel acceleration or deceleration values as well as the amount of brake slip.

When certain slip values are exceeded, the solenoid control value is actuated. This causes the pressure in the brake cylinder to be limited or reduced, thereby keeping the wheel within its optimum slip range.

Example of an ABS control cycle

The values recorded relate to the control cycle of one wheel. The initial vehicle speed is 80 km/h.



The control procedure

The driver actuates the braking system. The braking pressure increases. The speed of the observed wheel suddenly drops much faster than the reference speed. Although the wheel is still within the stable braking range (i.e. between 10 % and 30 % slip), the electronic control unit already starts the control procedure.

The ABS solenoid valve is actuated and rapidly reduces the pressure in the brake cylinder of that wheel, and the wheel begins to accelerate again.

The electronics cause the solenoid control valve to reverse, keeping the braking pressure at a constant level until the wheel runs within the stable slip range again.

As soon as more braking force can be transferred, the braking pressure is increased by means of pulsing - i. e. alternately holding and increasing pressure. If the wheel speed drops significantly relative to the reference speed during this process, a new control cycle begins.

This procedure is repeated for as long as the brake pedal is pressed too hard for these road conditions or until the vehicle comes to a halt. The maximum control frequency which can be achieved here is 3 to 5 cycles per second.

Drive Slip Regulation (ASR)

Why ASR?

Increasing the engine output (accelerating) on a slippery road surface can easily lead to the maximum adhesion on one or all powered wheels being exceeded causing them to spin, especially if the vehicle is unladen or partially laden. Spinning wheels when driving off or accelerating represent a safety risk just like locked wheels do when braking.

Reason:

- Wheels that spin transfer just as little cornering force as locked wheels.
- Spinning wheels also no longer transfer any tractive power onto the road.

The consequences:

- Vehicles that do not move or get stuck.
- Vehicles that can no longer be steered, jackknife on uphill gradients, or swerve in corners.

Benefits of ASR

ASR prevents the powered wheel from spinning and provides the following benefits:

- Tractive power and cornering forces are maintained.
- Stable driving behaviour is ensured when moving off, accelerating and negotiating corners on slippery roads.
- The signal light (if installed) is used to warn the driver of slippery road conditions.
- Tire wear is reduced to a minimum, and the motor vehicle's drive train protected.
- The risk of accidents is further reduced.

ASR and ABS

ASR represents a worthwhile addition to an ABS-controlled braking system. All that is required to turn ABS control into full ABS/ASR control is an ECU with the additional ASR function and a few additional components for controlling the differential brake and the engine. This why ASR is only available in combination with ABS.

Even a differential lock for off-road use and ASR do not exclude but complement each other.

Differential Brake Control

Immediately after the ignition has been switched on and the vehicle moves off, the ECU monitors the rotational behaviour of all wheels above a wheel speed of approx. 2 km/h.

The speed and acceleration values of the powered wheels are compared to those of the non-powered wheels.

When a certain difference in speed or slip threshold is exceeded, ASR control sets in.

As soon as a driving wheel exceeds the slip threshold as it accelerates, the ECU will actuate the respective differential brake valve and thus control the braking pressure in the applicable brake cylinder of the service brake.

The engine's driving torque is now supported on this braked wheel, causing the propulsion power on the other wheel to increase - in much the same way as with engaged differential lock.

Engine control

As soon as both powered wheels spins or the slip of one spinning wheel has exceeded a threshold value, the system switches from differential brake control to engine control, reducing the engine output. Differential brake control is now only used to synchronise the wheels. At a vehicle speed above 50 km/h only engine control is now used.

Use of differential braking and engine control

On wintry roads the coefficients of friction tend to vary. As a result, engine and differential brake control complement each other.

On an even road surface control is mainly implemented by a reduction of the engine speed, and differential brake control is restricted to synchronising the powered wheels.

If the friction coefficient differs on either side, differential brake control is prioritised and applies pressure only to the brake cylinder of the spinning wheel. The driving torque is therefore transferred to the other wheel.

To avoid overheating the wheel brake, the differential brake threshold value is linearly increased above approx. 35 km/h so that the slip increasingly regulated through engine speed control. Differential control is no longer initiated at speeds exceeding 50 km/h.

Traction mode and ASR off-road switch

In deep snow or in similar conditions the traction force can be increased by actuating the "ASR off-road" button which is available as an option. If this button is activated, the ECU changes the conditions (slip thresholds) for ASR control to permit higher slip ratios.

The ASR lamp flashes in regular cycles while the button is actuated to indicate to the driver that stability may be reduced.

Limits of ASR

The traction capacity of an all-wheel driven commercial vehicle can not be achieved by a motor vehicle with only one drive axle - not even with optimal ASR.

RSC and ESC

RSC (Roll Stability Control)

From the ABS E version onwards, trucks, semitrailer tractors and buses can be equipped with Roll Stability Control (RSC) in addition to ASR. This function is integrated in the ABS control unit and can be activated by the vehicle manufacturer.

RSC controls the engine output and applies the service brake to reduce the risk of overturning in corners. RSC identifies the critical lateral acceleration for this purpose.

When the lateral acceleration exceeds a specific level, RSC reduces the engine torque, activates the engine brake and brakes the towing vehicle axles - as well

as the trailer axles if applicable - via 3/2 solenoid valves installed in the towing vehicle.

A lateral acceleration sensor and the software for signal processing, monitoring and driving dynamics control are integrated in the ABS control unit for RSC.

ESC (Electronic Stability Control)

Trucks, semitrailer tractors and buses can be equipped with Electronic Stability Control (ESC) in addition to ASR control. ESC is available from the ABS E version onwards and requires additional components.

Within physical limits, ESC operates automatically and takes corrective action in terms of engine output and brake to keep the vehicle on track during extreme driving situations.

It operates when driving as well as braking and comprises two independent functions:

Control of tracking stability (yaw control)

This function is activated when the vehicle loses stability in critical situations (e.g. during a sudden lane change). In such situations ESC uses ABS or EBS to regulate the braking forces on each wheel, throttles the engine output, thereby reducing the risk of swerving when cornering and during avoidance manoeuvres.

ESC prevents potential "jack-knifing" of a semitrailer train by simultaneous, dosed braking of the semitrailer even if it is equipped with a conventional braking system.

Driving stability control (ROP – Roll Over Protection)

This function is activated when there is a risk of overturning, e.g. when cornering too fast. It is comparable to the RSC function.

The ESC control unit processes the data from the yaw rate, lateral acceleration and steering-wheel angle sensors and communicates with the ABS or EBS control unit via the braking system data bus.

The ESC function requires the following additional components:

- ABS control unit with ESC functionality
- ESC module
- Valves in accordance with the respective vehicle. The 3/2 solenoid valve on the front axle is needed to brake the front axle wheels separately. The 3/2 solenoid valve upstream of the trailer control valve is needed to brake the trailer at the same time.
- braking pressure sensor
- Steering-wheel angle sensor

6.1.3.1 ECU "ABS E"

Design types

446 003 XXX 0
446 004 XXX 0

The ECUs are available with 4 channels (446 004 XXX 0) and 6 channels (446 003 0XX 0) for on-board voltages of 24 or 12 volts. For vehicles braked in combination (Air Over Hydraulic or AOH units) with only one pressurising cylinder on the steering axle, special 4S/3M ECUs are available, i.e. using only one solenoid valve to control the front axle.

The non-steered axle(s) is/are controlled individually (IR). Modified individual control (MIR) is used for the steering axle. For vehicles with 4S/3M ECUs on the other hand the modified axle control (MAR, see Trailer ABS) is used on the steering axle.

Two sensors and one modulator are fitted on the steering axle for MAR. Control occurs per axle because the braking pressure is equal on all wheels of this axle. With MAR, none of the wheels on the axle will lock.

In combination with Variable Axle Control there are also two sensors and one modulator fitted on the steering axle. With VAR, however, one wheel on the axle is permitted to lock in contrast to MAR. VAR can be adjusted by means of various parameters.

Purpose

The electronic control unit (ECU) uses the wheel sensor signals to calculate the vehicle speed and the wheel speeds as well as the wheel deceleration and acceleration values. When required, it actuates the solenoid valves to prevent locking of the vehicle wheels.

The 4- and 6-channel ECUs have two circuits. Each circuit monitors two (three in the case of a 6-channel ECU) diagonal vehicle wheels and can be divided into four functional groups:

- Input circuit
- Master circuit
- Safety circuit
- Valve actuation

The RSC (Roll Stability Control) function has been integrated in the ECUs of the E generation. A lateral acceleration sensor and the software for signal processing, monitoring and driving dynamics control are integrated in the ABS control unit for this purpose.

It is possible to control the engine via CAN SAE J1939.

6.1.3.2 ABS solenoid valve

Design types

472 195 XXX 0

Solenoid control valves are available for 24 and 12 V vehicle electrical systems. The different types vary in terms of different connecting threads (metric screw-threads, inch-based threads, stepped hole for Voss connectors) and in the way the connecting plug is fastened (Kostal screw-in plug, bayonet locking or snap fastener).

A variant with fording ability is also available for special-purpose vehicles.

Purpose

During a braking process, the solenoid control valves are used to adjust the brake cylinder pressure in relation to the control signals received from the ECU.

On the drive axle the solenoid control valves are also used for ASR differential brake control.

The ABS solenoid valves permit the following ABS functions:

- Pressure build-up
- Pressure maintenance
- Pressure reduction

6.1.3.3 Wheel speed sensor and pole wheel

441 032 XXX 0	899 760 XXX 4	not part of WABCO's scope of supply
		

Purpose

The wheel speed sensor and the pole wheel pick up the rotary motion of the wheel. The pole wheels for medium-duty and heavy-duty commercial vehicles have 100 teeth; for wheels with a smaller rolling circumference, the pole wheels with 80 teeth may also be used. Because of the diagonal reference speed generated in the ECU, the ratio of the number of teeth and the wheel circumference on the front and rear wheels must be identical to an accuracy of a few percent.

The wheel speed sensor has been developed specially for use in commercial vehicles. High temperature stability and resistance to vibration ensure that it operates reliably even in extreme conditions.

Installation of the wheel speed sensor

The wheel speed sensor is clamped - movable - into a hole in the steering swivel by means of a clamp bushing or into a special sensor holder.

At the front axle, the wheel speed sensor is manually pushed into the clamp bushing all the way to the stop position while the wheel is mounted.

At the rear axle or at the trailer axles, the wheel speed sensor has to be pushed into the clamp bush up to the stop position with the wheel hub removed. Putting on the wheel hub, it is then pressed out again until the wheel speed sensor bears against the pole wheel.

! There is no need to set a minimum air gap for the wheel speed sensor because due to the wheel bearing play the gap is adjusted automatically during the first few wheel rotations.

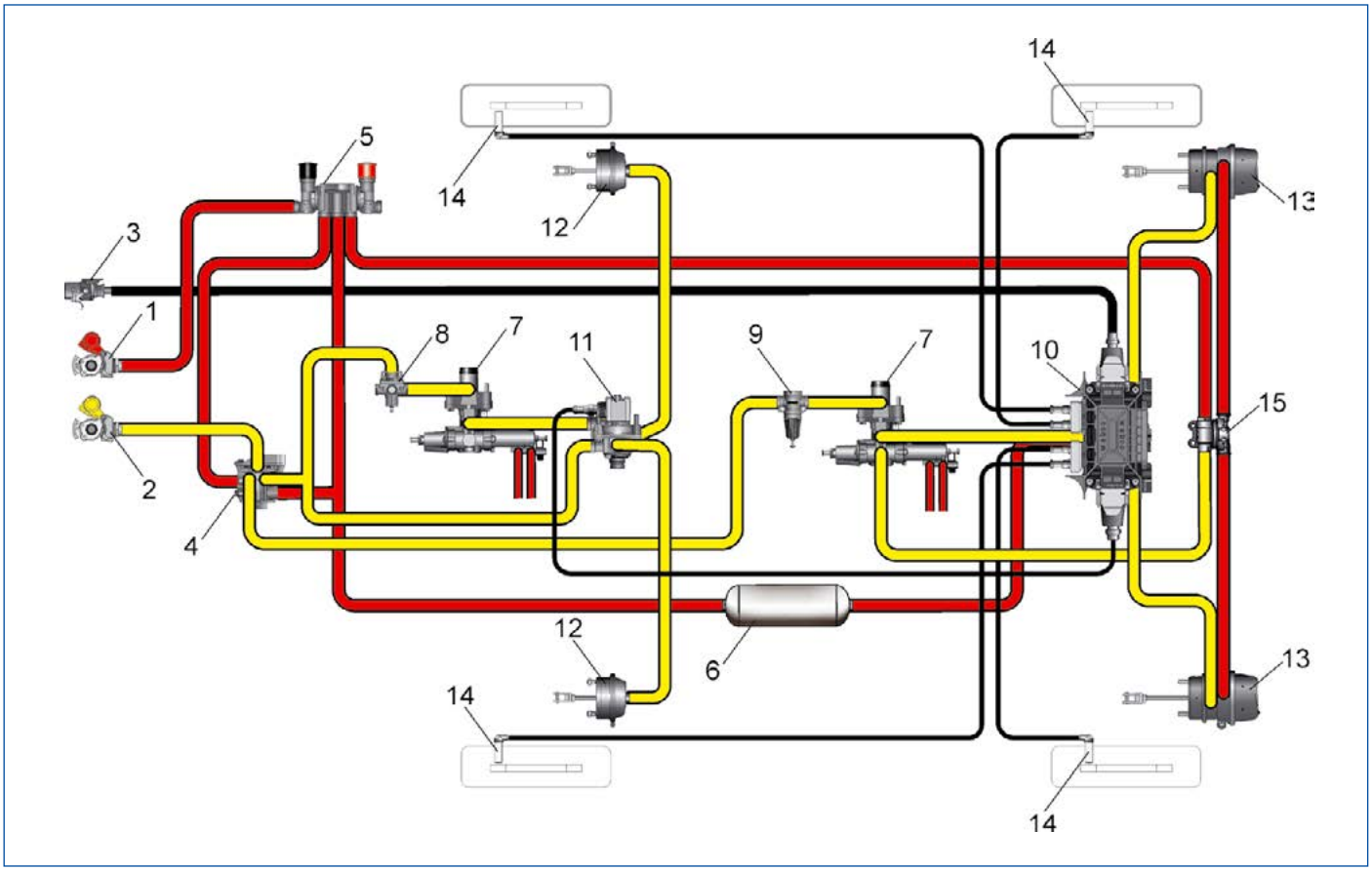
6.1.3.4 Additional components for ASR

PRODUCT FAMILY	FIGURE	DESCRIPTION
472 1XX XXX 0		Differential brake valve ■ The differential brake valve is connected upstream of the solenoid valves. When actuated by the ECU, it regulates the reservoir pressure for the ABS solenoid valves via a 2 way directional control valve independently of the foot brake valve. ■ While in the ASR B and C generation required a separate differential brake valve for each powered wheel, only one valve is installed with the D generation or higher. If differential brake control is necessary, it controls the supply pressure to the ABS solenoid valves of both powered wheels. The ABS solenoid valve of the wheel that is not to be braked is then switched to the blocking position (maintain pressure).
434 208 XXX 0		2 way directional control valve ■ The 2 way directional control valve is fitted between the differential brake valves and the ABS solenoid valves. The 2 way directional control valve allow alternate actuation of the ABS solenoid valve respectively fitted downstream of the service brake and ASR control. ■ In the event of an ABS or ASR control process, the subsequent sensitive air inlet and outlet air to and from the brake cylinders connected downstream is controlled by the respective ABS solenoid valve. While in the ASR B and C generation required a separate two-way valve for each powered wheel, only one valve is installed with the D generation or higher. If differential brake control is necessary, it controls the supply pressure to the ABS solenoid valves of both powered wheels. The ABS solenoid valve of the wheel that is not to be braked is then switched to the blocking position (maintain pressure) by the ECU.
534 017 XXX 0		2 way directional control valve ■ In order to permit the two-way alternate air intake of the positioning cylinder on the governor lever of the engine cut-off and proportional valve, another two-way valve with smaller flow cross-sections must be fitted between the engine cut-off valve and the engine control valve.
434 500 XXX 0		Double shut-off valve (Select Low Valve) ■ The double cut-off valve is used in vehicles with 2S/2M+Select-Low control in order to provide axle-by-axle braking (e.g. steering axle). ■ The pressures applied are the pressures outputted by the trailer modulator for each side. The lower pressure is then directed to the axle to be braked.

Notes

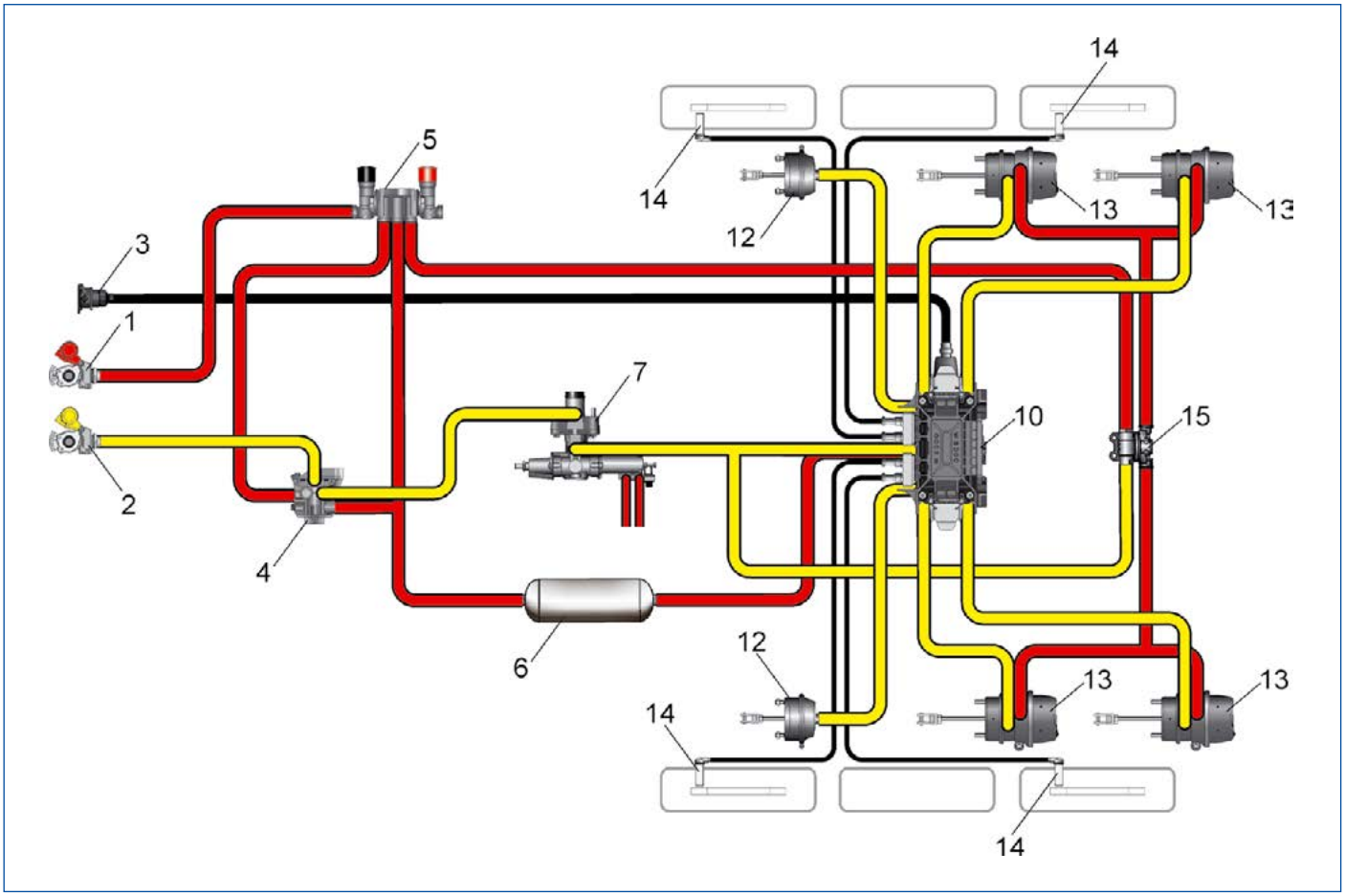
6.1.4 Pneumatic anti-lock system ABS (towed vehicle)

EC air brake system with ABS (4S/3M) in the drawbar trailer



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	ABS trailer plug connection	–	–
4	Trailer brake valve	971 002 XXX 0	73
5	Trailer release valve (double release valve)	963 001 XXX 0	80
6	Air reservoir	950 XXX XXX 0	52
7	LSV controller	475 71X XXX 0	77
8	Pressure ratio valve	975 001 XXX 0	75
9	Pressure limiting valve	475 010 XXX 0 475 015 XXX 0	74 74
10	VCS-ABS ECU with ABS boxer relay valve	4XX XXX XXX 0	99
11	ABS relay valve "steering axle"	472 195 XXX 0	126
12	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
13	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
14	Wheel speed sensor	441 032 XXX 0	49
15	2 way directional control valve	434 208 XXX 0	92

EC air brake system with ABS (4S/2M) in the semitrailer



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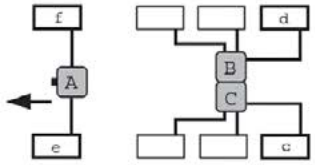
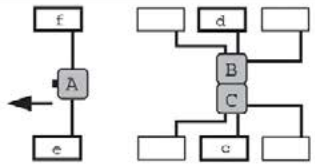
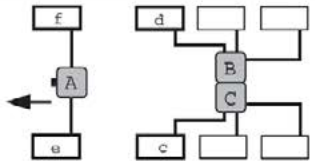
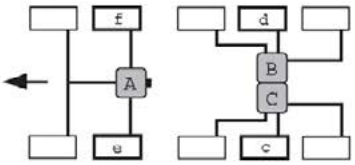
13	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
14	Wheel speed sensor	441 032 XXX 0	49
15	2 way directional control valve	434 208 XXX 0	92

6.1.4.1 ABS configurations

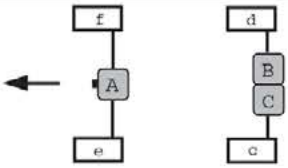
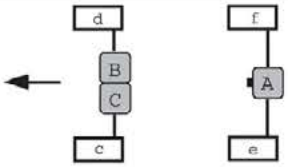
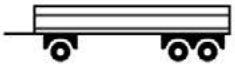
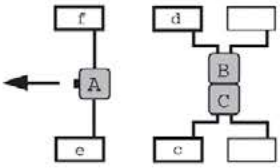
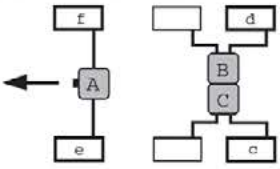
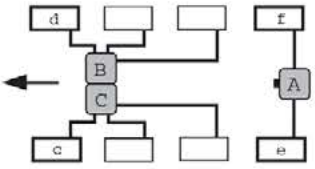
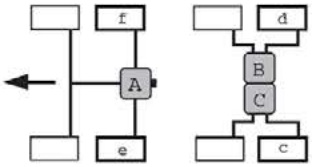
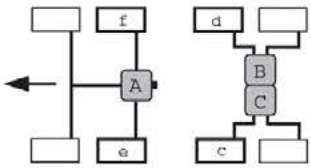
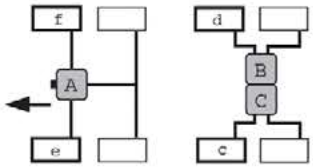
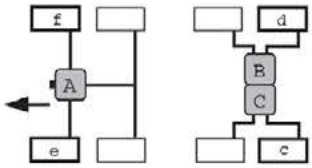
Assignment of the sensors / modulators

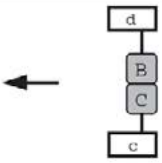
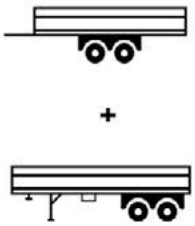
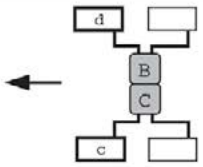
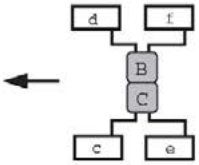
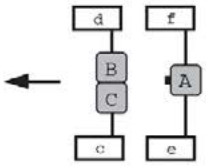
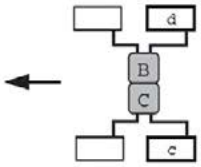
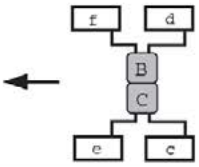
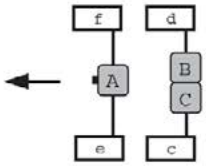
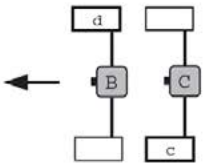
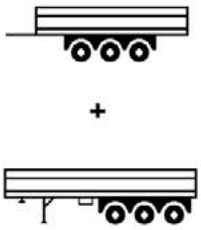
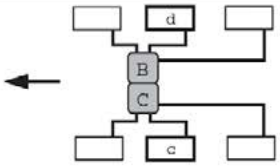
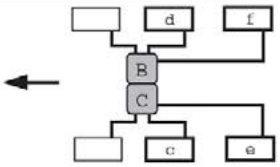
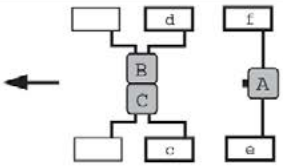
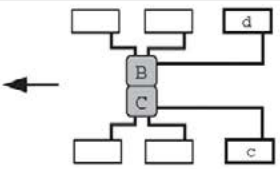
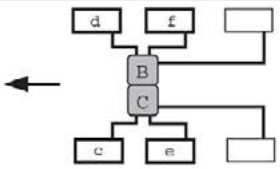
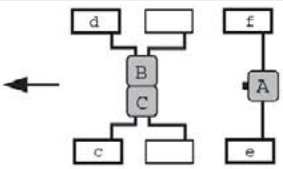
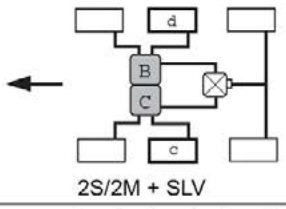
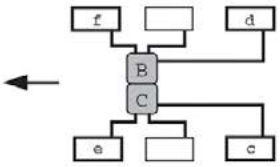
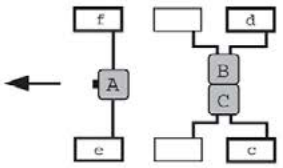
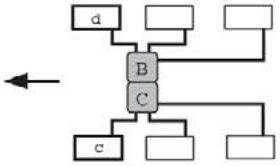
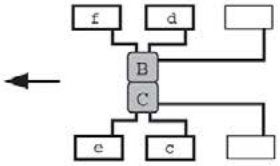
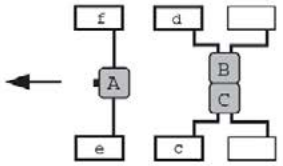
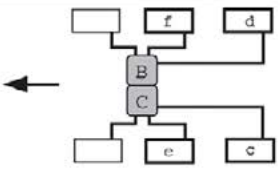
MODULATOR	ABS ROTATIONAL SPEED SENSORS	SYSTEM AXLE	CONTROL TYPE
ABS modulator main axle B/C	c, d	Main axle (non-lifting)	IR / MSR
ABS modulator valve A	e, f	Steering axle (lifting)	MAR
ABS modulator main axle B/C	e, f	Additional axle (lifting)	MSR
ABS modulator main axle B/C	d, f	Main axle (non-lifting)	IR

LEGEND			
	ABS modulator main axle B/C		ABS modulator valve A
	Driving direction		Double cut-off valve / Select Low Valve (SLV)
	Sensed wheel (directly controlled)		Non-sensed wheel (indirectly controlled)

	VEHICLE TYPE	2S / 2M	4S / 2M	4S / 3M
DRAWBAR TRAILER	* 			
				
				
SEMITRAILER	* 			

! * These types of vehicle are not listed in the "Type approval report no. EB 140.0" and require separate acceptance.

	VEHICLE TYPE	2S / 2M	4S / 2M	4S / 3M
DRAWBAR TRAILER				
				
				
				
SEMITRAILER + DRAWBAR TRAILER	 *			
	 *			
				
				
				

	VEHICLE TYPE	2S / 2M [1)]	4S / 2M	4S / 3M
CENTRAL AXLE TRAILER + SEMITRAILER				
				
				
		 2S/2M + DAR		
				
				
		 2S/2M + SLV		
				
				

1) For the Standard version 400 500 070 0, the allocation is "Modulator B / Sensor f and Modulator C / Sensor d".

6.1.4.2 VCS II (Vario Compact System)

Design types

PRODUCT NAME	FIGURE	DESCRIPTION
400 500 XXX 0		According to the specific requirements defined by the vehicle manufacturers, VCS II is available as a compact unit or as separate modules (i.e., control unit and valves can be installed separately). Plugs on the outside and new types of cable connections mean that it is no longer necessary to open the ECU for installation or diagnosis.
446 108 XXX 0		Depending on the ECU, the systems range from the 2S/2M system for semitrailers to the 4S/3M system for drawbar trailers or for semitrailers with steering axles.

The VCS II systems range from the 2S/2M system designed for semitrailers to the 4S/3M system for drawbar trailers or semitrailers with a steering axle for example.

VCS II is available as a compact unit or as separate modules (i.e., ECU and valves can be installed separately).

The Premium variant and the separate ECU are equipped with a towing vehicle - trailer interface according to ISO 11992. A 12 volt version of the Premium variant is also available.

All variants of the VCS II are equipped with additional in- and outputs or an analogue input.

This permits the implementation of functions beyond ABS in the trailer. These inputs/outputs are called Generic Input/Output (GenericIO).

Via PC diagnostic software the following predefined GenericIO functions can be set:

- Brake lining wear indicator (BVA)
- Integrated speed-dependent switch (ISS)
- Power supply
- Speed signal
- ECAS port
- ELM port
- Lifting axle control

Purpose

The control unit of the VARIO-COMPACT-ABS represents a further development of the tried and proven VARIO-C ABS.

VCS II is an ABS system for trailers, ready for installation. It meets all the statutory requirements defined for category A.

6.1.4.3 ABS solenoid relay valve

Design types

472 195 02X 0	472 195 03X 0	472 195 05X0
		

Purpose

The ABS solenoid relay valve is used in trailer ABS VARIO-C. Its purpose is to control the brake cylinder pressure for ABS control.

The ABS solenoid relay valves permit the following ABS functions:

- Pressure build-up
- Pressure maintenance
- Pressure reduction

When not actuated (solenoids with no current), the valve functions like a relay valve and rapidly increases or decreases the pressure in the brake cylinders.

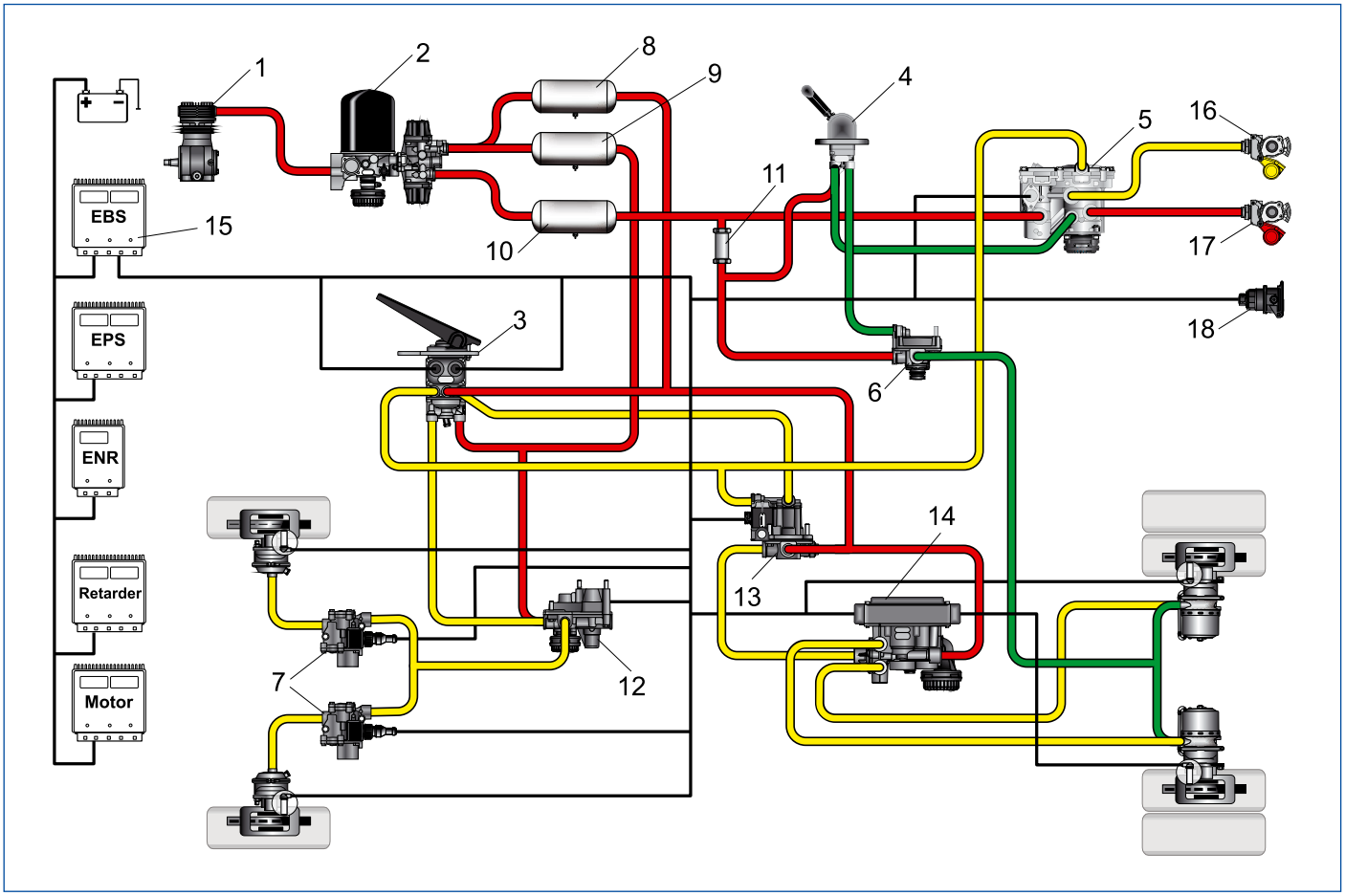
The ABS solenoid relay valve can be supplied for 24 V on-board voltage or 12 V on-board voltage. There is also a boxer valve. Two ABS relay valves with shared connections for control and supply pressure are here combined in one compact valve.

6.1.4.4 Additional ABS components

For additional or different ABS components for the towed vehicle, ▸ see chapter "6.1.3 Pneumatic anti-lock system ABS (towing vehicle)" on page 82.

Notes

6.1.5 Electronic braking system EBS (towing vehicle)



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Compressor	411 141 XXX 0	42
2	Air Processing Unit (APU)	932 500 XXX 0	49
3	Brake signal transmitter	480 003 XXX 0	109
4	Hand brake valve	961 72X XXX 0	60
5	Trailer control valve	973 009 XXX 0	66
6	Overload protection relay valve	973 011 XXX 0	62
7	ABS solenoid valve	472 195 XXX 0	117
8	Air reservoir circuit 2	950 XXX XXX 0	52
9	Air reservoir circuit 1	950 XXX XXX 0	52
10	Air reservoir circuit 3	950 XXX XXX 0	52
11	2 way directional control valve	434 208 XXX 0	92
12	Proportional relay valve	480 202 XXX 0	111
13	Backup valve rear axle	480 205 XXX 0	113
14	(Axle) modulator	480 10X XXX 0	114
15	EBS central module	446 135 XXX 0	110
16	Coupling head "brake" (yellow)	952 200 XXX 0	68
17	Coupling head "supply" (red)	952 200 XXX 0	68
18	Power supply via ISO 7638	–	–

The benefits of EBS

Braking comfort and improved safety through EBS

The driver enters his deceleration command by operating the brake. EBS then transmits this command to all braking system components electronically. Response and build-up times at the brake cylinders are reduced significantly due to electronic actuation. The ECU also facilitates a sensitive dosing of the braking system during this process. The result: a comfortable braking "feel", independently of the load status, and a much shorter braking distance.

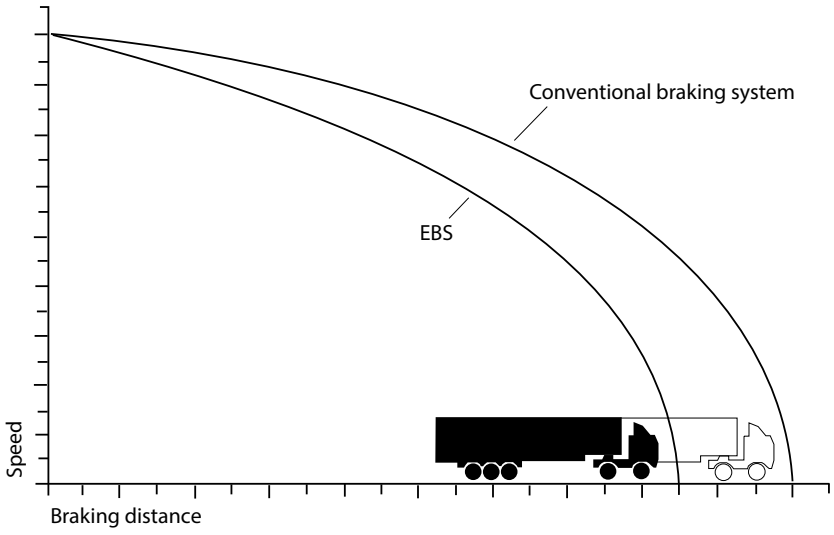
The functions integrated in EBS ensure that both the vehicle's driving stability and steerability are maintained during the braking process. The differential wheel slip control automatically distributes the braking forces between the front and rear axles depending on the status of the load. When operated with a trailer, differential slip control also ensures that the tractor-trailer combination is optimally balanced. Towing vehicle and trailer respectively brake their own portion of weight in the truck/trailer combination. The coupling force of the tractor-trailer combination is thus kept low when braking. Traction control is implemented by means of the integrated anti-slip regulation (ASR).

Lining wear optimisation and ease of maintenance through EBS

WABCO EBS provides the option to continuously monitor and balance lining wear. This means that service and lining replacement times can be coordinated. All linings on the vehicle are then replaced simultaneously. The integration of non-wearing brakes, such as retarder and engine brake, also help to protect brake linings for longer operating times.

EBS constantly monitors itself by means of comprehensive integrated diagnostic and monitoring functions. Corresponding warning signals alert the driver immediately of restrictions in operational readiness. A diagnostic device or the on-board diagnostic display in the vehicle can be used to determine the causes quickly and easily. Maintenance and workshop periods can also be significantly reduced by means of the extensive test functions of the diagnostic system.

Significantly reduced braking distance with EBS



Functional description

EBS basic function

WABCO EBS operates with electronic signals. The EBS electronic control unit controls the system through these signals and can communicate with the individual components at any time. The valves on the brake cylinders generate the required braking pressure according to the control signals.

Speed sensors installed on the wheels of the vehicle for the integrated ABS function constantly provide up-to-date wheel speed information to the EBS. Different integrated brake management functions detect any deviations from normal driving conditions and intervene in the driving process in the event of hazards. Apart from improving safety, specific functions also optimise driving comfort and lining wear.

If the electronic control system malfunctions, all valves simultaneously coordinate operation as in a conventional pneumatic system. Backup pressures are here conducted to the brake cylinders where the pneumatic system, however, is effectively applied only with a certain delay. Since the pneumatic system does not operate with a load-sensing valve, however, the pneumatic backup may cause overbraking of the rear axle. What is known as a backup valve therefore blocks the effect of the pneumatic circuit on the rear axle brake cylinders while EBS functions normally.

Brake management

Deceleration control / Braking force control

The deceleration control system is used to adjust the braking pressure level to the braking command from the driver. EBS ensures that with identical pedal operations the vehicle is always braked with the same effect, regardless of the load status. If the brake linings are wet for example, EBS will increases the braking pressure until the desired deceleration is achieved. For this reason there is no need for a separate axle load sensing system for braking force control.

However, this adaptation is only carried out within certain limits. When the coefficient of friction becomes too poor, deceleration control ceases to make any adjustments. This will bring the change in braking performance to the driver's attention.

In addition, deceleration control improves the braking hysteresis. During each brake release event the program selects the release steps in a manner that immediately changes the braking force.

Braking force distribution

The distribution of braking forces to front and rear axle depends, among other factors, on the comparison of actual and desired vehicle deceleration values computed by the "deceleration control" program function. The braking deceleration is captured via the wheel speed changes detected by speed sensors. An evaluation of the sensors provides exact information on the slip on each axle and thus their braking performance. If the slip differs, one axle contributes more towards deceleration than the other. Consequently, this axle is also subject to greater wear. EBS applies differential slip control to regulate the pressures on front and rear axle for optimum distribution of braking forces.

Brake lining wear control

EBS can obtain more accurate information on the wear condition of the brakes from analogue lining wear sensors. The brake lining wear control intervenes in the distribution of braking forces during uncritical braking events if a difference in the linings on the front and rear axles was detected. The pressure of the wheel brake with the greater wear is reduced slightly, and the pressure on the wheel brake with less worn linings is increased as required, but by no more than 0.5 bar. In this way wear is balanced without the driver noticing.

If brake lining wear sensors are installed instead of wear indicators, wear can only be regulated by the EBS ECU.

Endurance brake integration

The endurance brake integration function controls the correct application of the available brakes. It makes sure that the non-wearing brakes, such as retarder and engine brake, contribute the maximum possible portion of braking work for the vehicle as a whole. The wheel brakes thus stay cool, reducing wear of brake linings and drums or brake discs.

Brake assist system

The brake assist system supports the driver during full braking by detecting intense braking and supplying the full braking pressure into the brake cylinders - regardless of the brake pedal being fully depressed or not. Only when the driver releases the brake pedal does the brake assist system terminate the braking process.

Automatic Roll Brake (ARB)

The automatic roll brake allows the driver to start uphill comfortably by preventing the vehicle from rolling backwards. The driver can activate the function by briefly tapping the brake pedal, which is connected directly to the EBS ECU. The EBS then adjusts the braking pressure as required.

This function can be switched on and off using the ARB switch.

Drag torque control

Drag torque occurs in the drive line due to gear shifting or gas exchange. The resulting braking torques can cause the driving wheels to lock, making the vehicle unstable. The drag torque control function prevents this situation. When a defined slip state is exceeded, the engine torque is increased relative to the speeds of the driving wheels, reducing the braking torques that occur. Drag torque control terminates as soon as stable driving wheel values are received again.

Integrated ABS function

ABS is integrated in EBS. Inductive sensors measure the rotational speed of individual wheels so that any tendency to lock is detected early. The EBS ECU can then reduce, stop or increase the braking pressure for the brake cylinders on the front axle accordingly via the ABS solenoid valves. The axle modulator, whose electronic control unit includes the relevant control algorithms, performs the same task for the rear axle.

One problem that may occur with vehicles that are equipped with ABS is the yaw moment that occurs when braking on roads with extreme differences in the coefficient of friction between the left and right hand side. The brake force utilisation is then different on either side, which makes the vehicle impossible

or extremely difficult to control on such roads. This is why, while the rear axle wheels are controlled individually (IR), the braking pressures of the front axle wheel brakes are controlled dependent on one another (MIR). Pressure differences are only possible to a certain degree with this type of control; so the tires on the slippery side of the road surface do not lock and the vehicle remains steerable.

If the driving wheels show a tendency to lock during endurance brake application on a slippery road surface and there is a risk of an unstable vehicle state, the system deactivates the endurance brake via the vehicle data bus to ensure continued driving stability.

In vehicles with 3 and 4 axles and a 4S/4M system the wheels that are not sensed are also integrated in the control process side by side.

Integrated Anti-Slip Regulation (ASR)

If the driving torque on the wheels is greater than the static friction on the wheels, the slip becomes too great and there is a risk of the wheels spinning. The ASR function detects this and adjusts the driving torque via the engine control electronics. Such an intervention in engine control only makes sense if both wheels of one axle show a tendency to spin. If only one driving wheel spins, ASR can selectively brake this wheel using the axle modulator. An indicator indicates that ASR control has been activated.

Trailer control

Control of the trailer is implemented electronically by means of the towing vehicle to trailer interface (ISO 11992) as well as pneumatically via the electro-pneumatic trailer control valve. The coupling force is not sensed to save costs. Initially the deceleration of the towing vehicle lies at the centre of the EC Brake Band. If the trailer deceleration has the same value at this time, no coupling forces are generated. If the trailer deceleration deviates from this position at the centre of the band, the towing vehicle ECU detects this through the "deceleration control" program function and adjusts the trailer control pressure accordingly.

If the response threshold of the trailer brakes should be greater, this is compensated by a corresponding pressure inshot.

The inshot of pressure into the trailer's control line (yellow) occurs at the start of braking with approx. 2 bar. The inshot is brief so that the linings make contact quickly, then EBS adjusts the braking pressure in accordance with the deceleration command. Most of the problems known today are solved with this approach.

WABCO has collaborated in shaping the standardisation of the electronic towing vehicle to trailer interface (ISO 11992).

Supporting functions

Determining the nominal brake signal

The brake pedal distance measured by the sensors in the brake signal transmitter is transmitted to the EBS ECU which then calculates the corresponding desired deceleration value.

Pressure control on the axles and trailer control

The pressure is adjusted to the calculated desired deceleration value in the three pressure control circuits for front axle, rear axle and trailer control. The solenoid currents in the solenoid valves are controlled to improve the pressure control characteristics.

This does not apply if axle modulators of the 2nd or 3rd generation are fitted, because pulsed solenoid valves are used here.

Rotational speed sensing and tire compensation

Wheel speed sensing corresponds to the sensing function known from ABS. An automatic tire compensation function compensates differences in nominal tire sizes and thus the rolling circumferences between the axles. If impermissible wheel tire combinations are used, this is detected as a fault.

! New parameters need to be set for the braking system when wheels with different tire sizes are used or there is a change regarding the permissible axle load of the vehicle. Your vehicle manufacturer must be consulted in this case.

Electronic Stability Control (ESC)

Since 2000, WABCO offers ESC (Electronic Stability Control) as an extension to EBS (Electronic Braking System). While EBS is responsible for the brake management, ESC increases stability during normal driving. Particularly during lane change, avoidance and cornering manoeuvres there is a risk of commercial vehicles tilting, rolling or swerving due to their high centre of gravity and great weight.

Using the aid of various sensors, the ESC detects such critical situations and corrects the engine and braking performance accordingly if necessary. This assists the driver and improves road safety.

Additional components are required for ESC, ▸ see chapter "6.1.5.13 ESC components" on page 118.

ESC control functions

Within physical limits, ESC operates automatically and comprises two independent functions:

Control of tracking stability (yaw control)

This function is activated when the vehicle loses stability in critical situations (e.g. during a sudden lane change). The yaw movement is measured by a yaw rate sensor that is integrated in the ESC module. In such situations ESC uses EBS to regulate the braking forces on each wheel, throttles the engine output, thereby reducing the risk of swerving when cornering and during avoidance manoeuvres.

ESC prevents potential "jack-knifing" of a semitrailer train by simultaneous, dosed braking of the semitrailer even if it is equipped with a conventional braking system.

Driving stability control (RSC – Roll Stability Control)

RSC controls the engine output and applies the service brake to reduce the risk of overturning in corners. For this purpose, RSC identifies the critical lateral acceleration by means of the lateral acceleration sensor integrated in the ESC module.

When the lateral acceleration exceeds a specific level, RSC reduces the engine torque, activates the engine brake and brakes the towing vehicle axles as well as the trailer as required.

RSC also applies the brakes on the towing vehicle front axle by means of a 3/2 solenoid valve fitted there.

Specifics with ESC

Trailer operation with semitrailer tractors

In principle, ESC can also be used in combination with trailers. When the ESC control function intervenes, a coordinated braking of the trailer is carried out through the EBS brake management of the towing vehicle. In this regard it is of no significance whether or not the trailer is equipped with Trailer EBS.

For trailer operation with Trailer EBS and activated RSS function, the trailer is always controlled via RSS. Only when ESC initiates a higher pressure level than RSS is this higher pressure passed on to the trailer.

Deactivation of ESC by the driver

ESC must be deactivated for off-road driving, operation with snow chains and during test drives through banked curves. The system therefore provides the option to deactivate ESC via the ASR switch.

This option can be completely deactivated by setting certain EoL parameters, depending on the vehicle manufacturer. If you wish to be able to deactivate ESC, please contact the vehicle manufacturer directly.

6.1.5.1 Brake signal transmitter

480 003 XXX 0

Purpose

The brake signal transmitter is used to produce electrical and pneumatic signals, and to increase and decrease the air pressure of the Electronically controlled Brake System.

The device has a dual-circuit pneumatic and a dual-circuit electrical structure.

The start of actuation is registered electrically by means of a switch. The path of the actuation tappet is sensed and transmitted as a pulse-width modulated electrical signal. Further pneumatic redundancy pressure is delivered in circuits 1 and 2. The pressure of the 2nd circuit is held back to some degree.

In case of (electrical or pneumatic) failure of a circuit, the other circuits remain functional.

6.1.5.2 Central module

Design types

446 135 0XX 0 (EBS 1C)

446 135 2XX 0 (EBS 3)

Purpose

The central module is used to control and monitor the electronically controlled braking system. It determines the vehicle's nominal delay from the signals received from the brake signal transmitter. Together with the wheel speeds measured by the wheel speed sensors, the intended retardation is the input signal for EBS control which uses these readings to establish the demand pressure values for the front and rear axles and the trailer control valve.

The front axle's nominal pressure value is then compared to the measured actual value, and any existing deviations corrected with the help of the proportional relay valve. The trailer control pressure output is achieved in a similar manner.

Moreover, the wheel speed is evaluated so that when there is a tendency to lock, an ABS control can be carried out by modulating the braking pressure in the brake cylinders. The central module exchanges data, via the EBS system bus, with the axle modulator (or axle modulators in 6S/6M systems).

Electrical braking systems for trailers are actuated via a data interface to ISO 11992. The central module communicates with other systems of the towing vehicle (engine control, retarder, etc.) via a vehicle data bus.

6.1.5.3 Proportional relay valve

480 202 XXX 0

Purpose

The proportional relay valve is used in the electronically controlled braking system to modulate the braking pressure on the front axle.

The proportional relay valve consists of a proportional solenoid valve, a relay valve and a pressure sensor.

Electrical drive and monitoring takes place via the central module of the hybrid system (electro-pneumatically / pneumatically).

The control current given by the electronic unit is transformed via the proportional solenoid valve into a control pressure for the relay valve.

The proportional relay valve output pressure is proportional to this pressure.

The relay valve is pneumatically actuated by the brake signal transmitter’s redundant (back-up) pressure.

! In the EBS 3 system, the proportional relay valve is replaced by the 1-channel modulator 480 106 6XX 0 ▸ see chapter "6.1.5.6 (Axle) modulator" on page 114.

6.1.5.4 Central Brake Unit (CBU)

480 020 XXX 0

Purpose

The CBU is a combination of brake signal transmitter, central module and proportional relay valve. This is constructed as one pneumatic and one electronic circuit.

The CBU contains superior brake management functions for the front axle and the rear axle control and evaluates the sensor signals.

As the driver actuates the pedal, an electrical signal value and a pneumatic backup pressure are created, controlling the required front axle braking pressure by itself.

The pneumatic backup pressure for the front axle will now be deactivated via a 3/2 way valve integrated in the CBU through the electronic pressure regeneration as with the rear axle backup.

With a 4S/3M system, the integrated proportional relay valve on the CBU takes over the ABS function as per the principle of the Variable Axle Control.

With the 4S/4M system, control is carried out using two ABS solenoid valves as per the principle of the Modified Individual Control (MIR).

! The CBU can also be supplied in a version with two connectors on the top of the housing component.

6.1.5.5 Backup valve (for EBS 1C)

480 205 XXX 0

Purpose

The backup valve is used to supply air to and remove air quickly from the brake cylinder on the rear axle in case of backup, and comprises several valve units which must fulfil the following functions as a minimum:

- 3/2 way valve function for controlling redundancy in intact electro-pneumatic braking circuit.
- Relay valve function to improve the response times of the backup system.
- Pressure retention, to synchronise the beginning of pressure level control on the front and rear axle, in case of redundancy.
- Pressure reduction to avoid overbraking of the rear axle as far as possible in the event of a backup (reduction approx. 2:1).

6.1.5.6 (Axle) modulator

Design types

480 103 XXX 0

480 104 XXX 0

480 106 1XX 0 (2-channel)

480 106 6XX 0 (1-channel)

Purpose

The axle modulator controls the brake cylinder pressure on both sides of a single or dual axle.

The (axle) modulator contains two independent pneumatic pressure control channels (Channels A and B), each containing one inlet and one vent valve, plus one pressure sensor, sharing one electronic control unit. The central module defines the nominal pressures and is responsible for external monitoring. In addition, the wheel speeds are measured and evaluated by two speed sensors. In case of wheel-lock or wheel-spin, the set nominal value is modified. Provision has been made for the connection of two sensors to detect brake lining wear.

The (axle) modulator has an additional connection for a backup pneumatic braking circuit.

6.1.5.7 Trailer control valve (EBS 1)

480 204 00X 0

Purpose

The trailer control valve is used in the electronically controlled brake system to modulate actuator to modulate the coupling head pressures.

The trailer control valve consists of a proportional solenoid valve, a relay valve, a breakaway emergency valve and a pressure sensor. The central module is responsible for actuation and monitoring. The control current given by the electronic unit is transformed via the proportional solenoid valve into a control pressure for the relay valve. The initial pressure of the trailer control valve is proportional to this pressure. Pneumatic actuation of the relay valve is effected by means of the backup pressure from the brake signal transmitter and the output pressure from the hand brake valve.

6.1.5.8 Trailer control valve (EBS 3)

480 204 03X 0

Purpose

The trailer control valve is used in the electronically controlled brake system to modulate actuator to modulate the coupling head pressures.

The trailer control valve consists of a pressure control unit, a relay valve, a breakaway emergency valve and a pressure sensor. Electrical actuation and monitoring are effected by the central module.

The control current defined by the electronic control unit is transformed via the proportional solenoid valve into a control pressure for the relay valve. The output pressure of the trailer control valve is proportional to that pressure.

Pneumatic actuation of the relay valve is effected by means of the backup pressure from the brake signal transmitter and the output pressure from the hand brake valve.

6.1.5.9 3/2 directional control valve

472 17X XXX 0

Purpose

With EBS functions that operate with the second generation axle modulator and so with the integrated relay function, the backup can be controlled at a ratio of 1:1. This is the reason why the pneumatic rear axle backup in this version can also be controlled via a 3/2 directional control valve.

6.1.5.10 Pressure reducing valve

473 303 XXX 0

Purpose

The pressure reducing valve is a mechanically operating pressure ratio valve and is used in the 1C EBS system. It reduces the backup operating pressure controlled by the central module and conducted to the axle modulator. The pressure is reduced according to a predefined ratio of around 2:1.

In combination with the flanged-on solenoid valve on the axle modulator, the pressure reducing valve replaces the backup valve on the rear axle.

The reduction ratio takes into account that, during a backup event, vehicles with a low load portion on the rear axle, as is the case with two-axle semitrailer tractors for example, can be easily graduated up to the locking limit during braking and do not get into critical driving situations (even though not protected by ABS). Vehicles with a particularly high portion of load on the rear axle still have sufficient braking force reserves.

6.1.5.11 ABS solenoid valve

472 195 XXX 0

Purpose

The ABS Solenoid Modulator Valves are fitted on the front axle. The valves are open during normal driving conditions and control the activated pressure to the brake cylinder from the proportional relay valve. When the ABS is activated, the inlet valves close and do not let any new pressure into the brake cylinder. If the tires still lock, pressure is released through an additional outlet in the valve.

Different numbers of ABS solenoid valves are installed, depending on the system variant. For example, there are four speed sensors and two ABS solenoid valves fitted in a 4S/4M system. Two ABS solenoid valves are additionally integrated in the axle modulator to control the rear axle.

There are also systems where the pressure of both front axles are controlled via a CBU (e.g. 4S/3M).

6.1.5.12 Rotational speed sensor

441 032 XXX 0

Purpose

The rotational speed sensor permanently calculates the actual wheel speed via a pole wheel and transfers the data to the EBS, which then calculates the actual speed by means of the reference values.

On the rear axle the speed signals are transmitted to the EBS ECU via the axle modulator.

If there are any deviations to the normal condition, the system intervenes in the regulation of the brake and motor controls.

6.1.5.13 ESC components

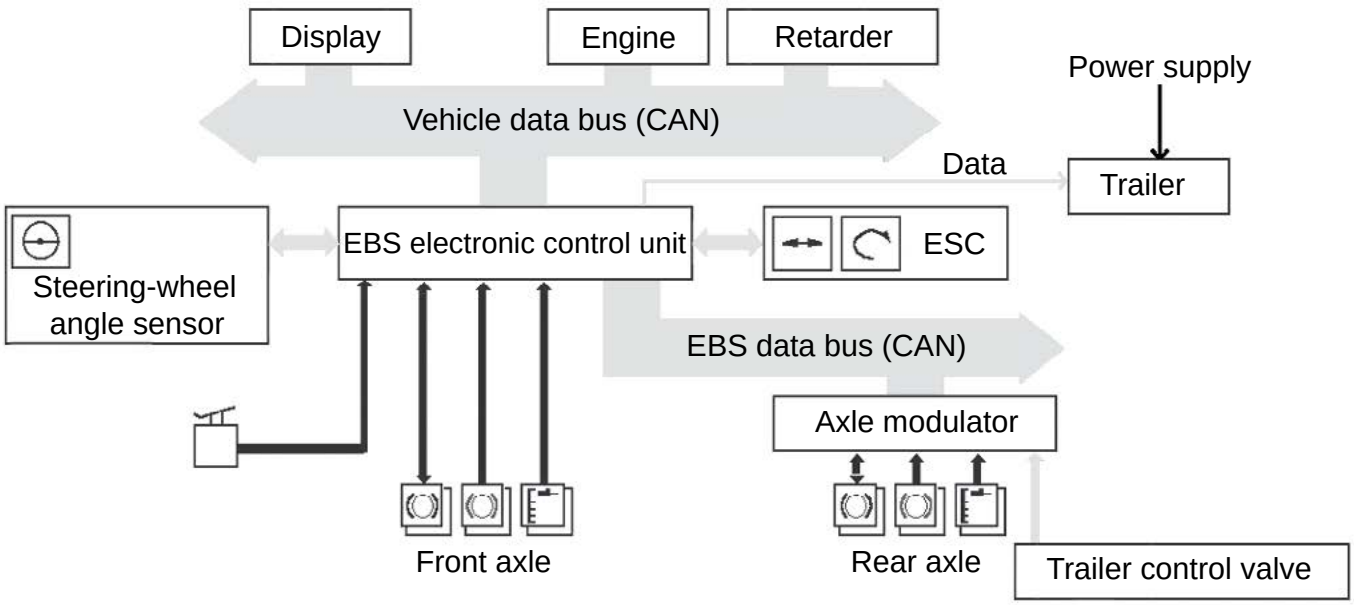
A prerequisite for the installation of ESC is a CAN data bus system with at least 500 kBit/s and an EBS ECU that can enable ESC. In addition to the EBS components, an ESC control module and a steering wheel angle sensor must be installed.

The overall sensing technology in the ESC system comprises:

- Wheel speed sensors - already required for EBS - that measure the wheel speed
- Steering-wheel angle sensor that measures the steering wheel's angle of rotation
  In some more recent braking systems, the steering wheel angle sensor is connected directly to the vehicle data bus and not the EBS data bus.
- The EBS ECU, which evaluates the signals from the steering wheel angle sensors and also assumes control of various ESC functions for fault detection and diagnosis
- The ESC control module into which the lateral acceleration and yaw rate sensors are integrated. At this point the sensor signals are immediately evaluated and are compared with nominal values.

! The ESC components cannot be retrofitted.

Connecting the ESC onto the Electronic Braking System from version EBS 1C

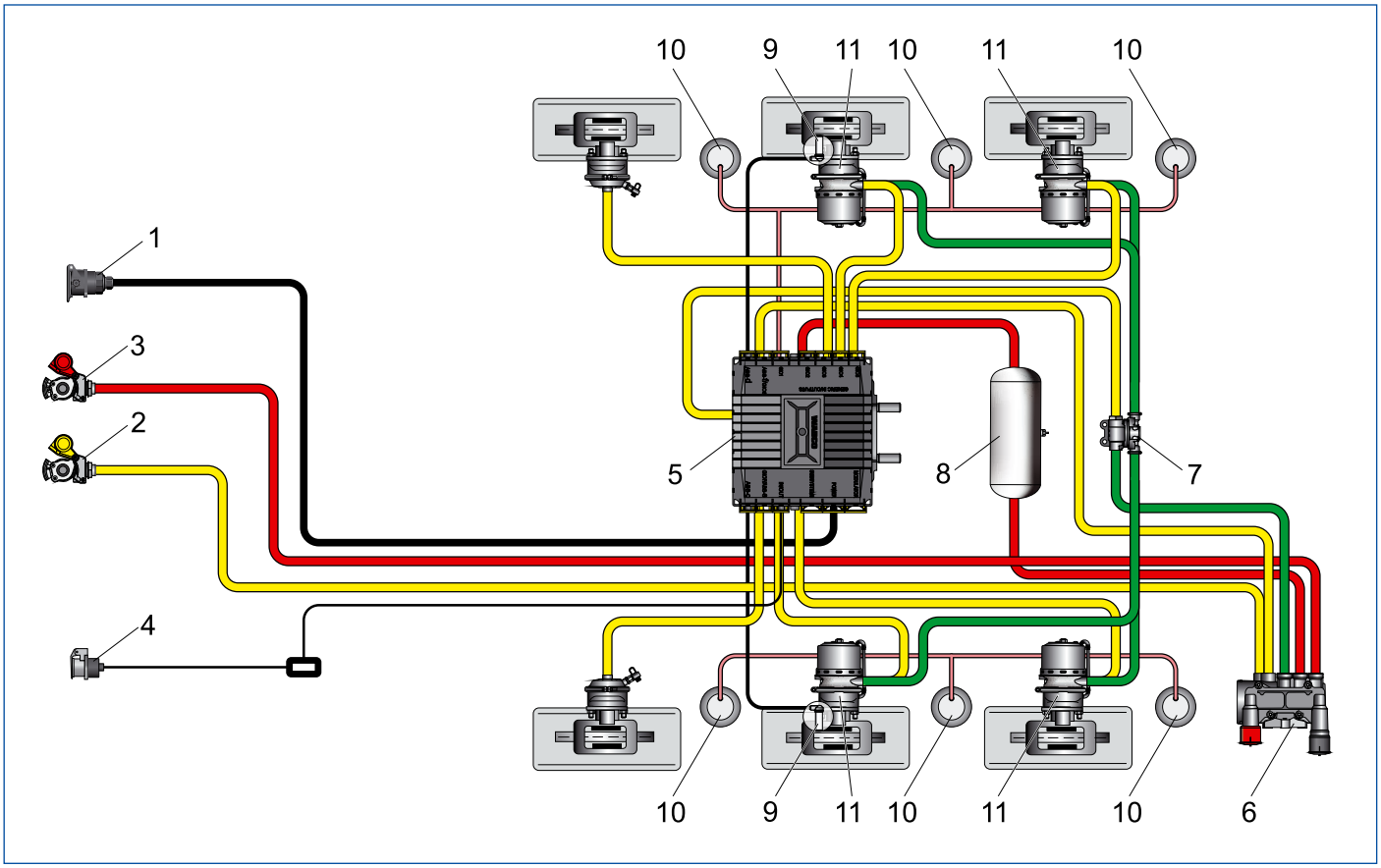


ESC components

PRODUCT FAMILY	FIGURE	DESCRIPTION
446 065 XXX 0		ESC control module ■ The ESC control module processes the data from the yaw rate, lateral acceleration and steering-wheel angle sensors and communicates with the EBS control unit via the EBS data bus. The yaw rate and lateral acceleration sensors are integrated into the ESC control module. ■ Besides the measurement data from the sensors, the ESC module also receives other data, such as the wheel speeds, for evaluating the current status of the vehicle from the EBS ECU. ■ In the event of regulation, the ESC module sends the regulation information to the EBS ECU. The necessary interventions are then initiated in the engine, transmission or retarder control. ■ If there are simultaneous requests for limiting engine output from the EBS, which is the case with activated anti-slip regulation for example, the request with the lowest torque has priority. ■ The ESC module is always mounted near to the vehicle's centre of gravity to enable correct measurement by the yaw rate and lateral acceleration sensors.
441 120 XXX 0		Steering-wheel angle sensor ■ The steering wheel angle sensor is installed between the steering wheel and the steering column. It captures the current angle of rotation at the steering wheel. The course desired by the driver is computed from the angle of rotation at the steering wheel, the vehicle speed derived from the wheel speeds and the speed differences at the wheels (left and right).

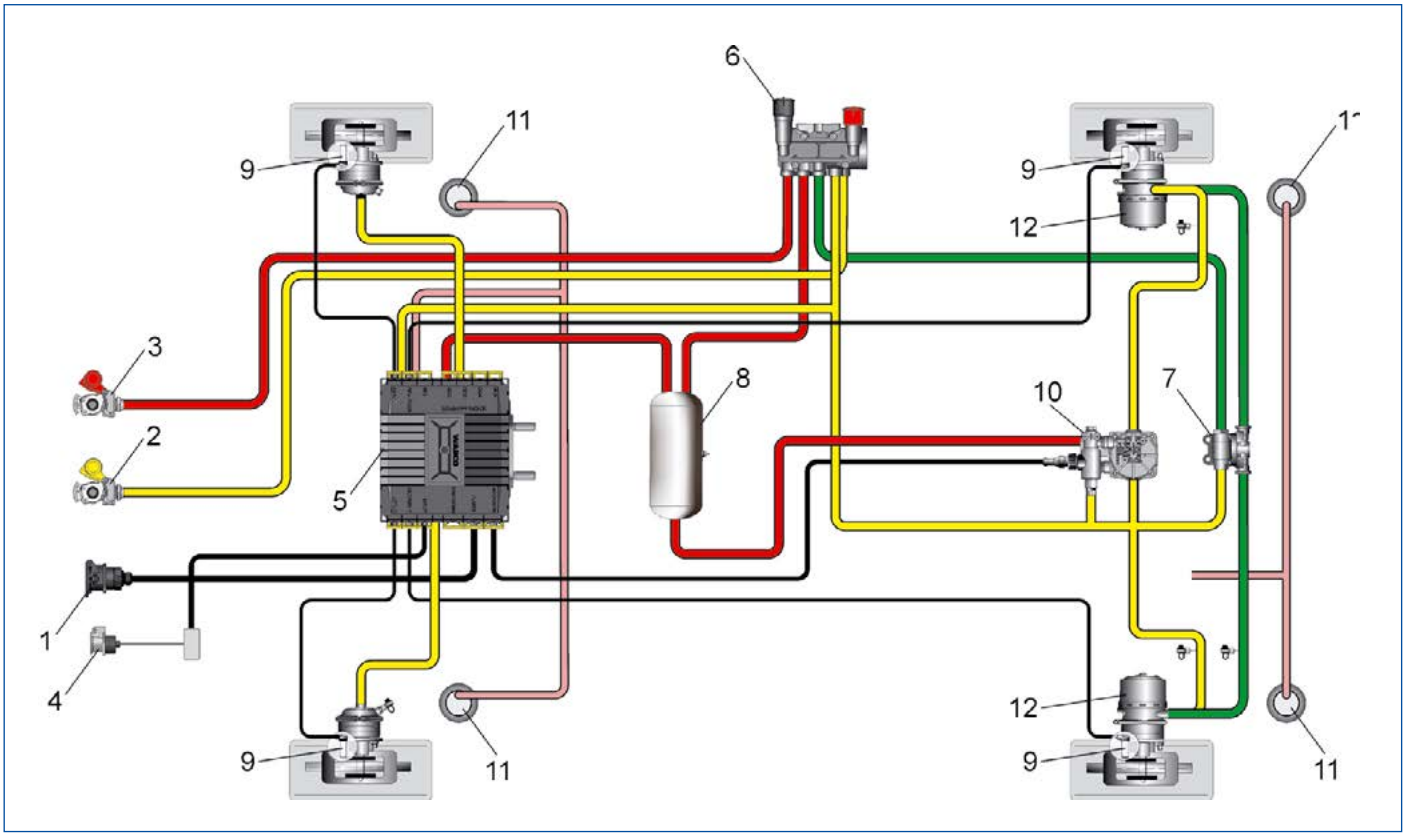
6.1.6 Electronic braking system EBS (towed vehicle)

Trailer EBS E – 2S/2M system for standard semitrailers



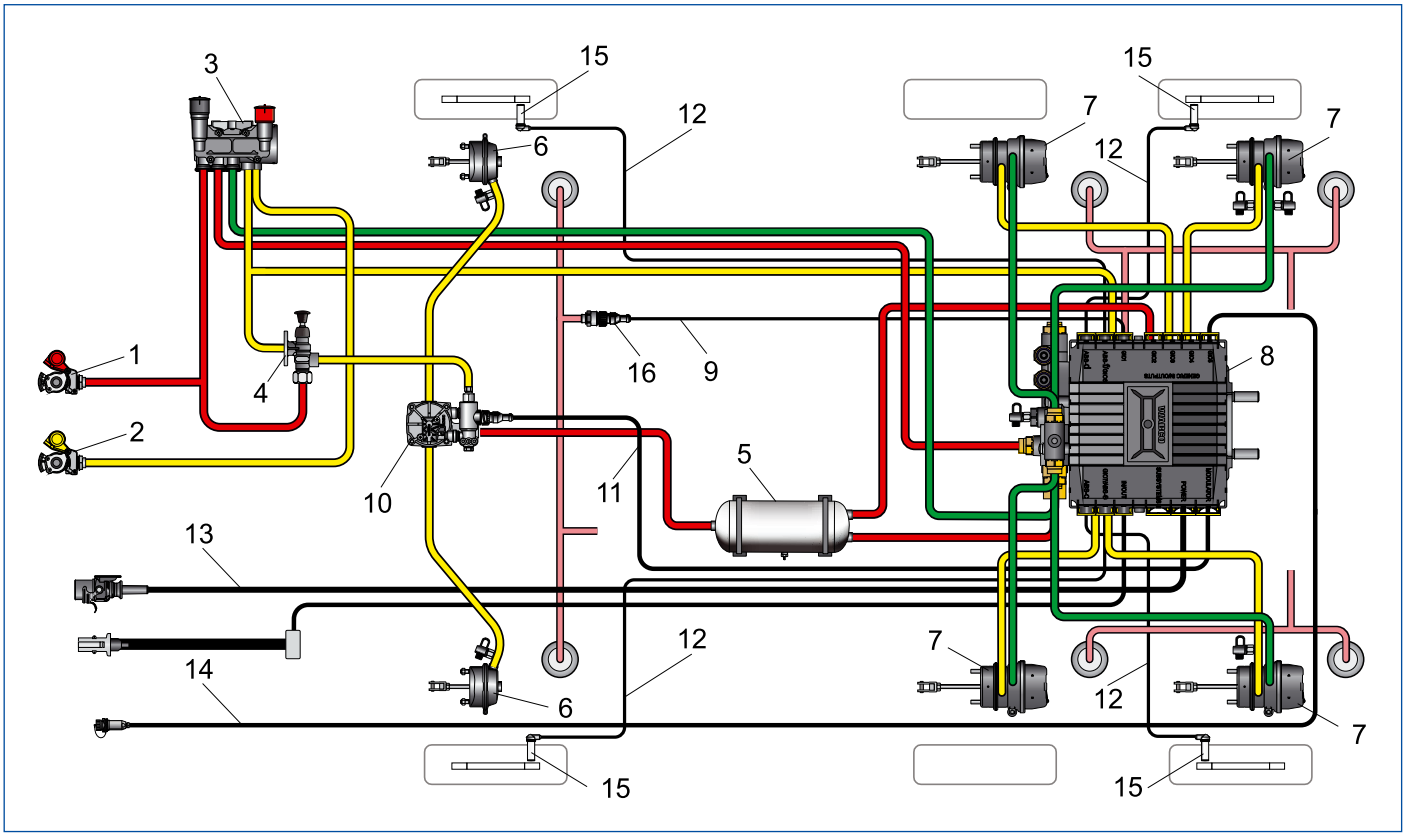
ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Power supply via ISO 7638	–	▸ see overviews "Cables", 202
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Coupling head with filter "supply" (red)	952 201 XXX 0	68
4	Stop light supply 24N via ISO 1185 (optional)	–	see overviews "Cables", 202
5	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
6	Park release emergency valve (PREV)	971 002 XXX 0	127
7	Overload protection relay valve	973 011 XXX 0	62
8	Air reservoir of the service brake system	950 XXX XXX 0	52
9	Wheel speed sensor	441 032 XXX 0	49
10	Support bellow	–	–
11	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137

Trailer EBS E – 4S/3M system for standard drawbar trailers with conventional air suspension



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Power supply via ISO 7638	–	–
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Coupling head with filter "supply" (red)	952 201 XXX 0	68
4	Stop light supply 24N via ISO 1185 (optional)	–	▸ see overviews "Cables", 202
5	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
6	Park release emergency valve (PREV)	971 002 XXX 0	127
7	Overload protection relay valve	973 011 XXX 0	62
8	Air reservoir of the service brake system	950 XXX XXX 0	52
9	Wheel speed sensor	441 032 XXX 0	49
10	EBS relay valve (3rd modulator; for controlling the 2nd axle)	480 207 XXX 0	126
11	Support bellow	–	–
12	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137

Trailer EBS E – 4S/3M system for 3-axle drawbar trailers with conventional air suspension



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Coupling head with filter "supply" (red)	952 201 XXX 0	68
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0	68
3	Park release emergency valve (PREV)	971 002 XXX 0	127
4	Trailer release valve	963 00X XXX 0	80
5	Air reservoir of the service brake system	950 XXX XXX 0	52
6	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0	135
7	TRISTOP™ spring chamber brake cylinder	925 XXX XXX 0	137
8	TEBS E Modulator (with integrated pressure sensors and integrated backup valve)	480 102 XXX 0	125
9	Cable to the pressure sensor	441 040 013 0	▸ see overviews "Cables", 202
10	EBS relay valve (3rd modulator; for controlling the 2nd axle)	480 207 XXX 0	126
12	Extension cable for sensor	449 723 XXX 0	▸ see overviews "Cables", 202
13	24N cable	449 349 XXX 0	▸ see overviews "Cables", 202
14	Supply cable	449 273 XXX 0	▸ see overviews "Cables", 202
15	Wheel speed sensor	441 032 XXX 0	49
16	Pressure sensor	441 040 XXX 0	176

6.1.6.1 ABS configurations

COMPONENTS	VEHICLE TYPE
2S/2M	
1x TEBS E Modulator (Standard) 2x ABS rotational speed sensor	1 to 3-axle semitrailer / central axle trailer with air suspension, hydraulic or mechanical suspension
4S/2M	
1x TEBS E Modulator (Premium) 4x ABS rotational speed sensor	2 to 5-axle semitrailer / central axle trailer with air suspension, hydraulic or mechanical suspension
4S/3M	
1x TEBS E Modulator (Premium) 4x ABS rotational speed sensor 1x EBS relay valve	2 to 5-axle drawbar trailers / 2 to 5-axle semitrailers / 2 to 3-axle central axle trailers with air suspension and one steering axle

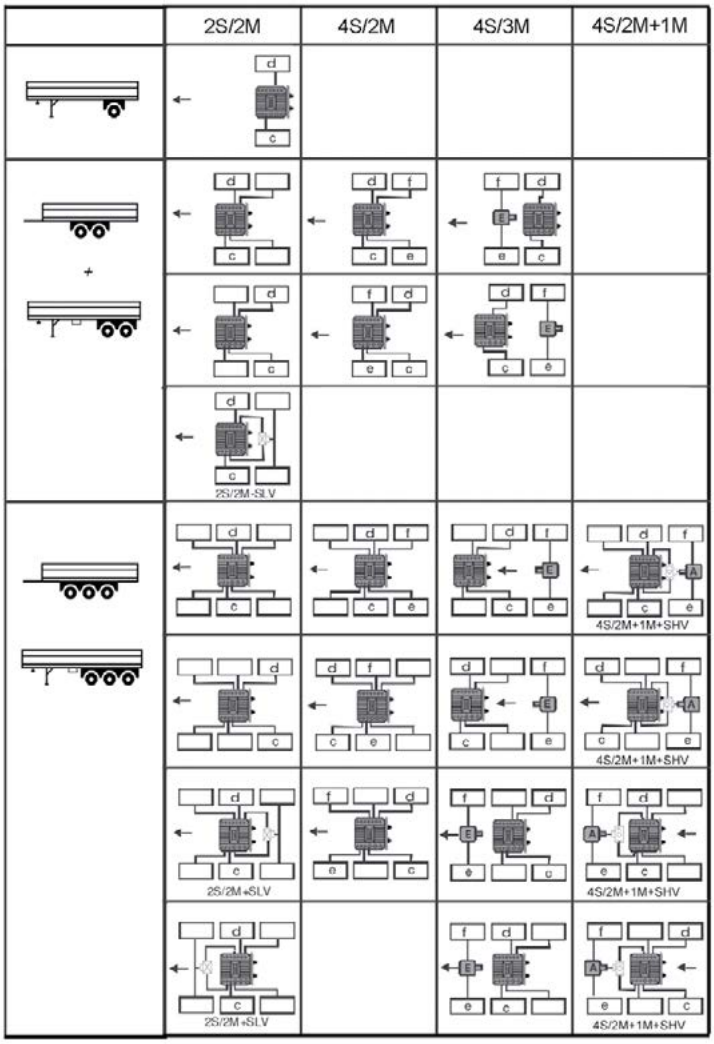
Assignment of the sensors / modulators

MODULATOR	ABS ROTATIONAL SPEED SENSORS	SYSTEM AXLE	CONTROL TYPE
Trailer	c-d	Main axle (non-lifting)	IR / MSR
Trailer	e-f	Additional axle (lifting)	MSR
ABS / EBS	e-f	Additional axle, steering axle or lifting axle	MAR

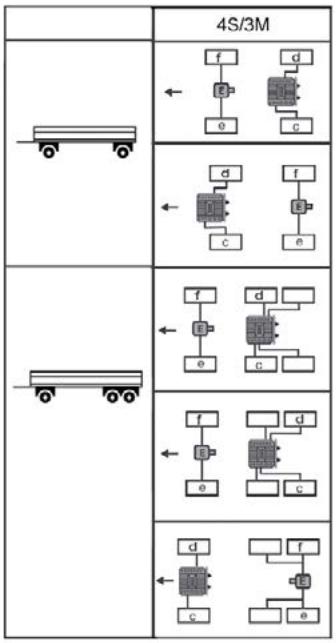
LEGEND					
	Trailer modulator		Driving direction	c	Sensed wheel (directly controlled)
	ABS relay valve		EBS relay valve		Non-sensed wheel (indirectly controlled)
	Double cut-off valve / Select Low Valve (SLV)		Double cut-off valve / Select Low Valve (SLV)		

Semitrailers and central axle trailers

The dolly is treated like a central axle trailer.



Drawbar trailer



6.1.6.2 EBS trailer modulator

480 102 0XX 0

Purpose

The EBS trailer modulator is used for controlling and monitoring the electro-pneumatic braking system.

The EBS trailer modulator is installed in the electro-pneumatic braking system between air reservoir or EBS trailer brake valve and brake cylinder near the axles on the frame (e.g. on a 3-axle semitrailer above the second axle).

The EBS trailer modulator controls the brake cylinder pressure on both sides of one, two or three axles.

Vehicle data / Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 480 102 XXX 0					
System	Push-in couplings				
	PEM	Supply	PREV	Actuators	Air suspension
Universal standard, 2S/2M	✗	✗	✗	✗	✗
Standard, 2S/2M	✓	Ø 16 × 2	Ø 8 × 1	Ø 12 × 1.5	Ø 8 × 1
	✗	Ø 15 × 1.5	Ø 8 × 1	Ø 8 × 1	Ø 8 × 1
	✓	Ø 15 × 1.5	Ø 8 × 1	Ø 12 × 1.5	Ø 12 × 1.5 Ø 8 × 1
	✓	✗	✗	✗	✗
	✓	Ø 15 × 1.5	Ø 10 × 1	Ø 8 × 1	Ø 8 × 1
	✓	Ø 15 × 1.5	Ø 8 × 1	Ø 12 × 1.5	Ø 8 × 1
Premium, max 4S/3M	✗	✗	✗	✗	✗
	✓	Ø 16 × 2	Ø 8 × 1	Ø 12 × 1.5	Ø 8 × 1
	✓	Ø 15 × 1.5	Ø 8 × 1	Ø 8 × 1	Ø 8 × 1
	✓	Ø 15 × 1.5	Ø 8 × 1	Ø 12 × 1.5	Ø 12 × 1.5 Ø 8 × 1
	✓	✗	✗	✗	✗
	✓	Ø 15 × 1.5	Ø 10 × 1	Ø 8 × 1	Ø 8 × 1
	✓	Ø 15 × 1.5	Ø 8 × 1	Ø 12 × 1.5	Ø 8 × 1
Multi-Voltage, max 4S/3M	✗	✗	✗	✗	✗
	✓	✗	✗	✗	✗

6.1.6.3 EBS relay valve

480 207 XXX 0

Purpose

The EBS relay valve is used in the electropneumatic brake system as an actuator for modulating the brake pressures in the front axle of drawbar trailers or an additional axle in semitrailers. The EBS relay valve consists of a relay valve and two solenoid valves (inlet/outlet valve), a backup valve and a pressure sensor.

Electrical control and monitoring is performed by the trailer modulator.

6.1.6.4 ABS relay valve

472 195 XXX 0

Purpose

The ABS relay valve familiar from conventional brake systems and a double non-return valve are used in the electro pneumatic brake system as an actuator for modulating the braking pressures on a steering axle of semitrailers.

Electrical control and monitoring is performed by the trailer modulator.

6.1.6.5 Park release emergency valve (PREV)

971 002 XXX 0

Purpose

The park release emergency valve replaces the trailer brake valve and the twin release valve, used till now in the trailer braking systems of the EBS D generation. This valve simplifies the trailer braking system by the elimination of one device and realises the functions typically for the trailer braking valve, as rupture function or pressure restraint when the (semi-)trailer has been unhitched.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 971 002 XXX 0			
Operating pressure [bar]	8.5		
Maximum permissible operating pressure [bar]	10		
Installation restrictions	Maximum deviation of the device from the vertical ± 15°		
Thermal range of application [°C]	-40 to +65		
Weight [kg]	1.6	1.8	1.9
Quickfit connections	no	yes	

6.1.7 Overview of ABS/EBS functions

FUNCTIONS	ABS	EBS
Brake regulation		
Electronic brake force limitation	X	X
Braking force distribution		X
Hybrid support		X
Delay control		X
Coupling force control		X
Halt brake		X
Hill start aid / roll brake	X	X
Stability control		
Anti-lock function	X	X
Traction control	X	X
Electronic Stability Control	X	X
RSS	X	X
Engine / drag torque control	X	X
Performance monitoring		
Brake lining wear control		X
Tire monitoring	X	X
Brake temperature monitoring		X
Braking power monitoring	X	X
Differential lock control	X	X

6.1.8 Air disc brakes

6.1.8.1 MAXX™

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
640 317 XXX 0		MAXX™17 ■ Air disc brake for light commercial vehicles ■ 20 % more performance at the same weight as compared to the successful PAN™17 ■ Exceptional driving comfort and EBS/ABS control – the mechanical efficiency is 95 % ■ Easily replaceable analogue wear sensor or wear indicator reduces maintenance
640 319 XXX 0		MAXX™19 ■ Air disc brake for medium-duty commercial vehicles ■ 14 % more performance at the same weight as compared to the successful PAN™19 ■ Reliable braking performance due to the redundantly sealed clamping unit ■ Easily replaceable analogue wear sensor or wear indicator reduces maintenance
640 322 XXX 0		MAXX™22 ■ Air disc brake for heavy-duty commercial vehicles ■ High braking performance for heavy-duty commercial vehicles and buses with highest requirements ■ Up to 17 % less weight than conventional brakes for heavy-duty commercial vehicles reduces fuel consumption ■ Easily replaceable analogue wear sensor or wear indicator reduces maintenance
640 322 XXX 0		MAXX™22T ■ Air disc brake for trailers ■ Innovative lightweight construction perfectly matching the requirements in trailers ■ 4 kg lighter than previous brakes for trailers ■ The payload is increased due to the overall weight being reduced by up to 24 kg in trailers
640 322 XXX 0		MAXXUS™ ■ Stable braking performance without fading and exceptional braking behaviour when driving downhill ■ Over 50 % lower labour costs for replacing the linings compared to drum brakes ■ Significant reduction of the braking distance as compared to drum brakes ■ High reliability lowers maintenance costs ■ Perfectly suits all axles – a ring adapter enables installation on drum brake axles

Purpose

The MAXX™ portfolio includes brakes for all types of commercial vehicles, from light to heavy duty.

WABCO's patented one-piston technology is the foundation for the compact design of the MAXX™ brakes. The new lightweight construction reduces the unsprung mass of the vehicle. This increases the payload or reduces the fuel consumption.

Directly connecting the brake cylinder to the calliper means the brake has a short overall axial length. This enables optimal utilisation of the installation situations.

Technical data

	MAXX™17	MAXX™19	MAXX™22	MAXX™22T	MAXXUS™
Braking torque / braking performance	12,000 Nm / 8,800 ft. lbs	20,000 Nm / 14,700 ft. lbs	30,000 Nm / 22,100 ft. lbs	21,000 Nm / 15,500 ft. lbs	23,000 Nm / 17,000 ft. lbs
Brake disc size	330x34 mm / 12.99x1.34 in	375x45 mm / 14.76x1.77 in	432x45 mm / 17x1.8 in	430x45 mm / 16.93x1.77 in	
Lining area	245 cm^2 / 38 in^2	291 cm^2 / 45 in^2	355 cm^2 / 53 in^2	340 cm^2 / 52.7 in^2	
Lining thickness	17 mm / 0.67 in	21 mm / 0.83 in	22 mm / 0.87 in	23 mm / 0.91 in	21 mm / 0.83 in
Weight (incl. brake linings)	23 kg / 51 lb	33 kg / 73 lb	39 kg / 86 lb	32 kg / 71 lb	37 kg / 82 lb
Rim size	17.5" / 17.5 in	19.5" / 19.5 in	22.5" / 22.5 in		
Maximum size of the brake cylinder	Type 20	Type 24	Type 30	Type 22	Type 24

6.1.8.2 PAN™

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
40 175 XXX		PAN™17 ■ Launch of the PAN™ 17 air disc brake in 1996 ■ Diagonal wear compensation in combination with the innovative WABCO one-piston technology has proven itself in practice time and again ■ Customer satisfaction at the highest level – Our success in the 17.5 inch segment proves the effectiveness of this technology
40 195 XXX		PAN™19 ■ Following the success of the PAN™ 17, the next logical step was introducing the one-piston technology to the 19.5 inch class ■ With PAN™ 19, WABCO set new standards for trailers and medium-duty commercial vehicles ■ At only 32 kg, PAN™ 19 is one of the lightest brakes of this size
40 225 XXX		PAN™22 ■ With PAN™ 22, WABCO continued successfully to develop the PAN series further ■ The PAN™ 22 model is perfectly suited for use in the trailer segment and for commercial vehicles up to 18 tons ■ The lining surface was optimised and the lining thickness extended by 2 mm ■ The service life was thereby increased and the downtimes significantly reduced as compared to standard 22.5 inch brakes ■ WABCO has therefore set a milestone that has now become standard in the industry
40 250 XXX		PAN™25 ■ The PAN™ 25 demonstrates that the one-piston technology works perfectly for 25 inch rims as well ■ With this model, WABCO has introduced the first air disc brake for off-road cranes ■ The PAN™ 25 model mainly replaces 500 mm drum brakes and, apart from significant price reductions, sets new standards in terms of comfort, safety and performance

Purpose

The reliable and proven single-piston technology has made the WABCO PAN™ series one of the most successful product range for air disc brakes for commercial vehicles.

The PAN™brake's reliability is enhanced by an encapsulated guidance system with robust metal fasteners as well as redundant seal systems for the guidance system and the adjuster unit.

This is reflected by high customer satisfaction in all common vehicle classes.

Technical data

	PAN™17	PAN™19	PAN™22	PAN™25
Braking torque / braking performance	10,000 Nm / 7,400 ft. lbs	17,000 Nm / 12,500 ft. lbs	Towing vehicle: 23,000 Nm / 17,100 ft. lbs Trailer: 21,000 Nm / 15,500 ft. lbs	25,000 Nm / 18,400 ft. lbs
Brake disc size	330x34 mm / 13x1.3 in	375x45 mm / 14.8x1.8 in	430x45 mm / 17x1.8 in	525x41 mm / 20.6x1.6 in
Lining area	240 cm^2 / 37 in^2	292 cm^2 / 45 in^2	340 cm^2 / 53 in^2	
Lining thickness	19 mm / 0.75 in	21 mm / 0.83 in	23 mm / 0.91 in	
Weight (incl. brake linings)	23 kg / 51 lb	32 kg / 71 lb	36 kg / 79 lb	39 kg / 86 lb
Rim size	17.5" / 17.5 in	19.5" / 22.5 in	22.5" / 22.5 in	25" / 25 in
Maximum size of the brake cylinder	Type 20	Type 24	Type 30	Type 22

6.1.8.3 Brake lining wear indicator / sensor

Design types

CWS BVA

Only available in a repair kit.

Purpose

BVA (lining wear indicator)

The brake lining wear indicator consists of an electrical contact that lies within the brake lining. As soon as the lining is worn, the wire contact is broken and the electrical circuit is interrupted. The ECU signals to the driver that the brake linings must be replaced.

CWS (Continuous Wear Sensor)

The continuous wear sensor monitors the wear of both brake linings on each air disc brake separately and continuously. Here the sensor also detects different wear of the brake linings on a respective air disc brake.

The continuous brake lining wear sensor must be replaced every time the linings are replaced. A replacement does not require any further configuration (plug & play).

Monitoring the brake cylinder stroke is also possible.

! WABCO brake lining wear indicators / sensors can be retrofitted.

6.1.8.4 WABCO EasyFit™ (slack adjuster)

433 543 XXX 0

Purpose

Transmission of the brake force to the wheel brake. Automatic readjustment of the brake shaft to compensate for lining wear, making the brake cylinder and the brake always operate within the ideal range.

Features

- WABCO EasyFit™ is based on the principle of air gap measurement.
- Innovative WABCO adjuster principle
- Power-controlled air gap readjustment
- Customer-specific slack adjuster for S cam brakes
- Up to 25 % time savings thanks to easier, more precise and faster installation of the self-adjusting slack adjuster
- Flexible mounting of the control lever permits multiple installation positions
- Maintenance-free thanks to lifetime lubrication

6.1.9 Brake cylinder, pneumatic

6.1.9.1 UNISTOP™ diaphragm brake cylinder

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
423 XXX XXX 0		Diaphragm brake cylinder for disc brakes ■ The cylinders are meant to be mounted directly on the brake calliper of modern pneumatic brake discs. ■ With clamping band or crimped sealing ring
423 XXX XXX 0		Diaphragm brake cylinder for expansion wedge brakes ■ Available with flanged mounting or thread on the piston pipe ■ With clamping band or crimped sealing ring
423 XXX XXX 0		Diaphragm brake cylinder for S cam brakes ■ Available with or without bellow ■ Some brake chambers can be adjusted for different installation positions by shortening the continuous threaded rod. ■ With clamping band or crimped sealing ring

Purpose

Diaphragm brake cylinders in vehicles with air brakes are used to generate, together with the mechanical wheel brakes, the braking forces required by the service brake relative to the size of the brake cylinder and the input pressure.

Features

- Exceptional reliability due to optimised crimping technology
- Low operating costs and less downtime
- Products adjusted to customer requirements with many options

Technical data

- Operating pressure up to 13 bar
- Stroke length up to 75 mm

6.1.9.2 TRISTOP™ D double diaphragm brake cylinder

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
925 37X XXX 0		TRISTOP™ D double diaphragm brake cylinder for disc brakes
925 37X XXX 0		TRISTOP™ D double diaphragm brake cylinder for expansion wedge brakes
925 37X XXX 0		TRISTOP™ D double diaphragm brake cylinder for S cam brakes

Purpose

TRISTOP™ D double-diaphragm brake chambers are the perfect solution for sophisticated applications in trailers. They are equipped with a space-saving internal ventilation valve (IBV in German) as well as a parking brake spring without winding contact and highly reliable interface to the brake. The double-diaphragm brake chambers are part of the successful WABCO brake cylinder range and are also available for S cam brakes.

TRISTOP™ D double diaphragm brake cylinder for trailers

The cylinders are specially designed for being mounted to trailer axles with FBA spring brake actuators and with a max. stroke of 75 mm provide the necessary extra distance required for vehicles without automatic slack adjuster.

Features

- Longer service life for brake cylinders due to extremely reliable parking brake component
- Very compact design of the brake cylinder due to barrel-shaped parking brake spring
- Greatest possible protection of the inner components due to optional internal breather valve

Technical data

- Operating pressure up to 10 bar
- Stroke length up to 75 mm
- Parking brake spring without winding contact

6.1.9.3 TRISTOP™ cylinder

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
925 4XX XXX 0		TRISTOP™ cylinder for disc brakes ■ The cylinders are meant to be mounted directly on the brake calliper of modern pneumatic brake discs. ■ With clamping band or crimped sealing ring
925 32X XXX 0 925 4XX XXX 0		TRISTOP™ cylinder for S cam brake ■ The various series refer to types 12/12 to 36/30. ■ With clamping band or crimped sealing ring
425 3XX XXX 0		TRISTOP™ cylinder for expanding wedge brake ■ The various series refer to types 9/9 to 24/24. Some variants are equipped with a quick-release facility. ■ With clamping band or crimped sealing ring

Purpose

TRISTOP™ cylinders (combined spring type actuator brake chambers) are used for linkage-free auxiliary and parking brake systems. They are responsible for generating the braking forces required for the service brake as well as the parking brake. The type specifications (example: Type 24/24) indicate the active piston surface (in square inches) in the diaphragm and spring brake actuator part.

If the service and the parking brake systems are switched on simultaneously, the brake forces are compounded in the wheel brake. If this is to be prevented, an overload protection valve or a two-way valve needs to be installed between the two systems.

Features

- The parking brake spring design without winding contact protects against corrosion
- Can be adjusted specially to customer requirements
- 8 cm shorter as compared to conventional brake cylinders by means of the integrated release system, particularly suitable for confined installation conditions
- Greatest possible protection of the inner components due to the internal breather valve

Technical data

- Operating pressure up to 13 bar
- Stroke length up to 75 mm

6.1.9.4 Piston cylinder

921 00X XXX 0

Purpose

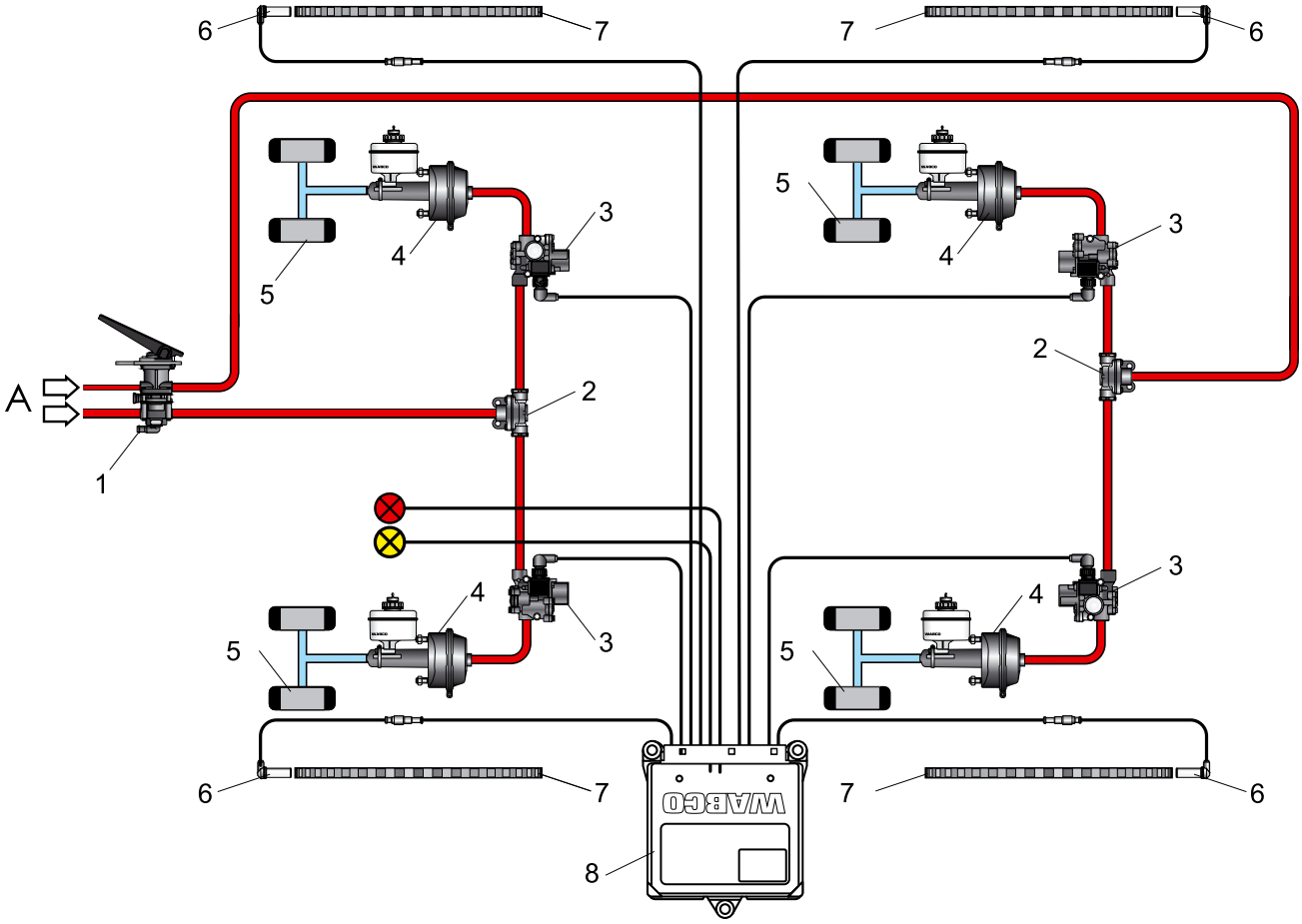
To generate the braking force for the wheel brakes. It can also be used to actuate other systems, e.g. for clamping, lifting or gear-shifting.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 921 00X XXX 0				
	921 002 XXX 0	921 003 XXX 0	921 004 XXX 0	921 006 XXX 0
Piston diameter	3" (76,2 mm)	4" (101,6 mm)	5" (127 mm)	6" (152,4 mm)
Maximum stroke	110	140		175
Weight [kg]	3.0	4.0	5.5	8.0
Volume [litres]	0.55	1.24	1.89	3.34

6.1.9.5 Air over Hydraulic (AoH) converter

Example of Air-over-Hydraulic (AoH) braking system with ABS



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
A	Air quality	–	–
1	Foot brake valve with pedal actuation	461 31X XXX 0	56
2	Quick release valve	973 500 XXX 0	79
3	ABS solenoid valve	472 195 XXX 0	117
4	AoH converter	–	139
5	Wheel brake cylinder	–	–
6	Wheel speed sensor	441 032 XXX 0	49
7	Pole wheel	–	–
8	ECU "ABS E"	446 003 XXX 0	89

Design types

423 0XX XXX 0	921 399 XXX 0
AoH converter with diaphragm cylinder	AoH converter with piston cylinder
	

Purpose

AoH converters are used in vehicles with pneumatic braking systems and hydraulic wheel brakes. The AoH converter is a combination of a pneumatic UNISTOP™ diaphragm brake cylinder and a hydraulic master cylinder.

The AoH converter transforms the lower pneumatic pressure into a higher hydraulic pressure.

Depending on the vehicle type, different sizes of pneumatic and hydraulic cylinders can be combined. AoH systems are mainly used in agricultural vehicles, construction machines and military vehicles.

There are also AoH converters with pneumatic diaphragm and piston cylinders.

Combinations – AoH converters with diaphragm cylinders

AoH COMBINATIONS		MAIN BRAKE CYLINDER TYPE (HYDRAULIC)					
		19.05	22.25	25.4	26.99	28.575	31.75
DIAPHRAGM CYLINDER TYPE (PNEUMATIC)	14"	X	X	X	X	X	X
	16"	X	X	X	X	X	X
	20"	X	X	X	X	X	X
	24"	X	X	X	X	X	X
	30"	X	X	X	X	X	X
	36"	X	X	X	X	X	X

Technical data – AoH converter with piston cylinder

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 921 399 XXX 0						
Displacement volume [cm^3]	50	52	60	60	52	30
p_{max} (hydraulic) [bar]	150	140	140	140	140	140
p_{max} (pneumatic) [bar]	8	7.5	8	8	7.5	8
With reservoir	yes	no	yes	no	yes	yes
Thermal range of application [°C]	-40 to +80					

! Please get in touch with your WABCO partner if you have different requirements.

6.2 Clutch servo

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
164 217 XXX 8		Clutch servo ■ Hydraulic medium: Brake fluid
970 051 1XX 0		Clutch servo ■ Hydraulic medium: Brake fluid
970 051 1XX 0		Clutch servo ■ Hydraulic medium: Brake fluid
970 051 4XX 0		Clutch servo ■ Hydraulic medium: Brake fluid

Purpose

Increasing engine torque leads to higher actuation forces which impacts maintenance costs and reduces the life of clutch components.

Choose WABCO, the technology leader in clutch control products and benefit from our advanced solutions. These are backed by 40 years of experience in developing and manufacturing reliable clutch control systems.

With WABCO clutch control systems you have many different options: Clutch slave cylinder (purely hydraulic or with compressed air support) easily adapt to your requirements.

Hydraulic slave and master cylinders are used for lower force requirements. For higher force requirements, the hydraulic clutch slave cylinder is used in combination with a compressed-air assisted master cylinder.

The clutch servos are available in many variants that meet the different requirements with respect to force, stroke and interfaces.

6.3 Hydraulic braking systems

6.3.1 Hydraulic master cylinder

Design types

468 411 XXX 0

- For single or dual circuit main brake cylinders.
- For standard or ABS applications.
- Available as single of tandem version.

Purpose

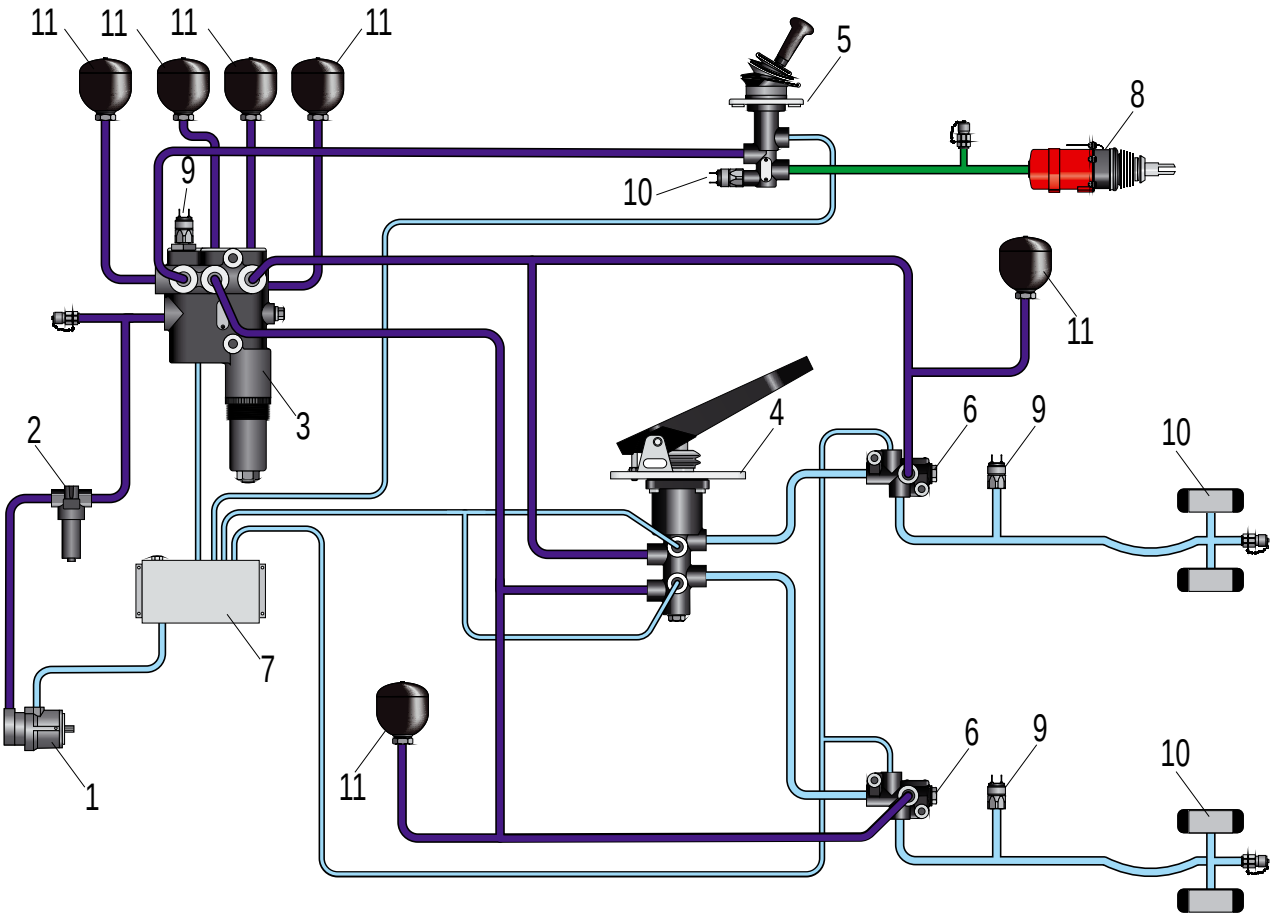
Generates hydraulic braking pressure via mechanical brake pedal.
For total vehicle weight up to 10 t.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 468 411 XXX 0					
Maximum operating pressure	ABS	Circuit(s)	Diameter		Displacement per circuit [approx.]
150	yes	single circuit	19.05 mm	3/4 inch	11 cm^3
			22.20 mm	7/8 inch	14 cm^3
			25.40 mm	1 inch	18 cm^3
			27.00 mm	1 1/16 inch	20 cm^3
			31.75 mm	1 1/4 inch	27 cm^3
		dual circuit	19.05 mm	3/4 inch	4 cm^3
			22.20 mm	7/8 inch	7 cm^3
			25.40 mm	1 inch	9 cm^3
			27.00 mm	1 1/16 inch	10 cm^3
			31.75 mm	1 1/4 inch	11 cm^3
	no	single circuit	19.05 mm	3/4 inch	11 cm^3
			22.20 mm	7/8 inch	14 cm^3
			25.40 mm	1 inch	18 cm^3
			27.00 mm	1 1/16 inch	20 cm^3
			31.75 mm	1 1/4 inch	27 cm^3
		dual circuit	19.05 mm	3/4 inch	4 cm^3
			22.20 mm	7/8 inch	7 cm^3
			25.40 mm	1 inch	9 cm^3
			27.00 mm	1 1/16 inch	10 cm^3
			31.75 mm	1 1/4 inch	11 cm^3

6.3.2 Full Hydraulic Power Brake (FPB™)

FPB™ – 2-circuit with relay valve and park brake circuit



ITEM	DESIGNATION	PRODUCT FAMILY	PAGE
1	Pump	in the vehicle	–
2	Pressure filter	in the vehicle	–
3	Cutoff valve	477 397 XXX 0	146
4	Brake valve	467 406 XXX 0	149
5	Hand brake valve	467 410 XXX 0	158
6	Relay valve	477 411 XXX 0	159
7	Hydraulic tank	in the vehicle	–
8	Spring brake cylinder	427 001 XXX 0	160
9	Pressure switch	441 014 XXX 0	157
10	Wheel brake cylinder	in the vehicle	–
11	Accumulator	458 501 XXX 0	156

Introduction

Currently the majority of agricultural vehicles and construction machines of 8 - 10 t dead weight are equipped with a hydraulic power braking system. Vehicles with a greater dead weight usually have a Full Hydraulic Power Brake.

The Full Hydraulic Power Brake is designed for vehicles with hydraulic wheel brakes.

The components of the hydraulic braking system are suitable for fluids on the basis of mineral oils and some bio-fluids which means that the fluids present in the construction vehicle's hydraulic system can be used as the energy transmitter for the braking system.

The line cross-sections of the devices have been adjusted to the viscosity of the above fluids.

The components are particularly robust to ensure that they are capable of withstanding the severe strain of everyday operation.

The legal requirements for the FPB™ with regard to the size of its energy accumulators, the performance of its energy source and the properties of the alarm devices are defined in EC directive 98 / 12 / EC, annex IV under item C.

In order to take into account the trend towards dual circuit service braking systems, we recommend that 25 km/h vehicles be fitted with a dual circuit FPB™ system.

! If the brake volume is greater than 75 cm³, at least the first (top) circuit of the foot operated brake valve must be equipped with a relay valve.

Always check the response and threshold times. It may be necessary to equip both circuits of the service brake system with relay valves.

All pipes in the braking system must have a nominal width of at least 10 mm.

The pipes should be installed in such a way as to permit problem-free bleeding, i.e. so that no air cushions can develop. If you detect noises when applying the brake, this is an indication of poor bleeding.

It is particularly important that the components all have their separate return lines, otherwise the return pressure can be present in the wheel brake in the form of residual pressure. This leads to unnecessary wear of the brake linings and excessive temperatures at the wheel brake and can thus result in hardening of the linings and in a failure of the seals on the wheel brake cylinders.

When combining the returns of the dual circuit foot brake valve, please make sure that hoses are used for connecting the return ports. Using a pipe to connect the two circuits can result in impaired functions due to distortions during installation.

For very long vehicles with large cylinder volumes, the installation of relay valves can be very helpful, reducing response and pressure build-up times to a minimum. The relay valve should be fitted as close to the wheel brake cylinders as possible. The lengths of the lines from the accumulator to the wheel brake cylinders are thereby reduced because the foot brake valve only actuates the relay valves. The input volume of the relay valves is approx. 1 cm³.

If cutoff valves with an integrated check valve are used, an additional accumulator of 0.7 litres needs to be screwed into the component. That additional accumulator is primarily used to monitor the actual pressure of the other three accumulators and pass them on to the control piston of the cutoff valve. The accumulators can be drained when the brakes are operated without being re-charged since all circuits are protected against one another by the check valves.

The additional accumulator will also prevent activation of the cutoff valve in the connection between the check valves in the event of minor leaks and associated pressure drops even though the pressure in the accumulators of the braking circuit is still higher than 120 bar.

The hydraulic accumulators must be specially designed to comply with the legal provisions for the FPB™ with regard to the size of energy accumulators.

We support our customers, free of charge, in identifying the appropriate accumulator layout and capacity.

It would further assist us if you could send us the data sheet for the wheel brake, ▸ see chapter "11 Data sheets / Forms" on page 203.

Regularly check the level of the brake fluid.

When working on the braking system, always make the sure that there is absolutely no pressure in the system.

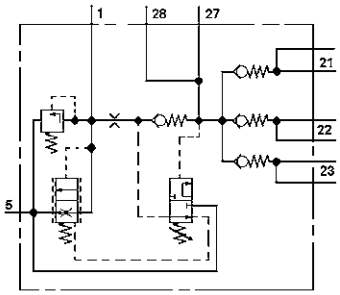
Further references

- ISO 3450:2011, Earth-moving machinery – Wheeled or high-speed rubber-tracked machines
- ISO 7131, Earth-moving machinery – Loaders – Terminology and commercial specifications
- ISO 7132:2003, Earth-moving machinery – Dumpers – Terminology and commercial specifications
- ISO 10265, Earth-moving machinery – Crawler machines – Performance requirements and test procedures for braking systems
- ISO 17063, Earth-moving machinery – Braking systems of pedestrian-controlled machines – Performance requirements and test procedures
- SABS 1589, The braking performance of trackless underground mining machines – Load haul dumpers and dump trucks
- CAN/CSA-M424.3-M90 (R2007), Braking Performance – Rubber-Tired, Self-Propelled Underground Machines
- EN 1889-1, Machines for underground mines - Mobile machines working underground - Safety - Part 1: Rubber-tired vehicles
- MSHA Website: http://www.msha.gov
- SAE J1329, Minimum Performance Criteria for Braking Systems for Specialized Rubber-tired, Self-propelled Underground Mining Machines
- SAE J1472:2006, Braking Performance – Rollers
- ECE R-13 Rev 1, Add 12, Rev 5 – Annex 18, Special Requirements to be applied to the safety aspects of complex electronic vehicle control systems
- USA 30 Code of Federal Regulations, Part 57, Safety and health standards – Underground metal and non-metal mines
- USA 30 Code of Federal Regulations, Part 75, Mandatory safety standards – Underground coal mines

6.3.2.1 Cutoff valve

Cutoff valve for single circuit braking systems

477 397 XXX 0



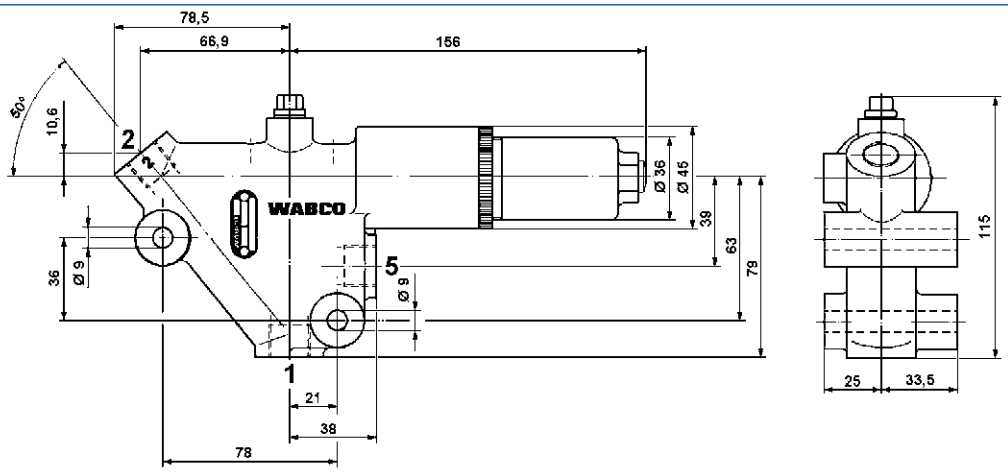
Purpose

The purpose of the cutoff valve is to control the pressure level in the accumulators.

Technical data

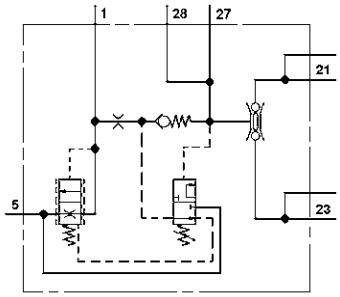
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 477 397 XXX 0			
Flow rate [l/min]	max. 16	1 to 2 : 2 to 3 1 to 5 : 45	1 to 2 : 17 to 19 1 to 5 : 45
Maximum operating pressure [bar]	200		
Pressure in port 5 [bar]	200		50
Activation pressure [bar]	120 +10		
Cut-off pressure [bar]	150 -10		
Permissible medium [mm²/s]	Mineral oil: 10 to 1940		
Thermal range of application [°C]	-30 to +80		
Weight [kg]	2.4		

Installation dimensions – Example of variant 477 397 001 0



Cutoff valve for dual circuit braking systems

477 397 XXX 0



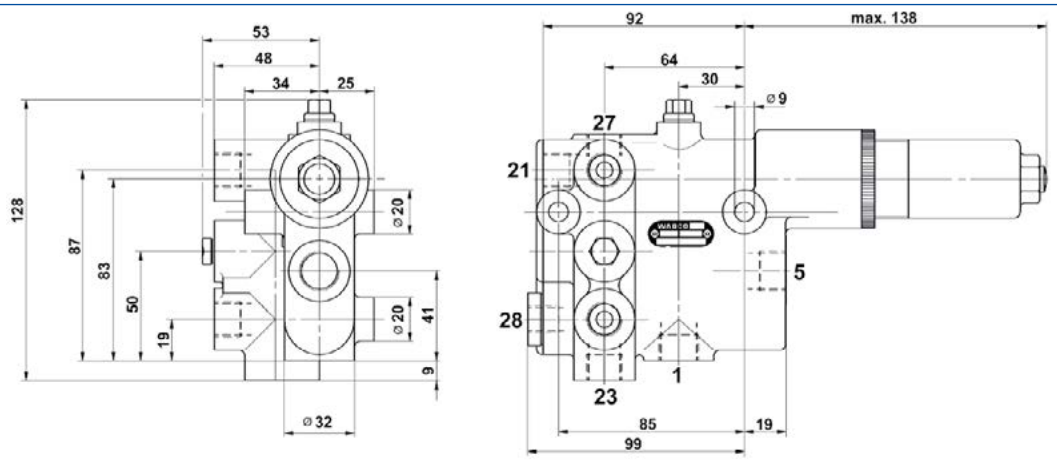
Purpose

The purpose of the cutoff valve is to control the pressure level in the accumulators.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 477 397 XXX 0		
Activation pressure [bar]	120 +8	70 +8
Cut-off pressure [bar]	150 -8	100 -8
Maximum flow rate [l/min]	45	62
Maximum operating pressure [bar]	200	
Pressure in port 5 [bar]	briefly 200	
Pressure switch in port 28	without	with
Volume flow to the brake circuits [l/min]	3 +1	10 to 12
Permissible medium [mm²/s]	Mineral oil: 10 to 2000	
Operating range [bar]	22 -8	
Thermal range of application [°C]	-30 to +80	
Weight [kg]	3.8	4.1

Installation dimensions – variant example

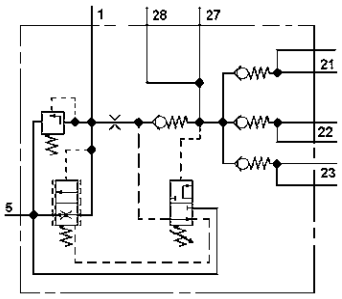


Towing vehicle

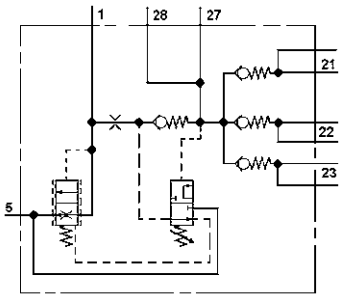
Cutoff valve for triple-circuit braking systems

477 397 XXX 0

Design example



Design example



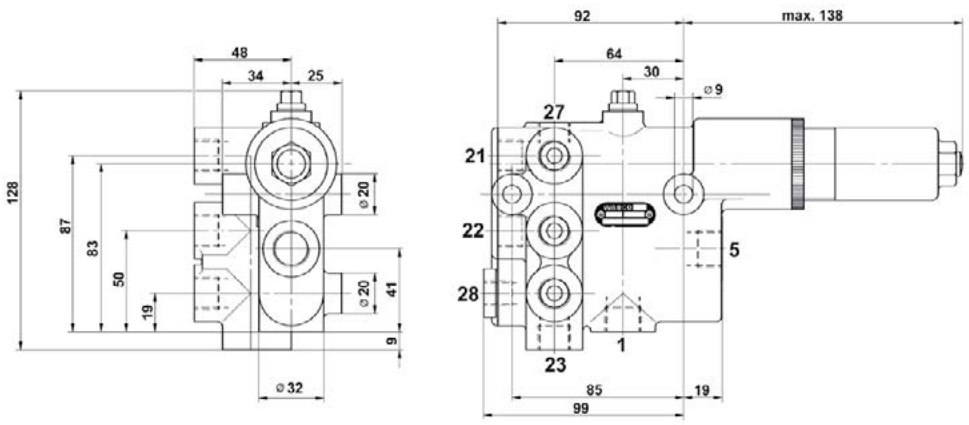
Purpose

The purpose of the cutoff valve is to control the pressure level in the accumulators.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 477 397 XXX 0		
Flow rate / max. Volume flow [l/min]	16	45
Activation pressure [bar]	120 +8	
Cut-off pressure [bar]	150 -8	
Volume flow to the brake circuits [l/min]	3 +1	
Maximum operating pressure [bar]	200	
Maximum pressure in port 5 [bar]	–	briefly 200
Pressure limitation [bar]	170 +30	–
Permissible medium [mm²/s]	Mineral oil: 10 to 2000	
Thermal range of application [°C]	-30 to +80	
Weight [kg]	3.8	

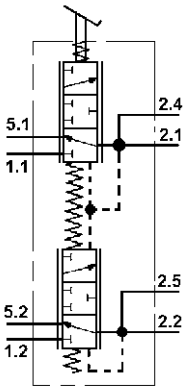
Installation dimensions – variant example



6.3.2.2 Brake valve

Brake valve for single circuit braking system

467 406 XXX 0



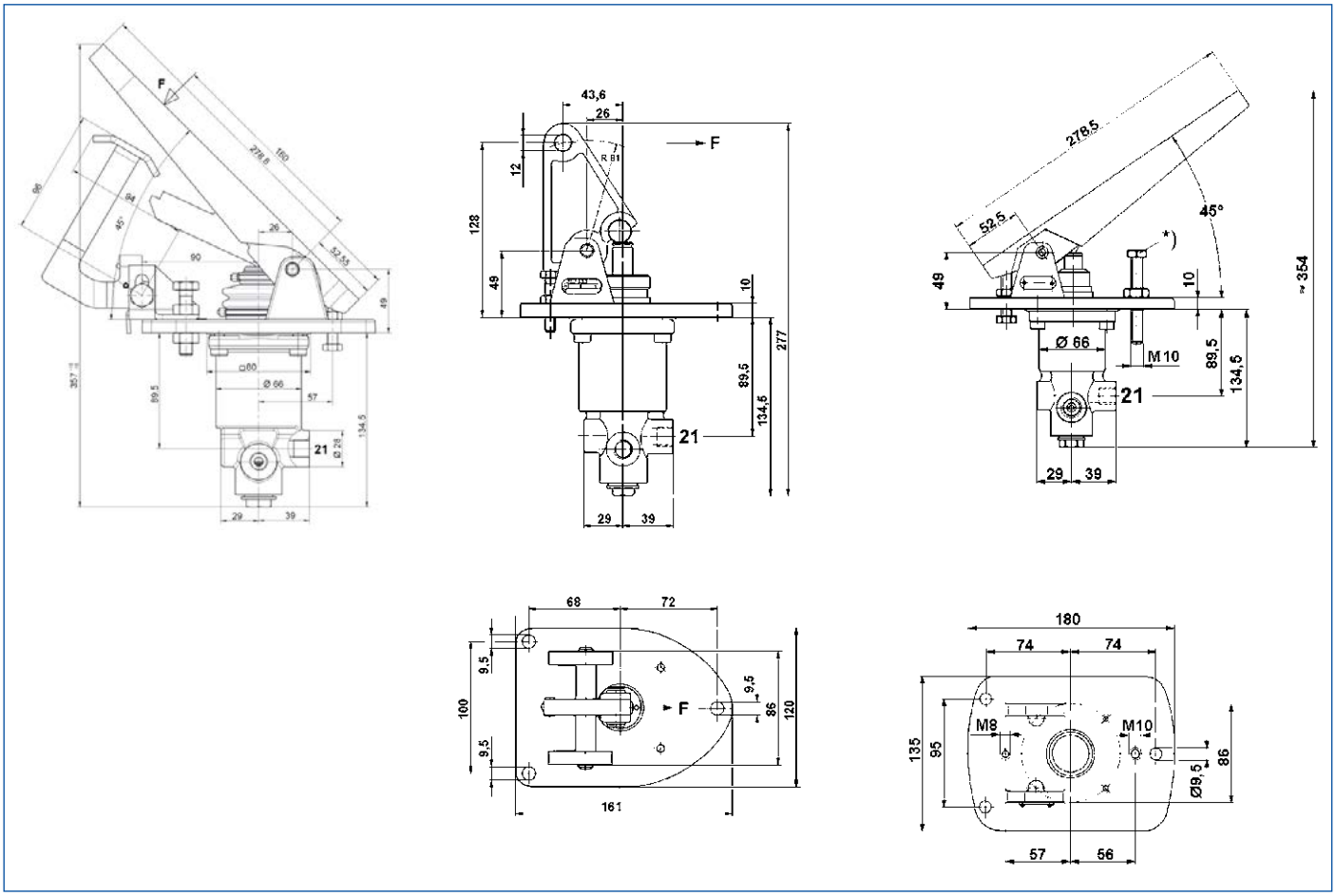
Purpose

The brake valve has the purpose of sensitively increasing and decreasing the braking pressure when the treadle (or the actuating lever) is operated.

Technical data

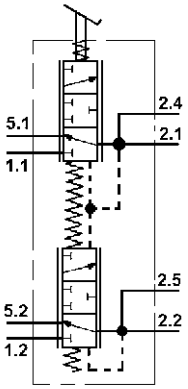
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 467 406 XXX 0					
Pedal angle [degrees]	Pedal force [N]	Pedal via port	Pressure limitation [bar]	Operating pressure [bar]	Thermal range of application [°C]
40	260	21	40	150	-30 to +80
	370	24	65		
	350	2	60 +8		
45	240	21	80		
	290		100		
	300	51	46 +8		
			100		
		–	100 +10		
	360	21	65		
	380		–		
	410	51	67 +8		
50	290		100		
–	820	–	–		
	2400				

Installation dimensions – examples of variants



Brake valve for dual circuit braking system

467 406 XXX 0



Purpose

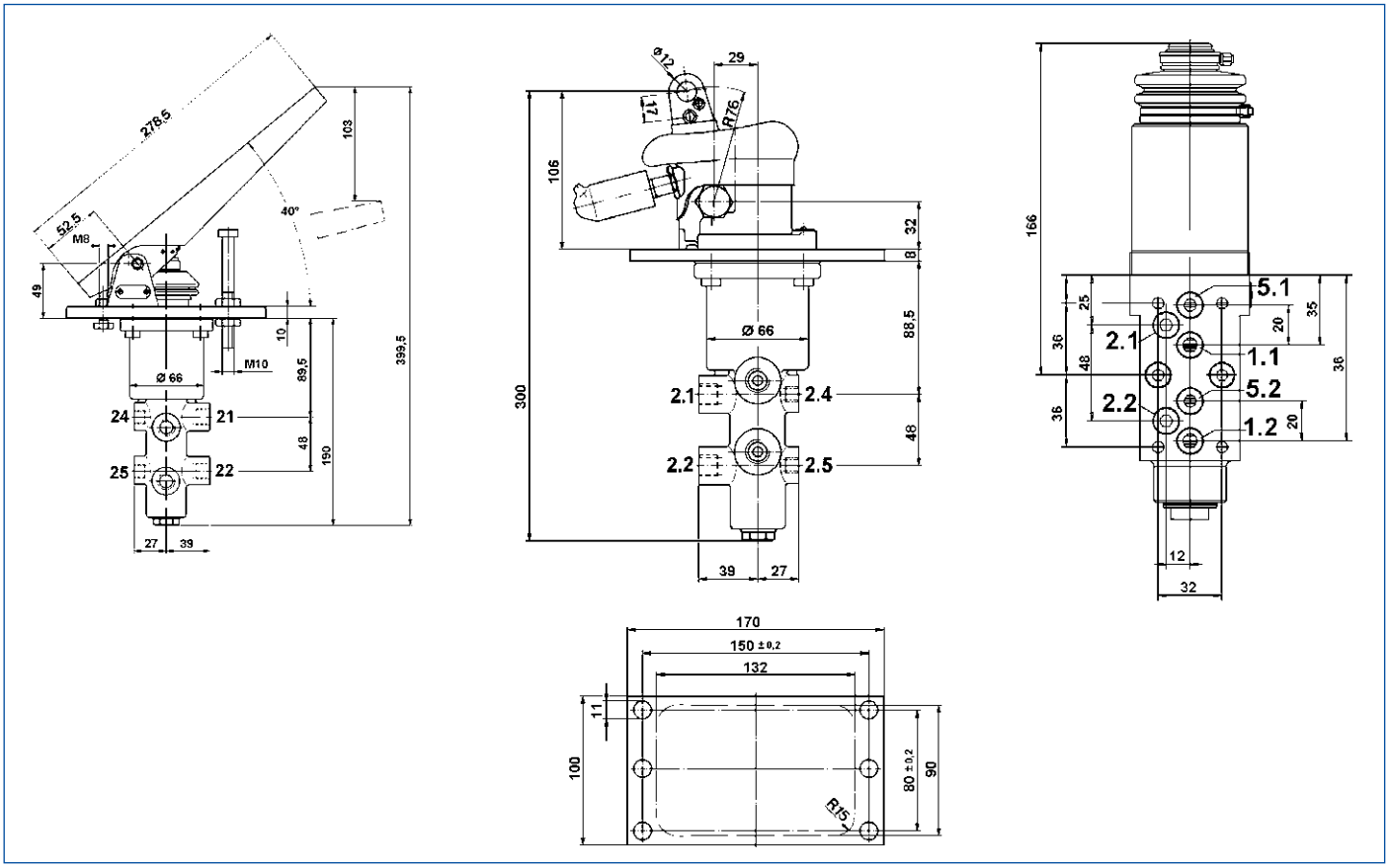
The brake valve has the purpose of sensitively increasing and decreasing the braking pressure when the treadle (or the actuating lever) is operated.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 467 406 XXX 0						
Slider Ø [mm]	Pedal angle [degrees]	Pedal force [N]	Pedal via port	Operating pressure [bar]	Pressure limitation [bar]	Thermal range of application [°C]
14	25	370	51	150	–	-30 to +80
		480				
	33	310			105	
	35	340	5		100 ±5	
		480	51		–	
	40	190	51		60	
		220	5		50 to 90	
		230	21		72	
		300			110	
		390			110 +10	
	45	150	51		40 +15	
		220	5		70 +10	
		390			120 +10	
	–	800	–		110	
		2880			–	
16	35	230	5		40 +8	
		300			60 +8	
	45	180	21		40	
		250			63	

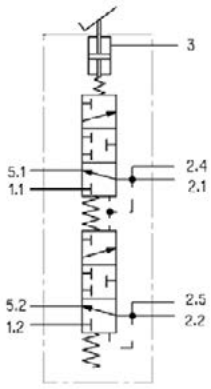
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 467 406 XXX 0						
16	45	300	51	150	70	-30 to +80
					70 +8	
		350	5		85	
	50	180	11		50	
20	40	330	21		63	
	45	280	51		55	
			5		40 +8	
	50	220	24		40	
	–	5200	–		–	

Installation dimensions – examples of variants



Brake valve with pilot actuation

467 406 XXX 0

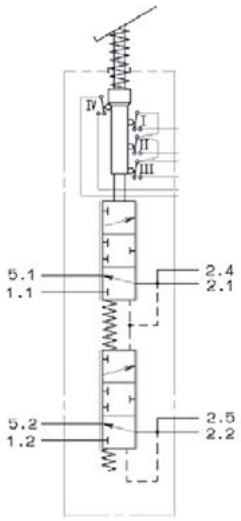


Purpose

The brake valve has the purpose of sensitively increasing and decreasing the braking pressure when the treadle is operated. In addition, there is the option to connect a further hydraulic actuation to port 3. This could be a single circuit brake valve, for example, to brake the vehicle in stages using the respectively other foot.

Brake valve with switch box

467 406 XXX 0



Purpose

The brake valve has the purpose of sensitively increasing and decreasing the braking pressure when the treadle is operated.

It is also equipped with a switch box containing up to 4 microswitches for stepped control of a retarder.

Technical data

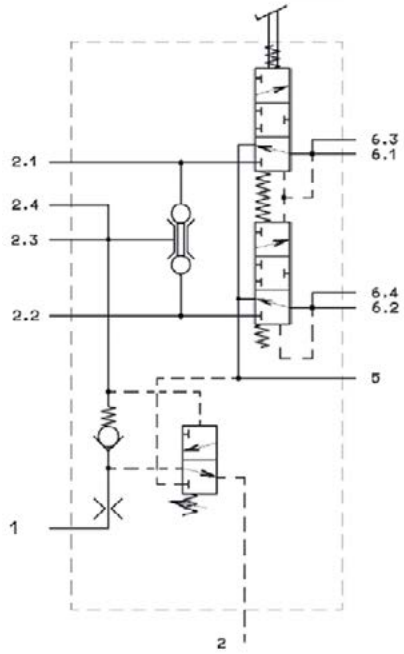
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 467 406 XXX 0						
Circuits	2					
Pedal angle [°]	35			45		
Pedal force [N]	400	450	510	340	450	400
Pedal via port	51			5		
Operating pressure [bar]	200	150		250		
Pressure limitation [bar]	128		–	128 +10		167±5

Brake valve with double pedal

467 406 XXX 0

6.3.2.3 Compact valve

467 415 XXX 0

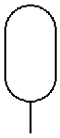


Purpose

The compact valve has the purpose of sensitively increasing and decreasing the braking pressure when the treadle is operated and to regulate the accumulators. The device is designed for use in load-sensing systems.

6.3.2.4 Hydraulic accumulator

458 501 XXX 0



Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy.

In hydro-pneumatic accumulators, the compressibility of a gas is utilised to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working to compensate for any losses through leakage and for vibration damping.

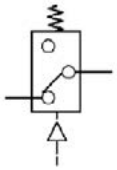
Technical data

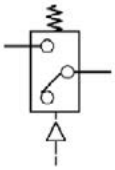
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 458 501 XXX 0			
Diameter [mm]	121	136	174
Installation height [mm]	146	160	307
Nominal volume [litres]	0.75	1.0	3.5
Priming pressure [bar]	50		40
Permissible medium	Mineral oil		
Maximum operating pressure [bar]	180	200	250
Thread	External M 18x1.5	External M 22x1.5	Internal G3/4 ISO 228
Thermal range of application [°C]	-30 to +80		
Installation position	Optional		
Priming gas	Nitrogen		

6.3.2.5 Pressure switch

Design types

441 014 XXX 0 Break contact Make contact





Purpose

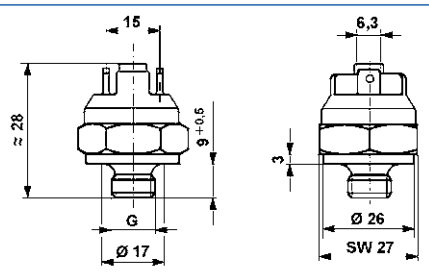
The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 441 014 XXX 0							
NC contact							
Permissible medium	Mineral oil						
Setting range [bar]	1 - 10	10 - 20	20 - 50		50 - 150	fixed	10 - 20
Switching pressure [bar]	3 ± 0.5	17 ± 1	21 ± 2	37 ± 2	100 ± 10	9 ± 0.5	10 - 20
Thread	M 12x1.5						M 10x1 tapered
Voltage [V]	42						

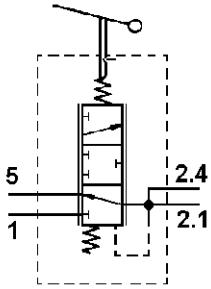
FURTHER OF VARIANTS FOR PRODUCT FAMILY 441 014 XXX 0					
NO contact					
Permissible medium	Mineral oil				
Thread	M 12x1.5				M 10x1 tapered
Setting range [bar]	1 - 10	20 - 50	50 - 150	fixed	1 - 10 ±0.5
Switching pressure [bar]	1 - 10	37 ± 2	54 ± 0.5	21 ± 2	adjustable
Voltage [V]	42				

Installation dimensions



6.3.2.6 Hand brake valve

467 410 XXX 0 Locked position = pressure reduced



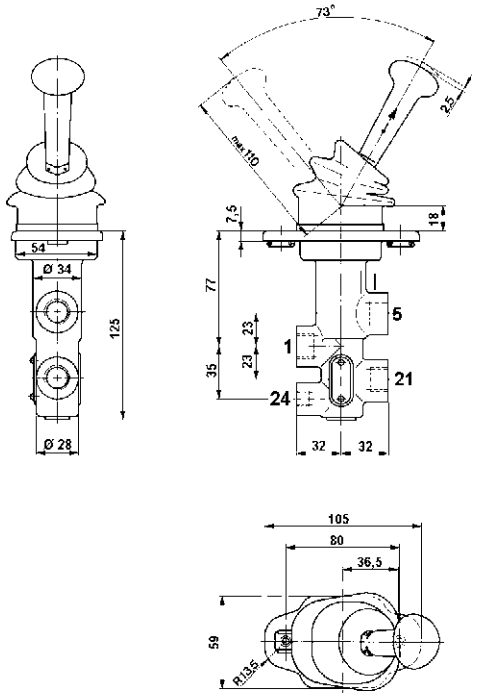
Purpose

The purpose of the hand brake valve is to sensitively increase and decrease the braking pressure when the hand brake lever is operated.

Technical data

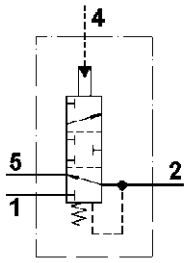
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 467 410 XXX 0		
Operating pressure [bar]	150	
Working pressure [bar]	50	125
Permissible medium	Mineral oil	
Thermal range of application [°C]	-40 to +80	
In locked position	pressure reducing	

Installation dimensions



6.3.2.7 Relay valve

477 411 XXX 0



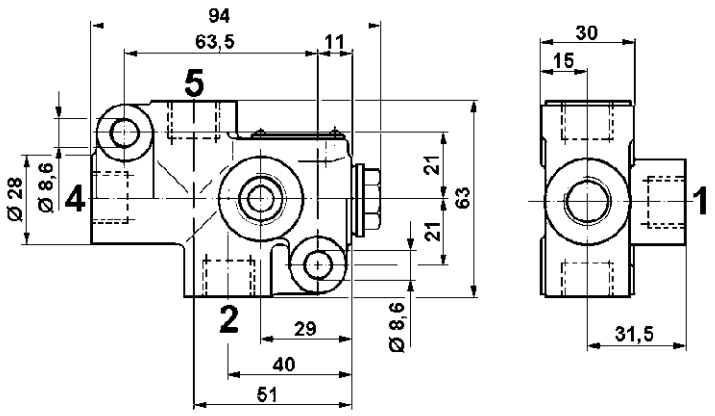
Purpose

The relay valve has the purpose of transferring large volumes to the wheel brake within a short time. It has the advantage that it can be actuated with a small actuating volume.

Technical data

EXAMPLE OF VARIANT FOR PRODUCT FAMILY 477 411 XXX 0	
Maximum operating pressure [bar]	250 bar
Control volume [bar]	1.3
Pressure in port 5 [bar]	< 3
Permissible medium [mm² /s]	Mineral oil: 10 to 2000
Thermal range of application [°C]	-40 to +80
Transmission ratio	1 : 1

Installation dimensions



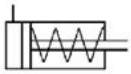
6.3.2.8 Spring chamber cylinder (SAHR: Spring Applied Hydraulically Released)

Design types

427 001 XXX 0

with quick release function

without quick release function



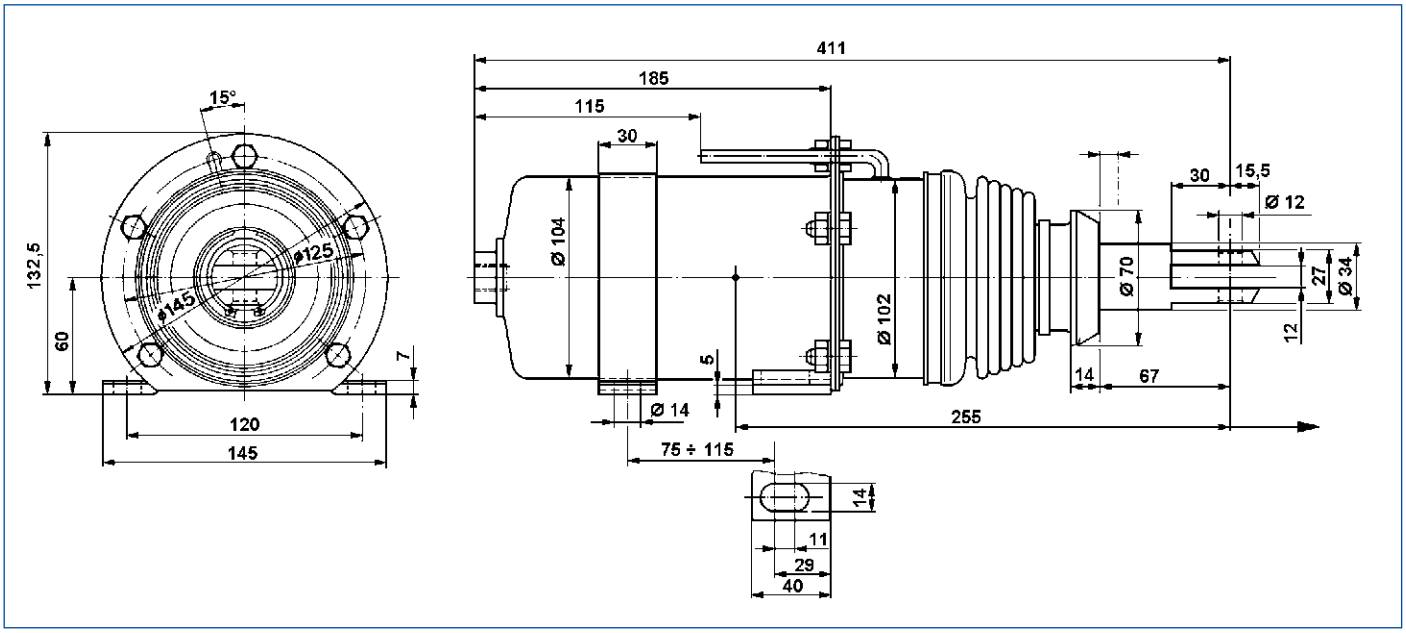
Purpose

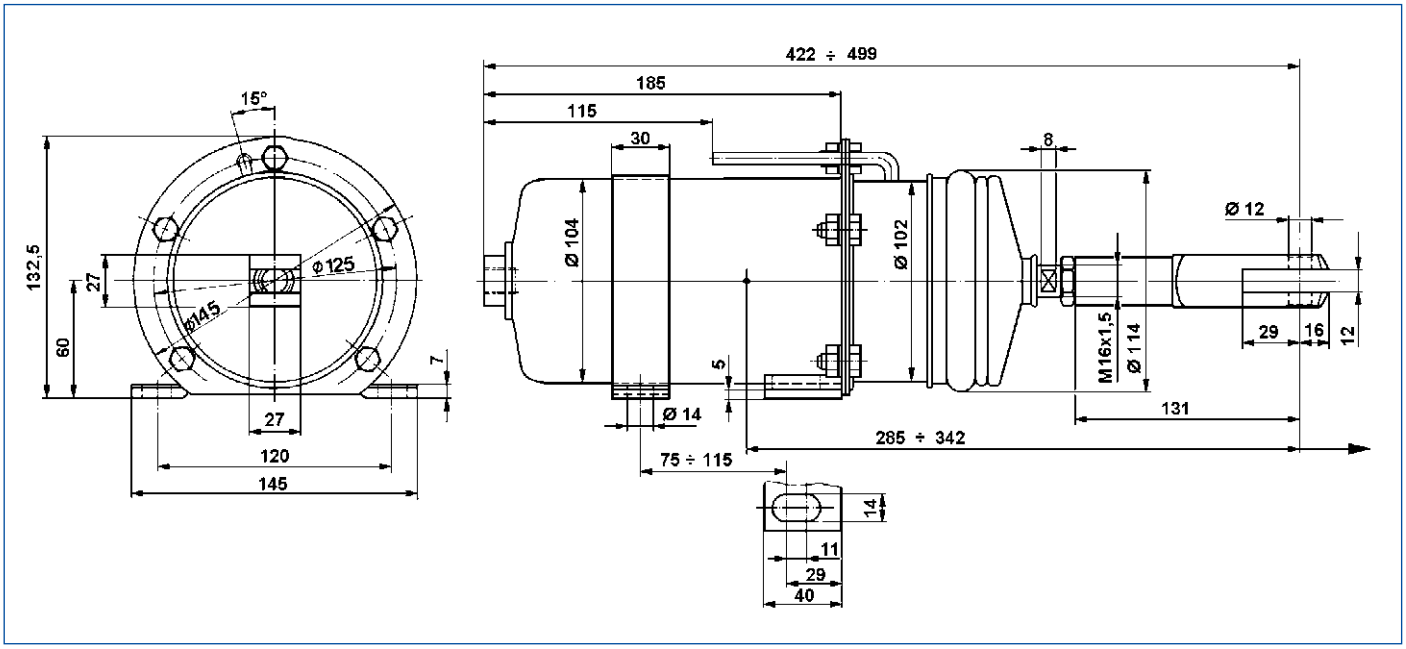
The spring brake actuator has the task of generating the braking force for the wheel brake in secondary and parking brake systems.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 427 001 XXX 0					
Maximum operating pressure [bar]	150				
Stroke [mm]	80 ± 3				
Release pressure [bar]	87 ±4	60 -4		40 ±4	95 +5
Thermal range of application [°C]	-30 to +80				
Permissible medium [mm² /s]	Mineral oil: 10 to 2000				
Output force at 0 mm stroke [N]	2745	2270		1505	3000
Output force at 80 mm stroke [N]	4320	3250		2205	5000
Piston rod pivoting range	3° on all sides				
Emergency release function	no		yes	no	yes
Gaiter	yes				
Yoke end	no	yes			
Weight [kg]	6.5	6.8 kg	8.0	6.8	8.0

Installation dimensions – examples of variants





6.3.3 Hydraulic-pneumatic trailer control

Trailer control valve (for dual line trailer braking systems)

Design types

470 015 0XX 0
470 015 2XX 0

Purpose

To control the dual line braking system of the trailer in connection with the trailer's hydraulic master brake cylinder or its hydraulic transmitter.

With a few 2-circuit, hydraulically controlled trailer control valves, there is an additional actuation, by which a trailer braking procedure can already be applied before the tractor brake becomes effective.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 470 015 0XX 0			
1-circuit hydraulic control			
Actuation pressure [bar]	Hydraulic part limit pressure [bar]	Displacement volume [cm³]	Control medium
4	25	2.2	Brake fluid
5	15		Mineral oil
	20		Brake fluid
	30		Mineral oil
7	40	1.5	Brake fluid
	45		
	70		Mineral oil

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 470 015 2XX 0			
2-circuit hydraulic control			
Actuation pressure [bar]	Hydraulic part limit pressure [bar]	Displacement volume [cm³]	Control medium
3	19	2 x 1.0	Mineral oil
3.5	8	2 x 2.2	
	12		
	14		
8	35	2 x 2.2	Brake fluid
	73	2 x 0.6	

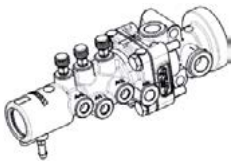
EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 470 015 2XX 0			
*** 1- circuit, hydraulically actuated and pneumatically pre-actuated**			
Pressure at coupling head "Brake" at p_{42} = 7.4 [bar]	Hydraulic part limit pressure [bar]	Displacement volume [cm³]	Control medium
0.0 to 1.0	4	5.5	Mineral oil
	8	2	
	11		Brake fluid
	14		Mineral oil
	19		Brake fluid
	20		Mineral oil
0.6 to 1.2	19		
0.6 to 1.6	11		
1.0 to 1.6	14		

Technical data (valid for all variants)

PRODUCT FAMILY 470 015 0XX 0	
Maximum operating pressure "Pneumatic part" [bar]	10
Maximum operating pressure "Hydraulic part" [bar]	120
Thermal range of application [°C]	-40 to +80
Weight [kg]	approx. 1 to 1.4 (dependent on variant)

Trailer control valve (for dual line trailer braking systems)

470 015 3XX 0



Purpose

To control the dual line braking system of the trailer in connection with the trailer's hydraulic master brake cylinder or the towing vehicle's hydraulic transmitter.

With these 2-circuit, hydraulically controlled trailer control valves, there is an additional actuation, by which a trailer braking procedure is already actuated before the tractor brake becomes effective. These trailer control valves also have a graduated hand brake function. The hand brake is actuated hydraulically and reduces the pressure.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 470 015 3XX 0		
Actuation pressure [bar]	0.0 to 0.5	
Hydraulic part limit pressure [bar]	60	95
Displacement volume [cm^3]	1.0	
Control medium [bar]	Mineral oil	
Maximum operating pressure "Pneumatic part" [bar]	8.5	
Maximum operating pressure "Hydraulic part" [bar]	120	
Thermal range of application [°C]	-40 to +80	-40 to +80
Weight [kg]	1.0	

Trailer control valve (for single or dual line trailer braking systems)

470 015 5XX 0

Purpose

To control the single or dual line braking system of the trailer in connection with the trailer's hydraulic master brake cylinder or its hydraulic transmitter.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 470 015 5XX 0			
Actuation pressure [bar]	Hydraulic part limit pressure [bar]	Displacement volume [cm^3]	Control medium
4	20	2.2	Mineral oil
5	15	1.5	
7	30		Brake fluid
	40		
	45		
	70		

Technical data (valid for all variants)

PRODUCT FAMILY 470 015 5XX 0	
Maximum operating pressure "Pneumatic part" [bar]	10
Maximum operating pressure "Hydraulic part" [bar]	120
Thermal range of application [°C]	-40 to +80
Weight [kg]	approx. 1.9

6.3.4 Hydraulic Anti-Lock Braking System (ABS)

Hydraulic anti-lock system for agricultural, construction and mining vehicles as well as special vehicles.

Available in the following variants:

- With brake fluid for vehicles up to 15 t.
- With mineral oil for vehicles up to 8 t.

Available as modular or compact systems (12 / 24 V).

Optional functions include ESC Hill Start Aid and traction control.

Meets requirements of future EU directives for agricultural vehicles beyond 2016.

Why ABS?

Anti-lock brake systems (ABS) - generally also referred to as anti-lock systems (ALS) - are designed to prevent the vehicle wheels from locking as a result of the service brake being applied with too much force, especially on slippery road surfaces. The idea is to maintain cornering forces on braked wheels to ensure that the vehicle or vehicle combination retains its driving stability and manoeuvrability as far as physically possible. The available power transmission or grip between tires and carriageway should also be utilised as far as possible to minimise the braking distance and maximise vehicle deceleration.

Although today the deployed wheel brakes are designed to a very high technical standard, braking on slippery roads often results in potentially dangerous situations: During full or even partial braking on a slippery road it may no longer be possible to fully transfer the braking force onto the road due to the low coefficient of friction (friction coefficient (k)) between the tires and the carriageway. The braking force is excessive and the wheels lock. When the wheels are locked, they no longer have any traction on the road surface and can thus transmit hardly any cornering forces (steering and tracking forces).

This often has dangerous consequences:

- The vehicle becomes unsteerable.
- The vehicle breaks away in spite of countersteering and starts to swerve.
- The braking distance is significantly increased.

Benefits of ABS

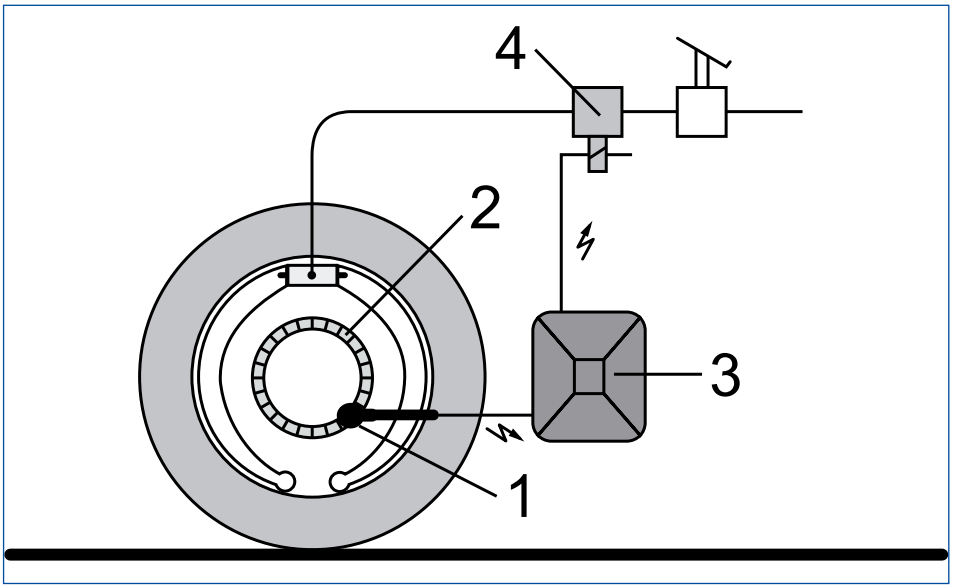
- Guarantees stable braking characteristics on all road surfaces
- Maintains steerability and, as a rule, shortens the braking distance
- Prevents jackknifing of vehicle combinations
- Reduces tire wear
- Meets requirements of future EU directives beyond 2016

Limits of ABS

Although ABS is an effective safety device, it can not override the limits defined by driving physics.

Even a vehicle fitted with ABS will become uncontrollable if driven too fast around a corner. So ABS is not a licence for a maladjusted style of driving or failure to observe the correct safety distance.

Layout of a hydraulic ABS control circuit



LEGEND			
1	Sensor	**2**	Pole wheel
3	ECU	**4**	Modulator

Operation

The fixed sensor connected to the axle continuously picks up the rotary movement of the wheel by means of the pole wheel. The electrical pulses generated within the sensor are transmitted to the electronic control unit (ECU) which uses them to compute the wheel speed.

At the same time, the ECU uses a certain mode to determine a reference speed that is close to the vehicle speed, which is not actually measured.

Using all this information, the electronic control unit continuously calculates the wheel acceleration or deceleration values as well as the amount of brake slip.

When certain slip values are exceeded, the solenoid control value is actuated. This causes the pressure in the brake cylinder to be limited or reduced, thereby keeping the wheel within its optimum slip range.

ABS system overview

	OFF-HIGHWAY ABS PNEUMATIC & AoH	OFF-HIGHWAY ABS HYDRAULIC	HPB ABS HYDRAULIC	ADD-ON ABS WITH ESC HYDRAULIC	ADD-ON ABS HYDRAULIC
					
ECU platform	modular	modular	integrated	integrated	integrated
Frame or cabin ECU	Frame & cabin	Frame & cabin	Frame	Frame	Frame
Braking system	Pneumatic/AoH	Hydraulic pump accumulator	Master cylinder	Master cylinder	Master cylinder
Voltage [V]	12/24	12/24	12/24	12	12/24
Control medium	Air	Mineral oil	Brake fluid	Brake fluid	Brake fluid
Volume of fluid per channel	–	> 15 ccm	< 15 ccm	< 15 ccm	< 15 ccm
ISO 25119/25226	yes	yes	no	no	no
Diagnosis	UDS	UDS	SAE J1587/ KWP2000/ k-line	UDS	SAE J1587/ KWP2000/ k-line
Enhanced functions (ESC/ATC...)	optional	optional	yes	yes	no
Applications / Vehicle segments	Agricultural tractors Special-purpose vehicles	Agricultural tractors Construction machines Special-purpose vehicles	Light and medium trucks Buses Special-purpose vehicles	Light and medium trucks Special-purpose vehicles	Light and medium trucks Special-purpose vehicles

Notes

7 Air suspension

7.1 Conventional air suspension (towing vehicle)

7.1.1 Cabin air-suspension valve

Design types

464 007 XXX 0	464 008 XXX 0
	

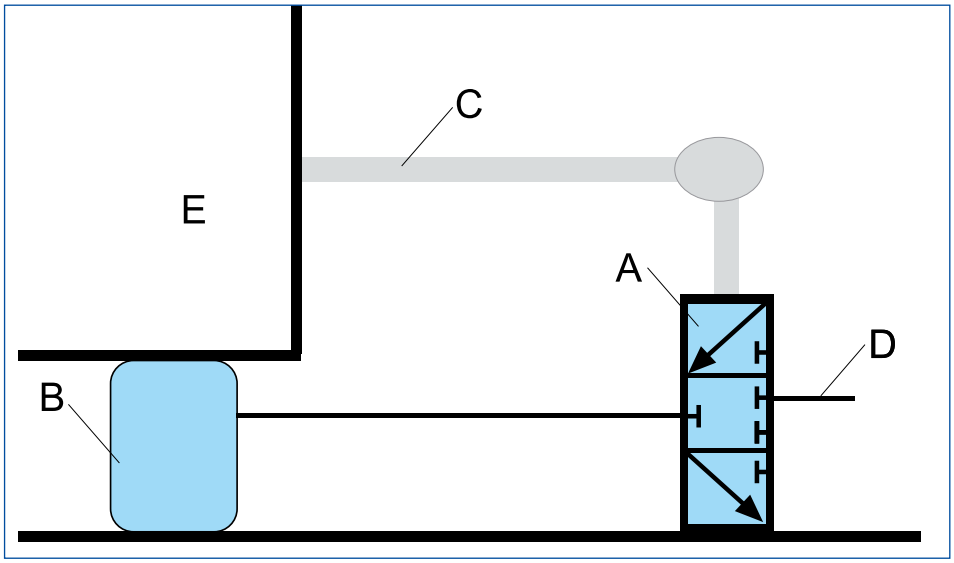
Purpose

The cabin levelling valve controls the level of the cabin and/or the vehicle seat suspension.

Here the levelling valve is fastened to the chassis and the air suspension lever via a link to the driver's cabin.

The cab levelling valve can change the position of the driver's cab by pressurising and venting the cab levelling valve gaiter. This means a certain cab level can always be maintained relative to the chassis.

Functional diagram



LEGEND			
A	Cab levelling valve	**B**	Cab levelling gaiter
C	Levelling valve lever incl. connection to driver's cab	**D**	Pneumatic line
E	Driver's cab		

7.1.2 Cabin Air Levelling Module II

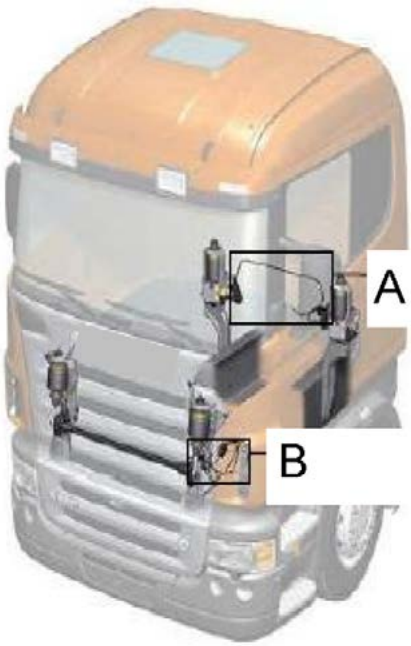
Design types

964 006 XXX 0	964 006 XXX 0
	

Purpose

The cabin air levelling module II is used for suspension and level control of the driver's cabin.
Generally the driver's cabin is connected to the chassis by means of 4 cabin airs suspension bellows.
The function of the cabin air levelling module II is analogous to the cabin air levelling valve function.
In this case the cabin levelling valve is integrated in one or several air suspension bellows.

Use in towing vehicle



LEGEND			
A	Rear: 2 cabin air levelling modules control one cab levelling valve in air suspension bellow respectively	**B**	Front: 1 cabin air levelling module controls both cabin air suspension bellows, front

7.2 Conventional air suspension

7.2.1 Chassis levelling valve

464 006 XXX 0

Purpose

Adjusting the level to a constant chassis ride height by air-spring air intake when compressing (loading the vehicle) and by venting them when decompressing. The height is measured via the angle of the lever that is connected to the axle over linkage.

Height limitation

The levelling valves 464 006 XXX 0 have an additional 3/2-way valve that closes as of a certain adjustable lever angle and switches to a venting function upon actuating the lever again. This "Height limitation" prevents the vehicle from being raised above a permitted level with the rotary slide valve.

Zero point adjustment

The ride height can be adapted to special application conditions of the vehicle with an operating cylinder integrated in the linkage.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 464 006 XXX 0				
3/2 directional control valve	no	yes	no	yes
Maximum operating pressure [bar]	13			
Maximum dynamic bellows pressure [bar]	15			
Permissible medium	Air			
Thermal range of application [°C]	-40 to +80			
Linkage	Round lever Ø 6 mm			
Nominal width levelling valve [mm]	2x Ø 3			
Nominal width shut-off valve [mm]	–	Ø 6	–	
Weight [kg]	0.41	0.51	0.53	0.70
Quickfit connections	–		5x Ø 8x1	

7.2.2 Rotary slide valve

463 032 1XX 0

Purpose

Control of lifting and lowering air-suspension vehicles with a hand lever.

On variants with deadman switch, the hand lever is automatically moved back into idle position when it is released to prevent accidents.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 463 032 1XX 0			
Maximum operating pressure [bar]	8.5	10	
Connections: Nominal diameter	12.6 mm² (Ø 4 mm) 28.3 mm² (Ø 6 mm) 63.6 mm² (Ø 9 mm)	12.6 mm² (Ø 4 mm) 28.3 mm² (Ø 6 mm) 63.6 mm² (Ø 9 mm)	1-circuit variant 12.6 mm² 28.3 mm² 63.6 mm²
Port threads	M 12x1.5-12 deep M 16x1.5 -12 deep	M 12x1.5-12 deep M 16x1.5 -12 deep	M 12x1.5-12 deep
Integrated check valve (port 1)	no	yes	
Permissible medium	Air		
Thermal range of application [°C]	-40 to +80		
Maximum actuation torque [Nm]	9	7	
Weight [kg]	1.5	1.4	
Quickfit connections	–	5x Ø 8x1	–

7.2.3 TASC (Return-To-Ride valve)

463 090 XXX 0

Purpose

TASC can be used to raise and lower the vehicle – in the same way as with a rotary slide valve. The chassis is also automatically returned to normal driving level as soon as the vehicle starts driving (RTR – Return-To-Ride).

The lifting/lowering process is started by simply turning the handle right or left. To halt this process the handle is moved back into the stop position. The system keeps the chassis at the set level.

TASC can be operated in combination with or without levelling valve with height limitation. TASC can be connected directly if levelling valves with height limitation are used. This avoids the bellows being permanently connected to the air reservoir at the upper stop position.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 463 090 XXX 0					
	Dual circuit				**Single circuit**
RTR function	yes				
Locking in lowering position	yes			no	yes
Pneumatic connection	8x1		M 16x1.5		
Test connection	yes	no			yes
Nominal width shut-off valve [mm]	–	Ø 6	–		
Operating pressure [bar]	3.5 to 10				
Voltage [V]	18 to 32				
Thermal range of application [°C]	-40 to +65				
Electrical connection	DIN 72585-B1-3.1-Sn/K2 - bayonet				

7.3 ECAS (towing vehicle)

The name ECAS stands for Electronically Controlled Air Suspension.

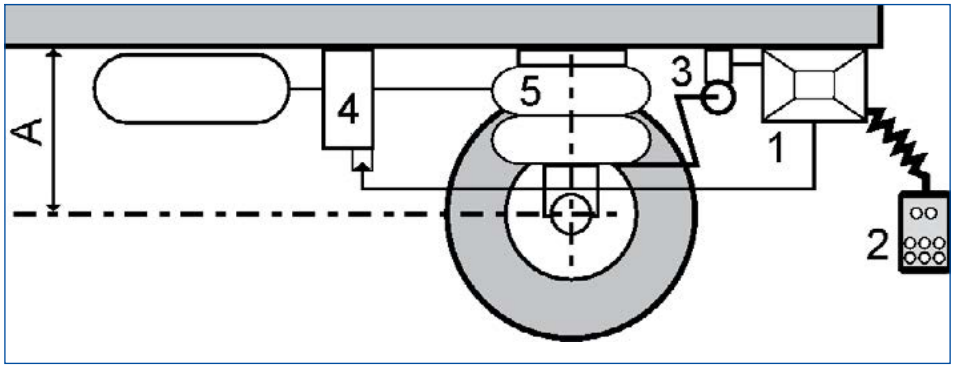
ECAS is an electronically controlled air suspension system with a large number of functions. The use of electronic control units greatly improved the conventional system:

- Reduction of air consumption whilst the vehicle is moving.
- It is possible to maintain different levels (e g ramp operation) by means of automatic readjustment.
- Additional functions like the programmable vehicle levels, tire deflection compensator, overloading protection, traction help and automatic lifting axle control can be easily integrated.
- Due to large valve diameters, pressurizing and venting processes are accelerated.
- Easy operations and maximum safety for those operating the system due to one single remote control unit.
- Highly flexible system due to the fact that electronics can be programmed via operating parameters (trailing end programming).
- Distinctive safety concept and diagnosis facility.

Unlike mechanically controlled air suspension systems in which the valve which measures the height also controls the air bellows, ECAS achieves control by means of an electronic control unit (ECU) which actuates the air bellows via solenoid valves, using the measured values received from sensors.

In addition to controlling the vehicle's level, the ECU, together with the remote control unit, also controls functions which if implemented with conventional air suspension systems, requires a large number of valves.

Example of function – semitrailer without lifting axle



LEGEND			
1	ECU (Electronics)	**2**	Remote control unit
3	Height sensor	**4**	Solenoid valve
5	Air suspension bellows	**A**	Nominal level

Functional description of the basic system

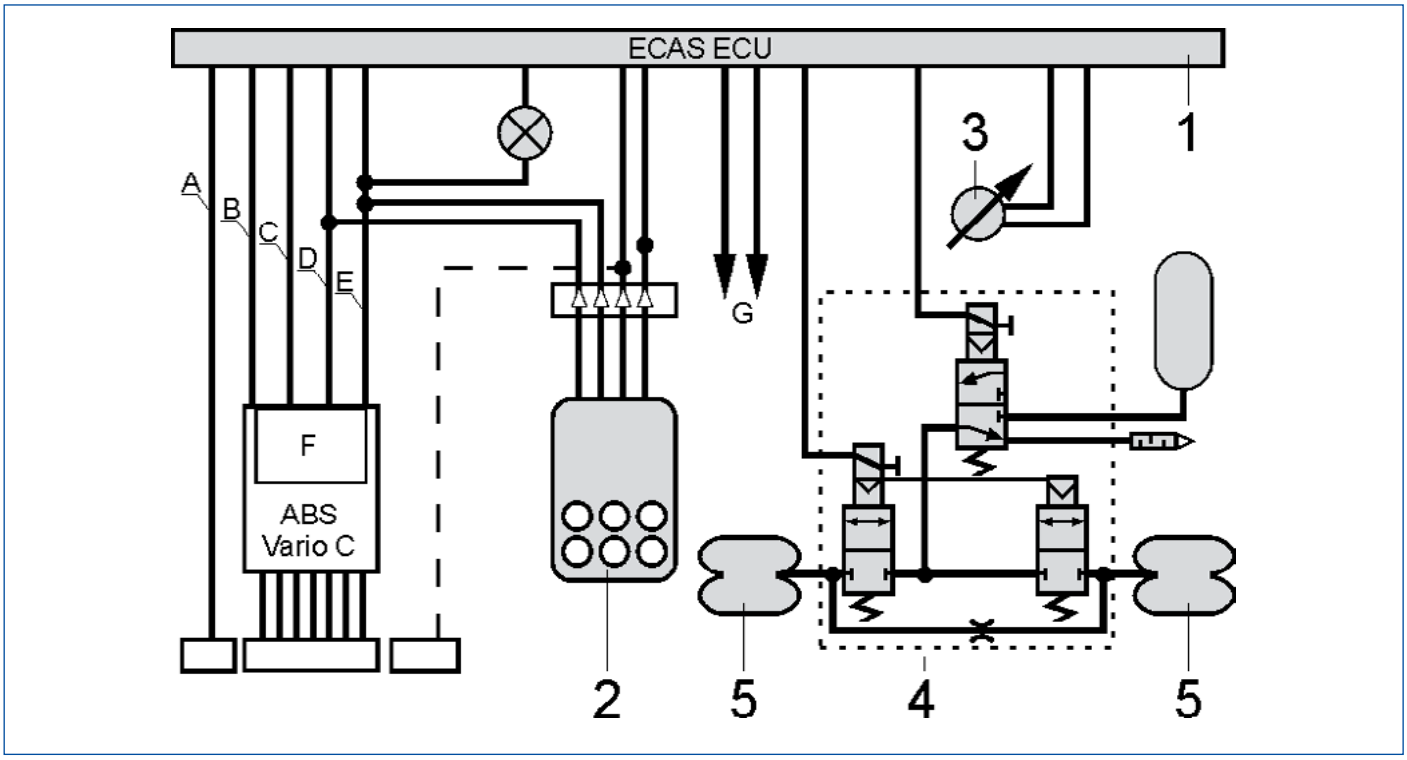
A height sensor (3) constantly records the height level of the vehicle and transmits the measured values to the ECU (1). If the ECU, after evaluating the signals, detects a deviation from the nominal level (A), a solenoid valve (4) is actuated in a manner that implements the required level change by means of pressurising or venting.

Via a remote control unit (2) the user can change the nominal level (A) below a defined speed threshold (when stationary) (important for ramp operation for example).

An signal light is used to notify the driver that the trailer is outside its normal level.

A flashing of this lamp indicates a fault within the systems which was discovered by the ECU (Electronic Control Unit).

Circuit diagram of the basic system



LEGEND			
1	ECU (Electronics)	**2**	Remote control unit
3	Height sensor	**4**	Solenoid valve
5	Air suspension bellows	**A**	Stop light
B	Odometer signal	**C**	Ground
D	Terminal 31	**E**	Terminal 15
F	Supply module ECAS	**G**	Diagnosis

Components

PRODUCT FAMILY	FIGURE	DESCRIPTION
446 170 2XX 0		ECAS ECU
472 890 XXX 0		ECAS solenoid valve
441 050 0XX 0		ECAS height sensor
441 040 00X 0		Pressure sensor

The Electronic Control Unit (ECU)

The Electronic Control Unit is the heart of the system and is connected with the different components on the towing vehicle by means of a 35-pole or 25-pole plug-in terminal. The ECU is located in the driver´s cab.

Together with a plug-in terminal for connecting the ECAS ECU for trailer's to the other components, the ECU is mounted on the trailer's chassis in a protective housing. This protective housing corresponds to the ABS-VARIO-C System. The ECU can be used to implement numerous system configurations. On the connector board, a slot is available for each height sensor, pressure sensor and valve solenoid. Depending on the system variant, parts of the connector board may not be used.

As in the ABS-VARIO-C system the cables are fed through glands in the lower part of the housing.

Function

The design of the ECU includes a microprocessor that only processes digital signals. Memory is allocated to this processor for data management.

The outputs to the solenoid valves and to the signal light are switched via driver modules.

The ECU is responsible for

- constant monitoring of incoming signals
- converting these signals into counts
- comparing these values (actual values) with the stored values (index values)
- calculating the required controlling reaction in the event of a deviation
- activation of the solenoid valves.

The electronics are also responsible for

- managing and storing the various index values (normal levels, memory, etc.)
- data exchange with the RCU and the Diagnostic Controller
- regularly monitoring the function of all parts of the system
- monitoring the axle loads (in systems with pressure sensors)
- plausibility checks on the received error detection signals
- error handling.

In order to ensure swift control reactions to any changes in actual values, the microprocessor cyclically processes a fixed program within fractions of a second, whereby one program cycle fulfils all the above requirements.

This programme is permanently written into a program module (ROM).

However, it accesses numerical values stored in a freely programmable memory. These numerical values, the parameters, influence the computing processes and thus the ECU's controlling reactions. They are used to communicate to the computing program the calibration values, the system configuration and the other preset values for the vehicle and functions.

ECAS solenoid valves

Special solenoid valve blocks have been developed for the ECAS system. The space required and installation time are kept to a minimum by combining several solenoid valves in one compact block.

The solenoid valves are actuated by the ECU as a control element; they convert the applied voltage into a pressurising or venting process, e.g. they increase, reduce or maintain the air volume in the bellows.

Pilot valves are used to achieve a large air throughput. The solenoids initially switch those valves with a small nominal width whose control air is then routed to the piston surfaces of the actual switching valves (NW 10 and/or NW 7).

Different types of solenoid valves are used, depending on the application: For controlling a single axle, one seat valve is sufficient whilst a complex sliding valve is required for controlling the lifting axle.

Both types of solenoid valves are based on a modular principle: The same housing is equipped with different valve parts and solenoids, depending on the application.

ECAS height sensor

The outer structure of the height sensor is similar to WABCO's conventional levelling valve, which means that it can often be fitted in the same location on the vehicle frame (the pattern of the two upper mounting bores is similar to that of the levelling valve).

In the sensor housing there is a coil, in which an armature is moved up and down. The armature is connected via a connecting rod to a cam on the lever's shaft. The lever is connected to the vehicle axle.

If the distance between the body and axle changes the lever is turned, which causes the armature to be moved into or out of the coil. This changes the coil's inductance.

This inductance is measured by the electronic control unit at short intervals and converted into a height signal.

Pressure sensor

The pressure sensor produces a voltage output that is proportional to the applied pressure. The measuring range lies between 0 and 10 bar; a pressure of 16 bar must not be exceeded.

The signal voltage is sent to the ECU via a connecting plug. The sensor must also be fed with a supply voltage from the ECU via a third conductor. The cable harness must be encased in a hose or similar material in such a way that the housing - which is otherwise waterproof - can "breathe".

7.4 ECAS with TEBS E (towed vehicle)

Purpose

The basic function of the ECAS is to compensate for level changes which occur, for example, due to a change in the load status or newly defined nominal values (e.g. from the remote control unit). These control deviations change the distance between the vehicle's axle and its superstructure. ECAS balances these control deviations by means of level control.

Two control circuits can be implemented (1-point or 2-point control since version TEBS E2).

ECAS can be fitted in various trailer types at various configuration levels.

For trailers, power is supplied from the ABS or the EBS system. In addition to that the ABS system, provides ECAS with the so-called C3 signal, i.e. information on the vehicle's current speed.

Components

PRODUCT FAMILY	FIGURE	DESCRIPTION
480 102 06X 0		TEBS E Modulator (Premium) with flange-connected PEM ■ Control and monitoring of the electronic air suspension
446 122 07X 0		Electronic Extension Module ■ In combination with TEBS E Modulator (Premium) ■ For 2-point control (with version TEBS E2 or higher) ■ Not required for 2-point control with TEBS E4 or higher
463 090 5XX 0		eTASC ■ ECAS valve with manual actuation for lifting and lowering ■ Only possible in combination with TEBS E Modulator (Premium) from version EBS E3 and with height sensor.
472 880 0XX 0		ECAS solenoid valve ■ For ECAS 1-point control ■ Control of the ride height on one or multiple axles on parallel circuits (lifting / lowering) ■ The support bellows on the vehicle sides are connected via a cross flow throttle. ■ Multivoltage modulator

PRODUCT FAMILY	FIGURE	DESCRIPTION
472 880 0XX 0		ECAS solenoid valve ■ For 2-point control (with version TEBS E2 or higher) ■ Lifting/lowering on two axles ■ The support bellows on the vehicle sides are connected via a cross flow throttle.
472 880 0XX 0		ECAS solenoid valve ■ For 2-point control (with version TEBS E2 or higher) of the vehicle sides or control of front and rear axle of a drawbar trailer
472 905 1XX 0		ECAS solenoid valve ■ For ECAS 1-point control ■ Control of the ride height on one or multiple axles on parallel circuits (lifting / lowering) ■ Pulse-controlled lifting axle ■ The front axle of a drawbar trailer can be additionally controlled using a valve 472 880 0XX 0.
472 905 1XX 0		ECAS solenoid valve ■ 2-point control (with version TEBS E2 or higher) ■ Control of the ride height on one or multiple axles on parallel circuits (lifting/lowering) ■ Pulse-controlled lifting axle
441 050 1XX 0		Height sensor ■ Measuring the normal level
441 050 XXX 0		Lever ■ Extension for height sensor lever

PRODUCT FAMILY	FIGURE	DESCRIPTION
433 401 XXX 0		Linkage ■ Connection to the axle
446 156 0XX 0		ECAS control box ■ Remote control unit (with 6 buttons) for adjusting the level and the lifting axle control by the driver ■ Installed on the side of the trailer ■ Remote control unit and cable connection must be protected against humidity.
446 056 1XX 0		ECAS remote control unit ■ Control unit (with 9 buttons) for adjustment of the level and the lifting axle control by the driver. ■ Normally installed on the side of the trailer. ■ Remote control unit and cable connection must be protected against humidity.
446 056 2XX 0		ECAS remote control unit ■ Remote control unit (with 12 buttons) for adjusting the level and the lifting axle control by the driver ■ Normally installed on the side of the trailer ■ Remote control unit and cable connection must be protected against humidity.
446 192 XXX 0		SmartBoard ■ Display and operating console for adjusting the level and lifting axle control by the driver ■ Normally installed on the side of the trailer
446 122 XXX 0		Trailer Remote Control ■ Display and operating panel for adjustment of the level and lifting axle control by the driver (from the driver's cab) ■ Only in combination with ELEX and version TEBS E2 or higher.

7.5 Lifting axle control

7.5.1 Dual circuit lifting axle control valve

Design types

PRODUCT FAMILY	FIGURE	DESCRIPTION
463 084 0XX 0		Lifting axle compact valve ■ mechanical
463 084 0XX 0		Lifting axle compact valve ■ electric
463 084 0XX 0		Lifting axle compact valve ■ pneumatic

Purpose

The lifting axle compact valve is responsible for lowering or lifting the lifting axle(s) manually and again automatically, as soon as the axle(s) that are down have reached their maximum permissible load.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 463 084 0XX 0			
Actuation	mechanical	electric	pneumatic
vehicle is being loaded	automatic lowering		
vehicle is being unloaded	lift by pressing button	electric lifting	automatic lifting
Maximum operating pressure [bar]	13		
Nominal width [mm]	Ø 7		
Permissible medium	Air		
Thermal range of application [°C]	-40 °C +80		
Switching pressure setting "lowering" [bar]	2.5 to 7	–	2.5 to 7
Set switching pressure [bar]	4 ± 0.2	–	Lowering 4.5 ±0.2 Lifting 2.5 ±0.2
Adjustable hysteresis	–	–	1.5 to 4
Voltage [V]	–	24 +6/-4.4	–
Current type	–	Direct current	–
Nominal current [A]	–	IN = 0.22	–
Weight	2.3		

7.5.2 Lifting axle compact valve

Design types

464 084 0XX 0 (single circuit, spring-returned)

464 084 1XX 0 (dual circuit, pulse-controlled)

Purpose

Single circuit, spring returned: The conventional lifting axle valve series (spring-returned) has been expanded with the single circuit variant. One lifting axle is actuated automatically depending on the axle load. The "Traction help" function can also be actuated by the Trailer EBS or Trailer ECAS depending on the current axle load. This variant can be used on rigid axles, for which the support bellows can be connected pneumatically for the left and right vehicle sides. Here the specifications of the axle manufacturer must be observed.

Dual circuit, pulse-controlled: With pulse-controlled valves, a special lifting axle actuation is possible, e.g. the lifting axle can be kept in the raised position after the ignition is switched OFF. This is not possible using spring-returned lifting axle valves.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 463 084 0XX 0 (SINGLE CIRCUIT, SPRING RETURNED)			
Maximum operating pressure [bar]	13		
Nominal width [mm]	Ø 8		
Permissible medium	Air		
Thermal range of application [°C]	-40 to +80	-40 to +65	
Voltage [V]	24 +6/-6		
Current type	Direct current		
Nominal current [A]	IN = 0.22		
Weight [kg]	0.9		
Quickfit connections	–	4x Ø8x1	3x Ø8x1; 1x Ø12x1.5

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 463 084 1XX 0 (DUAL CIRCUIT, PULSE-CONTROLLED)	
Maximum operating pressure [bar]	13
Connections: Nominal diameter	1, 21, 22: Ø 10 mm 23, 24, 25: Ø 8 mm 32: Ø 8.7 mm
Permissible medium	Air
Thermal range of application [°C]	-40 to +65
Voltage [V]	24 +6/-4.4
Current type	Direct current
Nominal current [A]	IN = 0.22
Weight [kg]	2.3

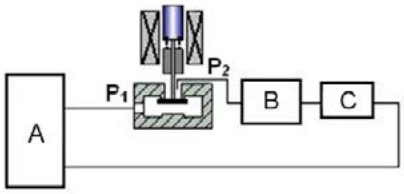
Notes

8 Emission control

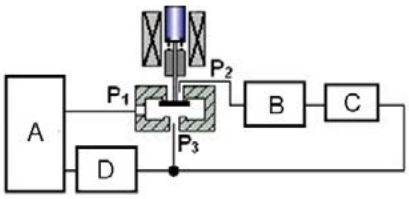
8.1 SCR valve

Design types (12 V / 24 V)

446 091 XXX 0
2/2 directional control valve



446 091 XXX 0
3/2 directional control valve



LEGEND							
A	Engine	**B**	Tank	**C**	Pump	**D**	Dosing unit

Purpose

The SCR valve (Selective Catalytic Reduction) is used to control the temperature of the aqueous urea solution (Ad blue) in SCR system tanks.

In order to be able to carry out the function, the SCR system must be maintained at a specific temperature level. The engine and vehicle manufacturers use the cooling water of the engine for this purpose.

The SCR valve is used to control the flow of cooling water through the system components. It is actuated through the engine's electronic system and controls the flow of cooling water through the SCR system components relative to the outside and coolant temperature.

Depending on the SCR system design (compressed-air assisted, airless), 2/2 or 3/2 directional control valves are used for this purpose.

Technical data

EXAMPLES OF VARIANTS FOR PRODUCT FAMILY 446 091 XXX 0				
Function	2/2 directional control		3/2 directional control	
Couplings	2x Voss 246	2x Norma (PS3 connection)	3x Voss 246	2x Norma (PS3 connection) 1x Voss 246
Electronic connector	Tyco HDSCS			

8.2 ACU (Air Control Unit)

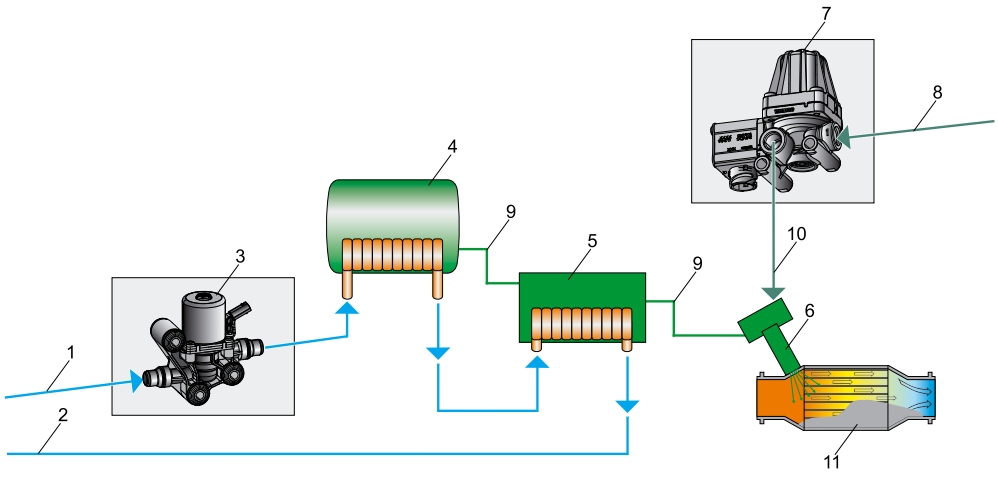
975 009 XXX 0

Purpose

The Air Control Unit (ACU) integrates three functions in one valve to control the compressed air for the injection of the urea solution (Ad blue):

- Pressure limiting valve
- Solenoid valve
- Check valve

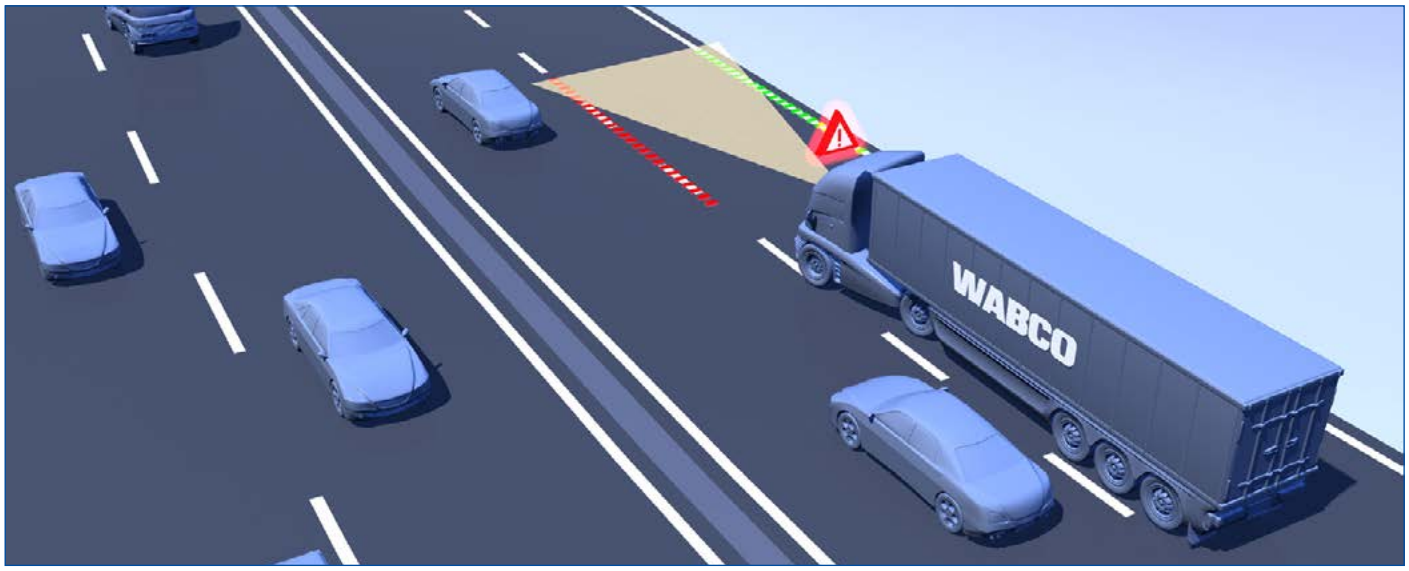
8.3 SCR functional diagram (compressed-air assisted)



LEGEND			
1	Cooling water feed line from engine	**2**	Cooling water return line to pump
3	SCR valve	**4**	Urea solution (Ad blue) - Tank
5	Urea solution (Ad blue) - Pump	**6**	Urea solution (Ad blue) - Injector
7	ACU (Air Control Unit)	**8**	Air supply
9	Urea feed line	**10**	Air line
11	Urea solution (Ad blue) - Catalyst		

9 Driver assistance systems

9.1 OnLane (lane departure warning)



Remain on track with WABCO's lane departure warning system (LDWS)

WABCO OnLane™ is a lane departure warning system specially developed for trucks and buses. It increases vehicle safety by warning the driver through visual, audio or vibration signals when he accidentally leaves the lane. This is the most frequent cause of accidents with commercial vehicle involvement.

OnLane is WABCO's first in a whole series of camera functions that will enable new safety functions such as driver fatigue warning, traffic sign detection and high beam control.

Benefits

Safety

- Helps to reduce the number of accidents
- Meets the requirements of EU regulations for LDWS (lane departure warning systems)

Flexible vehicle applications

- Camera can be mounted at the bottom or the top of the windscreen
- Compact design: ECU already integrated in the camera

Future integration of additional functions possible

- Beam width control
- Driver fatigue warning
- Traffic sign detection

Features

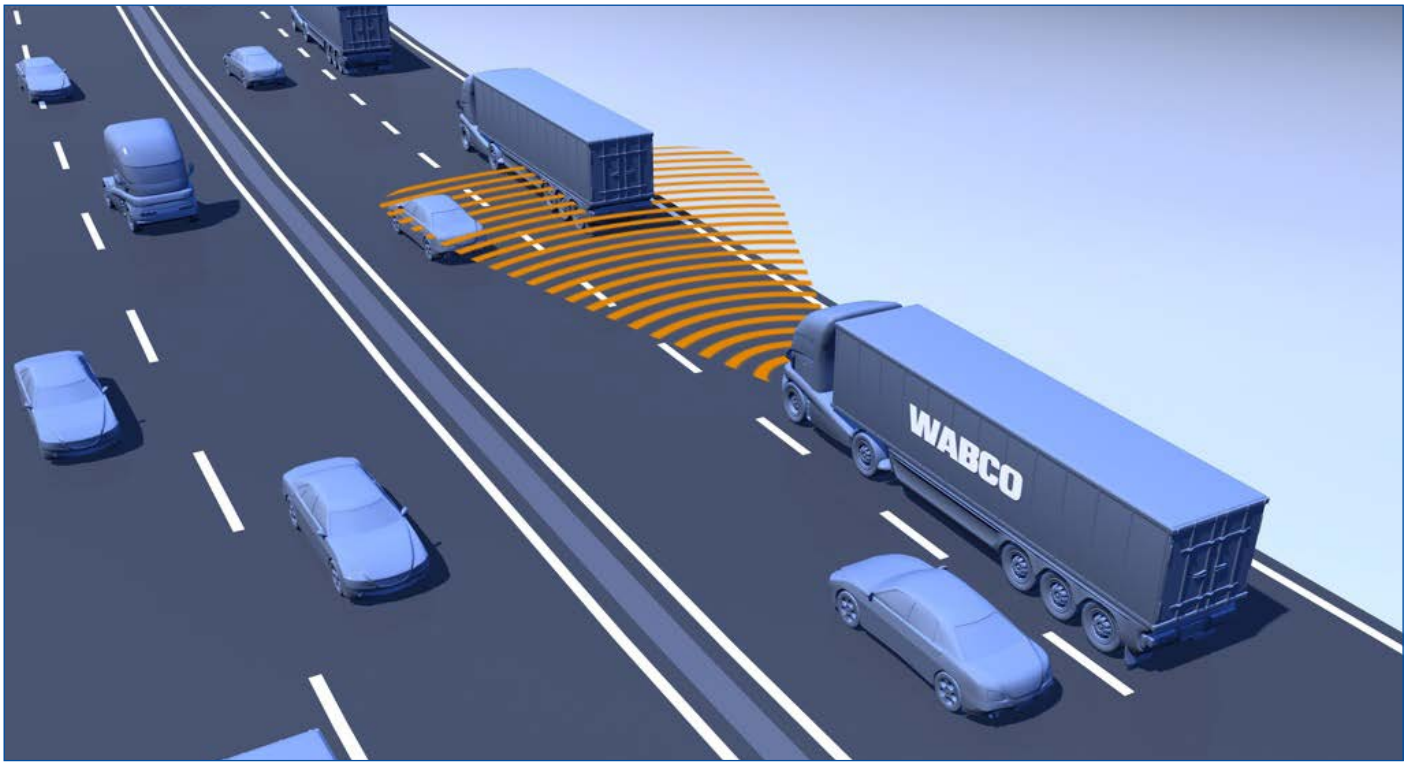
- Effective warning system when accidentally leaving the lane

- Camera-based detection of road markings and corresponding vehicle position
- System is activated at speeds from 60 km/h
- Complies with current EU regulation no. 351/2012
- Warning signal options range from visual (via light) over audio (sound signal) to haptic (via seat vibration) signals
- Optimised housing for use in trucks and buses
- Optional additional functions such as driver fatigue warning, beam width control and traffic sign detection will be available soon.

System components

COMPONENT	SET 1 446 069 010 0	SET 2 446 069 020 0	SET 3 446 069 910 0
Camera with connector cable 	✔		
Mounting bracket (angle range 75-90°, windscreen inclination) Mounting bracket (angle range 60-75°, windscreen inclination) 	✔		✔
2x T-15 Torx cap screw, 1x secondary lock A, 1x secondary lock B, 1x bushing housing, 16x bushing connecting pins (18 AWG), 16x bushing connecting pins (20 AWG)	✔		
Switch 		✔	
Speaker 		✔	
Cable harness 		✔	
Installation kit		✔	

9.2 ACC (Adaptive Cruise Control)



Safety and comfort through intelligent cruise control

The adaptive cruise control system (ACC) was specially developed for commercial vehicles. It enables the driver not only to control the vehicle speed, but also adjusts the speed adaptively. If a vehicle in the same lane in front of the truck slows down, ACC adjusts the speed of truck so that the safety distance is maintained.

Features

- Extension of standard speed control systems
- Regulates the constant and safe distance to vehicles ahead
- Enables the driver to define a vehicle speed as well as the trailing distance
- Controls the engine and the brakes
- Includes advance collision warning
- Advance collision warning is permanently "on", even when ACC is deactivated

Benefits

- Increases general driving safety by maintaining a safe distance to the vehicle ahead
- Reduces lining wear
- Reduces fuel consumption
- Reduces vehicle downtime

9.3 OnGuard (collision protection system)

Difference due to active brake intervention

OnGuard™ was the first collision protection system with active brake intervention for commercial vehicles. This innovative system can automatically maintain a safe distance to the vehicle driving ahead and helps to reduce the severity of rear-end collisions through appropriate brake intervention.

The OnGuard™ system can activate the brakes even before the drivers actuates them if an unsafe distance is detected between the truck and the surrounding traffic. This reduces the time until the required braking pressure is built up. The additional time can help to avoid collision and significantly reduce the consequences.

Its radar sensor technology uses an integrated yaw rate sensor to detect if the vehicle is driving through a corner. On this basis, the prognosis for the route taken is adjusted to identify as relevant objects that are also located in the course of the corner.

Features

- Collision prevention system with automatic partial braking in situations that threaten a collision
- The integrated adaptive cruise control unit ACC helps to save fuel
- The warning function for rear-end collisions is always switched on and active
- The system brakes the vehicle in the event potential collision situations when driving as well as decelerating vehicles are involved
- The system reduces the collision energy
- Distance warning, warning function for rear-end collisions and collision mitigation are available

Benefits

Safety

- Reduces the risk of accidents
- Increases driving safety

Operating safety

- Reduces repair costs
- Reduces vehicle downtime

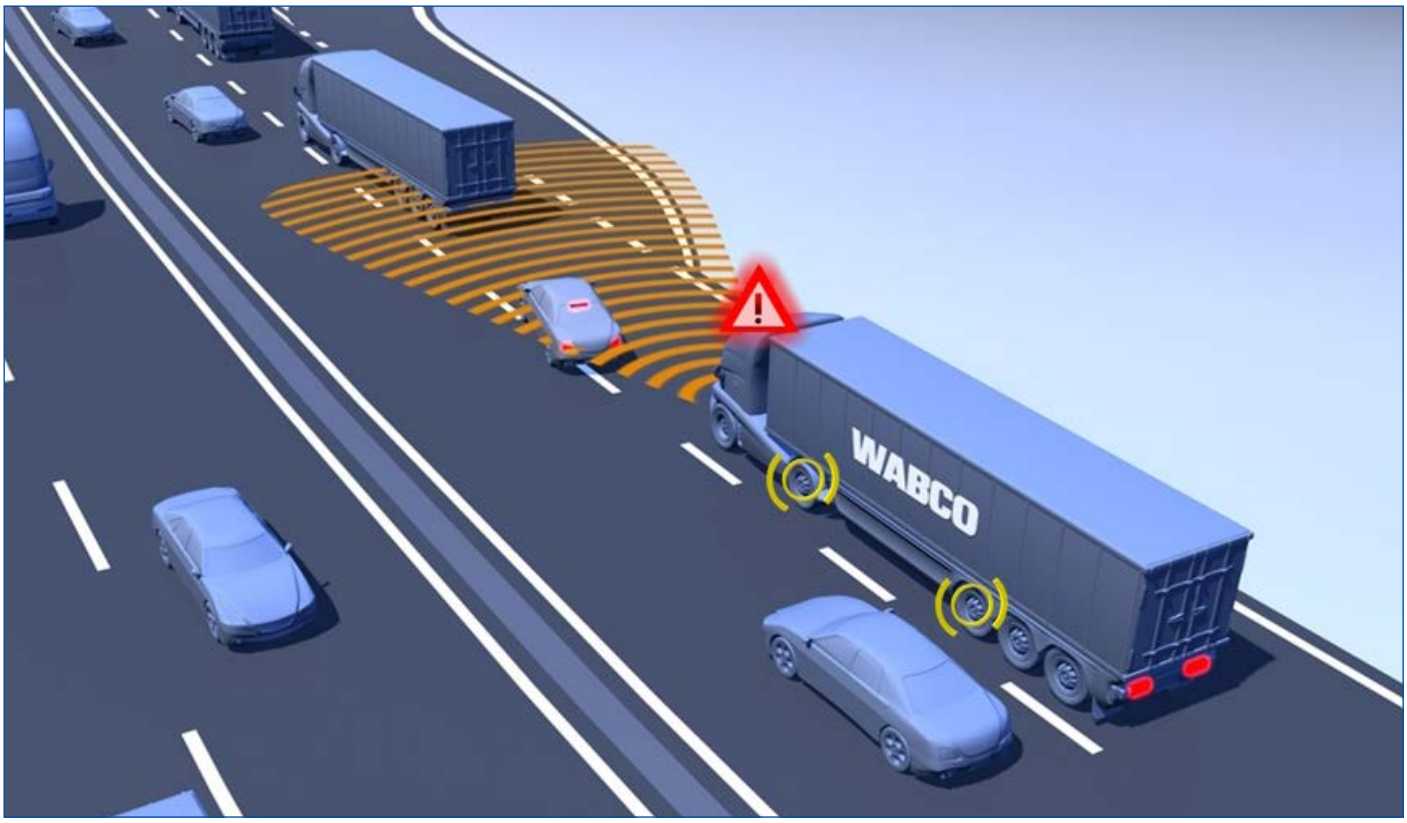
Flexibility

- Tested options for system integration into additional driver assistance, brake and vehicle electronics systems

Performance

- The first collision mitigation system on the US market
- Already used by 50 major US fleet operators
- Minimised erroneous signalling behaviour

OnGuard*PLUS*™



Solution for collision mitigation complies with European regulations

WABCO OnGuard*PLUS*™ is a highly modern emergency braking system (AEBS) that was developed especially for commercial vehicles.

OnGuard*PLUS*™ enables fully autonomous brake interventions for driving or decelerating objects. In the case of stationary vehicles, it is also equipped with warning and extended brake assistance functions. It automatically initiates fully autonomous emergency braking, thereby enabling maximum possible deceleration and can bring the vehicle to a complete standstill.

OnGuard*PLUS*™ is the first commercial vehicle system of the industry that complies with European directives.

Features

- Complies with the regulations of the European Union for AEBS
- Emergency braking assistance system helps to avoid collisions with vehicles driving ahead
- Integrated ACC function helps to lower fuel consumption
- Advance collision warning is permanently "on"
- Responds to vehicles driving ahead as well as ones that are decelerating
- Initiates partial braking when stationary vehicles are detected
- Informs the driver via acoustic, optic or haptic warning signal
- Helps to mitigate or avoid the consequences of accidents

Benefits

Automatic alignment

- Does not require manual configuration at the end of the line or in the workshop
- Can also be used for vehicles without air suspension

Compact design

- No separate ECU required
- No camera required

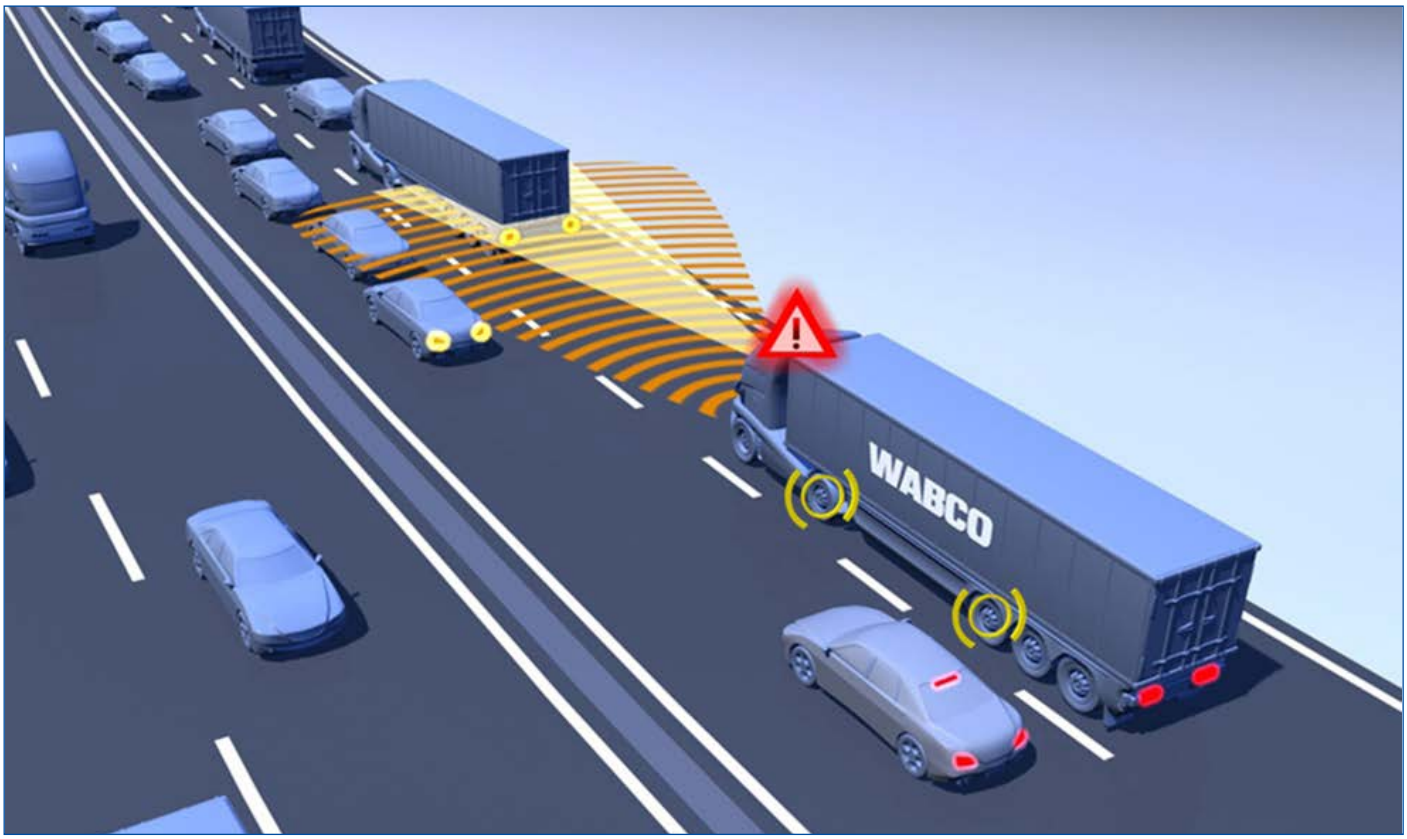
Flexibility

- Can be used for EBS and ABS braking systems (pneumatic, hydraulic & AoH)
- Can be used with and without RSC and ESC
- Options of extended functions

Performance of the radar detection range

- Ready for subsequent data fusion
- Highly developed radar sensor technology
- Reduced braking distance
- Accident braking

OnGuardMAX™



Autonomous emergency braking for driving and stationary vehicles

Rear-end collisions are one of the most frequent accident types with commercial vehicles. The groundbreaking technology of OnGuardMAX™ from WABCO is the first system of the industry for fully autonomous emergence braking (AEB) in the event of an impending collision with a stationary vehicle or a vehicle in motion.

The innovative OnGuardMAX™ system reduces the risk of collisions with driving or stationary vehicles by means of a multi-stage warning concept and autonomous braking.

The system included Adaptive Cruise Control, collision warning and the lane departure warning system.

Features

- Fully autonomous emergency braking
- Integrated ACC function helps to lower fuel consumption
- Advance collision warning is permanently active
- Combined distance sensor and front camera enable the system to register vehicles driving ahead of the truck as well as stationary ones.
- Emergency braking is initiated prior to colliding with driving or stationary vehicles

Benefits

Automatic alignment

- Does not require manual configuration
- Can also be used for vehicles without air suspension
- Single unit radiator grill concept possible

Flexibility

- Can be used with EBS or ABS braking systems (pneumatic, hydraulic & AoH)
- Can be used with and without RSC and ESC
- Options of extended functions

Performance

- Full braking when stationary vehicles are detected

Radar observation range

- Ready for stop & go function without additional sensors
- Benefit of data fusion
- Highly developed radar sensor technology
- Reduced braking distance
- Accident braking

9.4 TailGUARD (Reverse monitoring system Main level)

Purpose

TailGUARD™ reduces risk when reversing by detecting small, large, stationary and moving objects in the blind spot behind the vehicle. The system stops the vehicle automatically at a safe distance.

The system reduces stress when reversing and helps to prevent collisions with objects/persons behind the trailer.

The integration of TailGUARD™ in die WABCO brake technology provides the following functions: automatic stop before objects, automatic braking when the speed is too high, the option to program the distance and an intelligent communication between towing vehicle and trailer.

The Trailer Remote Control is a display and remote control unit that is installed in the driver's cabin. It increases the driver's comfort and vehicle efficiency.

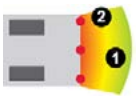
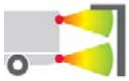
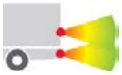
Trailer

- Combination for Trailer EBS E (version 2 or higher)
- Can be retrofitted in vehicles with Trailer EBS E Premium as of Version 2
- System is independent of the towing vehicle due to indication via side marker lamps or Trailer Remote Control

Towing vehicle

- Independent system for ABS and EBS vehicles
- Retrofitting possible

Recommended configurations for different logistics environments and trailer types

FEATURES	TailGUARD™	TailGUARD ROOF™	TailGUARDMAX™
Typical logistical environment	Loading ramps and large objects, such as palettes, vehicles and posts of metal or wood that vary in shape and size and are unknown to the driver.	Areas with restricted heights: e.g. warehouses, loading gates, trees and roof constructions.	Areas with small and / or moving objects: e.g. forklift loading, street signs, shops, residential areas. Tested to ISO 12155.
Number of ultrasonic sensors (dot = sensor)	3x 	5x 	6x 
Area covered by sensors (View from top of vehicle)	 Complete rear of the vehicle is covered by sensors. 1 and 2 indicate Objects behind the vehicle.		
Area covered by sensors (side view)			
Each bar represents a distance of 50 cm. Red: 0 to 150 cm Yellow: 150 to 300 cm Green: 300 to 450 cm In close proximity (red LEDs) the following also applies: Each LED has 2 states, constant and flashing. This indicates the distance with a precision of 25 cm.	 Indication on the Trailer Remote Control	 Display Floor height  Display Roof height The level with nearest object will be displayed.	 Indication on the Trailer Remote Control
Sensitivity of sensors	Big moving objects are detected independent of one another and displayed.	Objects at ground level and roof level are detected and displayed, independent of one another.	Small moving objects are detected independent of one another and displayed.

Main components

PRODUCT FAMILY	FIGURE	DESCRIPTION
Towing vehicle and trailer		
446 122 07X 0		Electronic Extension Module ■ Control electronics
446 122 4XX 0		Ultrasonic sensor ■ Variants: 0°; 15° (default setting: right/left) ■ Quantity depends on the respective configuration
Towing vehicle		
446 122 08X 0		Trailer Remote Control ■ Indication and remote control unit ■ Installed in the driver's cabin

9.5 OptiTire (tire pressure monitoring)

Purpose

OptiTire™ constantly monitors wirelessly the pressure and temperature on all wheels of a vehicle.

OptiTire™ transmits the information via radio or CAN bus to the vehicle ECU and the dashboard.

Benefits

- Early detection of leaks due to burst tires can prevent accidents and reduce downtimes.
- Maximises the service life of tires by maintaining the recommended tire pressure.
- First system for commercial vehicles that can handle external as well as internal wheel sensors.
- Reduces fuel consumption by up to 2 %.
- Easy to retrofit and compatible with IVTM.
- Suitable for commercial vehicles and road trains.

Main components

PRODUCT FAMILY	FIGURE	DESCRIPTION
446 220 1XX 0		ECU ■ Monitors the signals and information from the wheel sensors and signals malfunctions wirelessly to the display on the dashboard.
960 732 XXX 0		Internal sensor ■ Monitors and measures temperature and pressure of the tire and transmits the data to the ECU.
960 731 XXX 0		External sensor ■ Monitors and measures the pressure of the tire and transmits the data to the ECU.

10 Accessories

10.1 Couplings, pipes and hoses

Document "Coupling Catalogue"

– Open the WABCO INFORM online product catalogue: http://inform.wabco-auto.com

– Search for the documents by entering the document number 815 010 080 3.

Please note that publications are not always available in all language versions.

10.2 Cable

Cable overviews

– Open the WABCO INFORM online product catalogue: http://inform.wabco-auto.com

– Find the overviews by entering the index word "cable".

– Please select "Cable" and then click on "Overview".

11 Data sheets / Forms

11.1 Data sheet for Air-Over-Hydraulic converter

WABCO

Application Data Sheet
for Air-Over-Hydraulic Converter

Date _____

Name _____ Title _____

Company _____

Address _____ Country _____

Email _____ Phone _____

Is this a military application? ☐ Yes ☐ No If yes, what is the destination country? _____

Is this a deep mining application? ☐ Yes ☐ No

Vehicle Specification

Type of vehicle _____ Name and model number _____

Estimated annual production volume min. _____ max. _____

Gross vehicle weight *kg* _____ Empty vehicle weight *kg* _____ Wheel base *m* _____

Maximum speed *k.p.h* _____

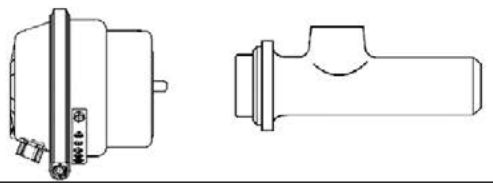
Countries of use _____

Braking standards and regulations _____

AOH-Converter Specification

Max. Air pressure bar	Max. Hydr. Pressure bar	Effective displacement cm^3	Fluid type

ABS qualified yes / no	Reservoir yes / no	MC Thread size inlet	MC Thread size outlet	Mounting space L / W / D (mm)



11.2 Data sheet for pump accumulator braking systems

WABCO

Application Data Sheet

for Hydraulic Full Power Brake Systems

Date _____

Name _____ Title _____

Company _____

Address _____ Country _____

Email _____ Phone _____

Is this a military application? ☐ Yes ☐ No If yes, what is the destination country? _____

Is this a deep mining application? ☐ Yes ☐ No

Vehicle Specification

Type of vehicle _____ Name and model number _____

Estimated annual production volume min. _____ max. _____

Gross vehicle weight *kg* _____ Empty vehicle weight *kg* _____ Wheel base *m* _____

Maximum speed *k.p.h* _____

Countries of use _____

Braking standards and regulations _____

Hydraulic Brake Specification

Service Brake ☐ Single-circuit ☐ Dual-circuit

Service brake pressure *bar max.* _____ Auxiliary brake pressure *bar* min. _____

Parking Brake ☐ No

☐ Yes SAHR type ☐ No Parking brake pressure *bar* min. _____ max. _____

☐ Yes Release pressure *bar* min. _____ max. _____

Pushrod force *N min.* _____ max. _____

Load Sensing: ☐ Yes ☐ No

Pump flow *l/min* min. _____ max. _____ Pump pressure *bar* max. _____

Operating temperature *°C* min. _____ average _____ max. _____

System fluid used _____ Fluid manufacturer and brand name _____

Wheel brake type _____ Wheel brake manufacturer _____

Wheel brake consumption volume per circuit cm^3 max. _____ min. _____

Parking brake type _____ Parking brake manufacturer _____

Parking brake consumption volume cm^3 max. _____ min. _____

ABS / ETC Requirements

Type of system ☐ ABS ☐ ETC ☐ Both

Nominal voltage ☐ 12 VD ☐ 24 VD Other _____

Number of drive wheels ☐ 4 x 4 ☐ 6 x 6 ☐ 8 x 8 Other _____

Protection class ☐ IP 65 ☐ IP 67 Other _____

11.3 Data sheet for hydraulic master cylinder

WABCO

Application Data Sheet

for Hydraulic Master Cylinder

Date _____

Name _____ Title _____

Company _____

Address _____ Country _____

Email _____ Phone _____

Is this a military application? ☐ Yes ☐ No If yes, what is the destination country? _____

Is this a deep mining application? ☐ Yes ☐ No

Vehicle Specification

Type of vehicle _____ Name and model number _____

Estimated annual production volume min. _____ max. _____

Gross vehicle weight *kg* _____ Empty vehicle weight *kg* _____ Wheel base *m* _____

Maximum speed *k.p.h* _____

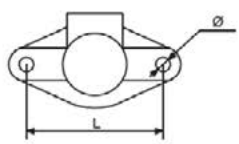
Countries of use _____

Braking standards and regulations _____

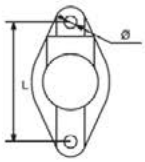
Mastercylinder Specification

Flange pattern A/B/C/D/E/F	Flange hole Ø mm	L mm	L1 mm	L2 mm	J °	Fluid type

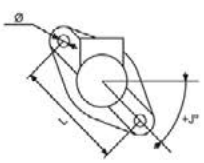
MC Bore Ø mm	Max. Pressure bar	Min. Displacement cm^3	Lenght mm	ABS qualified yes / no	Max. Stroke mm	Thread size inlet	Thread size outlet



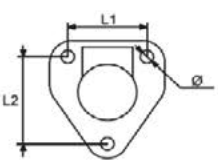
A



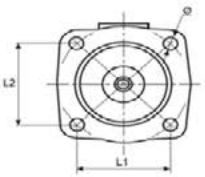
B



C



D



E

OTHER

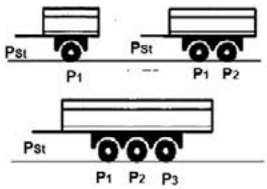
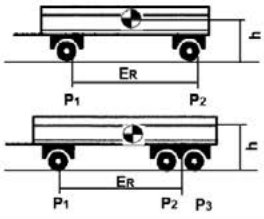
F

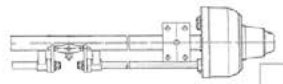
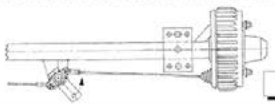
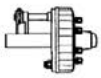
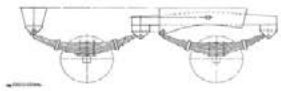
11.4 Brake calculation for agricultural or forestry vehicles

WABCO

Brake calculation data sheet (national regulations) for agricultural or forestry trailers

Please ☐ mark with a cross!

vehicle manufacturer:				trailer type:	
max. speed	☐ up to 25 km/h		☐ 25 km/h up to 40 km/h		
	☐ 40 km/h up to 60 km/h		☐ more than 60 km/h (ABS required)		
country of approval:			☐ single line	☐ twin line	
centre-axle trailer				laden	unladen
	max. total mass	P	kg		
	drawbar load	P_{St}	kg		
	actual axleload axle 1	P_1	kg		
	actual axleload axle 2	P_2	kg		
	actual axleload axle 3	P_3	kg		
	actual axleload axle 4	P_4	kg		
full trailer				laden	unladen
	max. total mass	P	kg		
	actual axleload axle 1	P_1	kg		
	actual axleload axle 2	P_2	kg		
	actual axleload axle 3	P_3	kg		
	centre of gravity height	h	mm		
	existing wheel base	E_R	mm		

brake type	bogie type		
s-cam brake	bogie	assembly without dyn. compensation	
 ☐	 ☐	 ☐	
spread-lever brake	stub-axle	assembly with dyn. compensation	
 ☐	 ☐	 ☐	

wheel brake manufacturer:	(BPW / Knott / Peitz / ADR ...) TDB-no.:					
wheel brake type:	(see type label on anchor plate)					
tyre size:	tyre manufacturer:					
load apportioning with:	☐ load apportining valve	☐ load sensing valve				
in case of LSV:	☐ in front of trailer control v.	☐ behind trailer control valve				
	☐ ABS (VCS)	☐ EBS				
desired cylinder:	☐ piston cylinder	☐ brake chamber	☐ TRISTOP®			
which axle shall be braked ?		axle	1 ☐	2 ☐	3 ☐	4 ☐
cylinder quantity:		(1 o. 2)				
possible lever length		(mm)				

sender:	further informations:
name:	
phone:	
fax:	
e-mail:	

Please fill in clear and complete, otherwise it is not possible to make a brake calculation!

11.5 Technical questionnaire Disc brake

WABCO

Technichal Questionnaire
Disc Brake

Companyname					
Requestor name					
phone#					
e-mail					
Address					
Project title					
Vehicle type:	Trailer				
Annual quantity:				**Date of job one**	
Additional information					

Basis/Base	1				
Vehicle Data		Wheel size: 22,5: 19,5: 17,5: other			
		Dynamic radius		tyre radius	[m]
		Cross vehicle weight			[kg]
Number of axles		Front		Rear	
		Axle load			
Unladen		Front		Rear	[kg]
Laden		Front		Rear	[kg]
		Height: Center of gravity			[m]
Additional information		Wheel base			[m]

Brake system	Air	**Medium**			
		ABS			
		EBS			
		Mechanic			
Additional information		Max. pressure		Minimum pressure	[bar]

Requirements		Maximum Speed			[km/h]
		Maximum deceleration			[m/s²]
from		[km/h]	to 0		
		Up/Down			[%]
		Legal requirements			
		ECE R13			
Additional information		FMVSS			

Additional Information	Line Haul			**Vocational applications**
Max air chamber size		Service		Spring
		Engine brake		
		2D assembling drawing		3D assembling drawing
Additional information		Retarder/Jake brake		Permanent

11.6 Brake calculation for trailers

WABCO

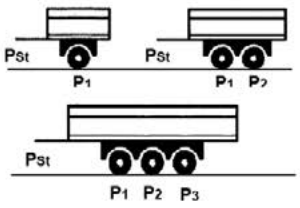
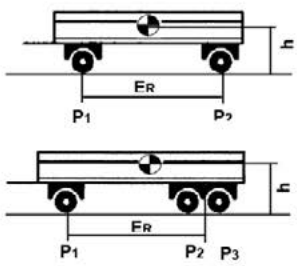
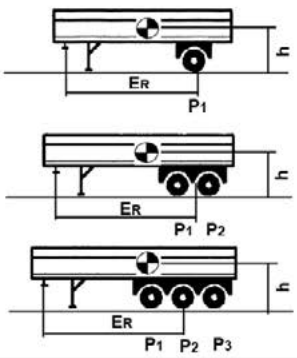
Technical vehicle data

for the brake calculation of trailers

1/2

vehicle manufacturer: | **type:**

approvel as per: EG / ECE ☐ other ☐ **max. speed** ☐

	designations			laden	unladen
centre-axle trailer					
	maximum mass	P	kg		
	drawbar load	P_{St}	kg		
	axleload axle 1	P_1	kg		
	axleload axle 2	P_2	kg		
	axleload axle 3	P_3	kg		
full trailer					
	maximum mass	P	kg		
	axleload axle 1	P_1	kg		
	axleload axle 2	P_2	kg		
	axleload axle 3	P_3	kg		
	centre of gravity-height	h	mm		
	exist wheel base	E_R	mm		
	range of wheel base	E_R	mm		
semitrailer					
	maximum mass min.	P	kg		
	maximum mass max.	P	kg		
	axleload axle 1	P_1	kg		
	axleload axle 2	P_2	kg		
	axleload axle 3	P_3	kg		
	centre of gravity-height	h	mm		
	exist wheel base	E_R	mm		
	range of wheel base	E_R	mm		

axle:			1	2	3	
brake chamber: numb./type	K_{DZ}					
possible lever lengths	l_{BH}	mm				
drum/disk radius	r_{Bt}	mm				
C* or brakefactor						
mechanical efficiency	η	%				
cam radius	r_{Bn}	mm				
dynamic tyre radius min.	r_{dyn}	mm				
or exist						
tyre type max.						
threshold torque	M_{AL}	Nm				

axle manufact.: | **type:** | **test report number:**

brake size: *With "standard axles", only the manufacturer and the test report number necessary !*

WABCO-brake diagram-no.: | *Axle bogie see page 2 !*

self steering axle: ☐ | **spring brake:** ☐ | **ABS VCS:** ☐ | **EBS :** ☐

WABCO

Technical vehicle data

for the brake calculation of trailers

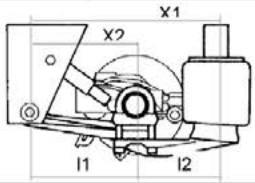
2/2

axle bogie

manufacturer:

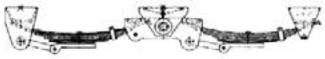
type:

air suspension

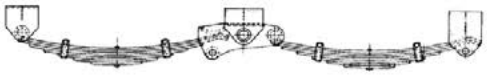


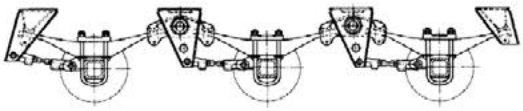
	distance l1 / l2 [mm]:	/
or	distance X1 / X2 [mm]:	/
	bag diameter [mm]:	
	drawing-no.:	

leaf spring bogie (with dyn. compensation)



leaf spring bogie (without dyn. compensation)





balance beam bogie

individual axles mechanical

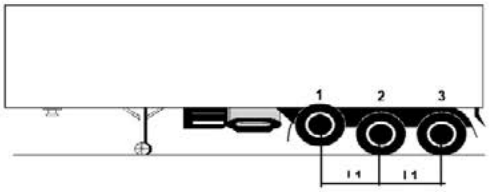
In case of another axle suspension, please add bogie drawing !

bag pressure [bar]:	**laden**	/ **unladen**
front axle:		
rear axle(s):		

spring deflection [mm]:	
front axle:	
rear axle(s):	

semitrailer with lift axle/s

In combination with EBS, data not required !



axle	1	2	3
which axle/s shall be lifted [x]:			
wheel base l1 [mm]:			
bag pressure laden [bar]:			
bag pressure unladen (with axle/s lifted) [bar]:			
bag pressure unladen (all axle/s on bottom) [bar]:			
axle load unladen (with axle/s lifted) [kg]:			
axle load unladen (all axle/s on bottom) [kg]:			

remarks:

company:	**street:**
name:	**city:**
telephone:	**telefax:**
e-mail:	

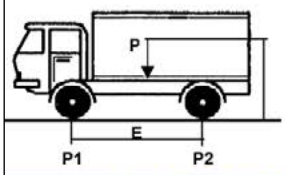
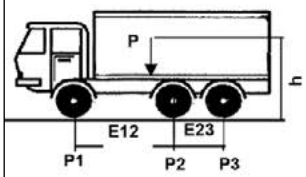
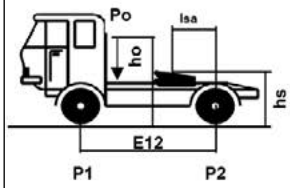
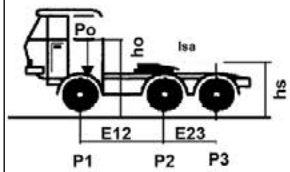
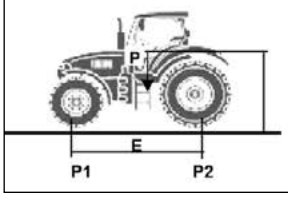
11.7 Brake calculation for trucks, tractor units, crane vehicles and tractors

WABCO

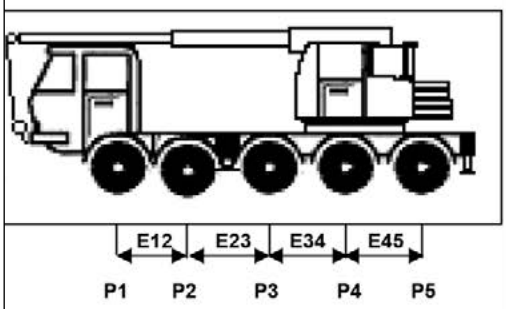
Technical Vehicle Data

for the brake calculation of trucks and tractors

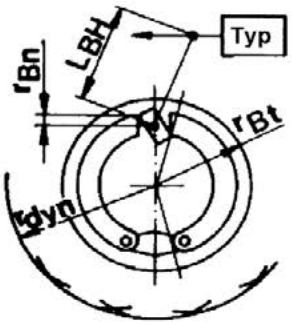
Vehicle Manufacturer: | **Type:**

	Designation			Laden	Unladen
2-axle Truck / Bus	Maximum mass	P	kg		
					
	Axle load axle 1	P1	kg		
	Axle load axle 2	P2	kg		
	Centre of gravity-height	h	mm		
	Wheel base	E	mm		
3-axle Truck / Bus	Maximum mass	P	kg		
					
	Axle load axle 1	P1	kg		
	Axle load axle 2	P2	kg		
	Axle load axle 3	P3	kg		
	Centre of gravity-height	h	mm		
	Distance axle 1-2	E12	mm		
	Distance axle 2-3	E23	mm		
Semi-trailer Tractor	Empty mass	Po	kg	-------	
	Maximum mass	P	kg		-------
					
	Axle load axle 1	P1	kg		
	Axle load axle 2	P2	kg		
	Centre of gravity-height	ho	mm		
	Kin pin height	hs	mm		
	Distance king pin	lsa	mm		
	Distance axle 1-2	E12	mm		
Semi-trailer Tractor	Empty mass	Po	kg	-------	
	Maximum mass	P	kg		-------
					
	Axle load axle 1	P1	kg		
	Axle load axle 2	P2	kg		
	Axle load axle 3	P3	kg		
	Centre of gravity-height	ho	mm		
	King pin height	hs	mm		
	Distance king pin axle 3	lsa	mm		
	Distance axle 1-2	E12	mm		
	Distance axle 2-3	E23	mm		
2-axle Tractor	Maximum mass	P	kg		
					
	Axle load axle 1	P1	kg		
	Axle load axle 2	P2	kg		
	Centre of gravity-height	h	mm		
	Wheel base	E	mm		

5-axle AT crane



Maximum mass		P	kg		
Axle load axle 1		P1	kg		
Axle load axle 2		P2	kg		
Axle load axle 3		P3	kg		
Axle load axle 4		P3	kg		
Axle load axle 5		P3	kg		
Centre of gravity-height		h	mm		
Distance axle 1-2		E12	mm		
Distance axle 2-3		E23	mm		
Distance axle 1-2		E34	mm		
Distance axle 2-3		E45	mm		
Length/width/height		L/B/H	mm		



Axle:				1	2	3	
1	Characteristic value C*						
2	Mechanic efficiency	Eta	%				
3	Brake drum radius	rBt	mm				
4	Cam radius	rBn	mm				
5	**Brake factor**						
6	Dynamic tire radius	rdyn	mm				
7	No.of brake cyliner per axle	n					
8	Lenght of brake lever	LBH	mm				
9	Brake chamber, type						
#	Threshold torque	MAL	Nm				

either 1+2+3+4 or 5

Braking system : (Please indicate circuiting and part numbers of the brake devices)

for modified vehicles (e.g. with front / trailing axle): setting values of the load sensing valve according to LSV cable

11.8 Questionnaire for project planning of an off-highway vehicle

WABCO **Data - Entry - Form**
for develpoping an Off Highway Vehicle

☐ please mark with a cross !

Company:	**Postal Code:**
Official in Charge:	**Street:**
E-Mail Addr:	**Phone- No.:**
WABCO-Customer- No.:	**FAX:**

Vehicle Manufacturer:			**Vehicle - Type**		
Country of first Registration:			**Special Regulations** e.g. Underground. Dangerous Goods		
Maximum Speed:	_____ km/h		_____		
Permissible maximum Weight	≤ 3,5 t ☐	≤ 8 t ☐	> 8 t ☐	< 10 t ☐	> 10 t ☐

Pneumatic Brake Sytem				
Vehicle Type:	**w/o Electronic**	**AoH**	**ABS**	**EBS**
Motor Vehicle	☐	☐	☐	☐
Mobil Crane	☐	☐	☐	☐
Drawbar Trailer	☐	☐	☐	☐
Central Axle Trailer	☐	☐	☐	☐
Semi Trailer	☐	☐	☐	☐
AG Tractor *)	☐	☐	☐	☐
Implements	☐	☐	☐	☐
AG Towed Machines	☐	☐	☐	☐
Construction- / Mining Vehicle	☐	☐	☐	☐

Hydraulic Brake System			
Vehicle Type:	**Master Cyl.**	**FPB**	**Optional with ABS**
Motor Vehicle	☐	☐	☐
Mobil Crane	☐	☐	☐
Drawbar Trailer	☐		☐
Central Axle Trailer	☐		☐
Semi Trailer	☐		☐
AG Tractor *)	☐	☐	☐
Implements	☐	☐	☐
AG Towed Machines	☐		☐
Construction- / Mining Vehicle	☐	☐	☐

*) Needed information for AG tractors (important to find the right Trailer Control Valve)
Hydraulic brake pressure at 35% deceleration _____ bar (up to 25 km/h)
Hydraulic brake pressure at 50% deceleration _____ bar (above 25 km/h)

Number of Axles: _____	Which axles are **Driving axles**? _____
Which Axles are Standard - **Trailling axles** ? _____	Which axles are **Steering axles?** _____
Which Axles are **Lift axles**? _____	Which axles are **Tag axles** ?**) _____

**) Axles with ventilated Air Bellows but not lifted

Type of Wheel Brake:	**Drum Brake**		**Disc Brake**		
	pneumatic ☐	hydraulic ☐	pneumatic ☐	hydr. Wet ☐	hydr. Dry ☐
	Wedge ☐	S-Cam ☐			

WABCO	**Data - Entry - Form** **for develpoping an Off Highway Vehicle**

Vehicle Suspension			
Mechanic ☐	Hydraulic ☐	Pneumatic ☐	Hydro-Pneumatic ☐

Air compressor on board ?			
Yes, ☐ (please cross)		Flange driven	☐
Product number:		Belt driven	☐
Manufacturer:		Elektric switch off	☐
		Air cooled	☐
No, ☐ **favored**: (please cross)		Water cooled	☐

Park Brake Actuation				
Mechanic	Leverage	☐	Cable Pull	☐
Pneumatic	Spring Brake	☐	Piston Cylinder	☐
Hydraulic	Cylinder	☐	Direct	☐

Auxilariy Consumers	existing	favored
Cabin Suspension	☐	☐
Seat Suspension	☐	☐
Tire - Pressure - Regulation	☐	☐
Anti Freezer	☐	☐
Air Dryer	☐	☐
Air - Supply Trailer	☐	☐
Others:	☐	Which ?:

WABCO Assistence Systems		existing	favoured
OnLane™	Keep - in -Lane System	☐	☐
ACC	Distance Regulation	☐	☐
OnGuard™	autom. Anti - Collision System	☐	☐
TailGUARD™	Rear Blind Spot Monitoring	☐	☐
OptiTire™	Tire-Pressure-Monitoring	☐	☐

In case of existing Wheel - Brake - Certificates please add to this form

On basis of this information we will be able to provide a better support for a special system layout

For a vehicle specific Brake - Calculation we need more vehicle details.
This information is collected in our WABCO - Brake - Calculation - Sheets.

Further Comments:

12 Requirements of Regulation (EU) 2015/68

WABCO

Regulation Requirements Matrix

(29.09.2017)

(EU) 167/2013 Vehicle Classes				(EU) 2015/68 requirements	service braking system			secondary braking system	
				(EU) 2015/68 differentiation		Annex II 3.1.1.1.	An. II App. I 1.1.1.1.	Annex I 2.2.1.16.1.	Annex I 2.2.1.16.2.	Annex II 3.1.2.
	T1	UM > 600 kg, GC < 1000mm, TW > 1150mm	"a" < 40 km/h	< 30 km/h		d_m = 3.55 m/s² s = 0.15v + v²/92		in case a tractor is allowed to tow R2 R3, R4 or S2: if the service brake of the tractor is actuated, there shall also be a graduated braking action on the towed vehicle	In case of secondary braking action of the tractor, there shall also be a braking action in the towed vehicle	d_m = 1.5 m/s² s = 0.15v + v²/39
	T2	UM > 600 kg , GC < 600mm, TW > 1150mm								
	T3	UM < 600kg								
	T4	tractor for special purposes								
	T4.1	high-clearance tractors		> 30 km/h		d_m = 5.00 m/s² s = 0.15v + v²/130	shall comply to compatibility bands			d_m = 2.2 m/s² s = 0.15v + v²/57
	T4.2	extra-wide tractors								
	T4.3	low-clearance tractors								
	C	tractor on tracks								
	T1	UM > 600 kg, GC < 1000mm, TW > 1150mm	"b" > 40 km/h	< 30 km/h		d_m = 3.55 m/s² s = 0.15v + v²/92			In case of secondary braking action of the tractor, there shall also be a braking action in the towed vehicle; this braking action shall be graduable	d_m = 1.5 m/s² s = 0.15v + v²/39
	T2	UM > 600 kg , GC < 600mm, TW > 1150mm								
	T3	UM < 600kg								
	T4	tractor for special purposes								
	T4.1	high-clearance tractors		> 30 km/h		d_m = 5.00 m/s² s = 0.15v + v²/130	shall comply to compatibility bands			d_m = 2.2 m/s² s = 0.15v + v²/57
	T4.2	extra-wide tractors								
	T4.3	low-clearance tractors								
	C	tractor on tracks								
UM = unladen mass, GC = ground clearance, TW = track width					Annex I 2.2.2.	Annex II 3.2.1.	An. II App. I 1.1.1.1.	Automatic braking Annex II 3.2.3		
	R1	sum of axle load < 1500 kg	"a" < 40 km/h		no service braking system required	if vehicles R1 or S1 are fitted with a braking system, the performance shall meet requirements for vehicles R2 or S2 for continuous / semi-continuous type: X % stat. Wheel load X = 50 (>30 km/h) X = 35 (<30 km/h)		automatic braking performance in the event of a failure (2.2.1.17.1 and 2.2.1.18.5 An I) for a laden vehicle shall not be less than 13.5 % of the maximum stationary wheel load		
	R2	sum of axle load: 1500 - 3500 kg			continuous / semi cont. /		shall comply to compatibility bands if > 30 km/h			
	R3	sum of axle load: 3500 - 21000 kg		< 8000 kg	continuous / semi cont. /					
				> 8000 kg	continuous / semi continuous					
	R4	sum of axle load > 21000 kg			continuous / semi continuous					
	S1	sum of axle load < 3500 kg			no service braking system required					
	S2	sum of axle load > 3500 kg		< 8000 kg	continuous / semi cont. /		shall comply to comp. bands if > 30 km/h			
				> 8000 kg	continuous / semi continuous					
	R1	sum of axle load < 1500 kg	"b" > 40 km/h	< 750 kg	no service braking system required					
				> 750 kg	continuous / semi cont. /					
	R2	sum of axle load: 1500 - 3500 kg			continuous / semi cont. /		shall comply to compatibility bands			
	R3	sum of axle load: 3500 - 21000 kg			continuous / semi continuous					
	R4	sum of axle load > 21000 kg			continuous / semi continuous					
	S1	sum of axle load < 3500 kg		< 750 kg	no service braking system required					
				> 750 kg	continuous / semi cont. /					
	S2	sum of axle load > 3500 kg			continuous / semi continuous		shall comply to compatibility bands			

parking braking system		number of actuated wheels	differential braking	wear adjustment	additional coupling	failure in connection lines	connections	ABS	load sensing
Annex II 3.1.3.1. / 3.1.3.2.	Annex II 3.1.3.4.	Annex I 2.2.1.6.	Annex I 2.2.1.1.	Annex I 2.2.1.10.		Annex I 2.2.1.17.1	Annex I 2.1.4.1	Annex I 2.2.1.21.	
shall hold vehicle at: 18 % up/down gradient	on tractors, where the coupling of towed vehicles is allowed the parking brkaing system of the tractor shall hold the whole combination at a 12 % up /down gradient	service brake shall act on all wheels of at least one axle	if differential braking is activated, no travel speeds > 40 km/h shall be possible if travel speed is > 40 km/h the differential braking function should be disabled	wear of service brakes shall be compensated manually or automatically		in case of a failure in the pneumatic control line, the pressure in pneu. supply line shall fall to 1,5 bar within 2 seconds	permitted: 1 x pneu supply 1 x pneu control or 1 x pneu supply 1 x pneu control 1 x el.control or hydraulic dual line or until 2019/20 hydraulic single line not yet permitted: 1 x pneu supply 1 x el. control not permitted: 1 x pneu control	no ABS required	currently no load sensing device is required by regulation
40 % up/down gradient		service brake shall act on all wheels of the vehicle							
shall hold vehicle at: 18 % up/down gradient		service brake shall act on all wheels of at least one axle		wear of service brakes shall be compensated automatically				> 60 km/h ABS Cat. I after confirmation of assessment of European Commission also for >40 km/h new type: 01.2020 new vehicle: 01:2021	
40 % up/down gradient		service brake shall act on all wheels of the vehicle							
shall hold vehicle at 18 % up/down gradient									
Annex II 3.2.2.1.	Annex I 2.2.2.10.	Annex I 2.2.2.4.	Annex I 2.2.1.1.	Annex I 2.2.2.8.1.	Annex I 2.2.2.9.2.	Annex I 2.2.2.9.	Annex I 2.1.6. + 2.1.7	Annex I 2.2.2.16.	Annex I 2.1.1.5
shall hold the laden towed vehicle, when separated from the tractor on 18 % up/down gradient	if a service braking system is in the vehicle, the parking brake shall be ensured even when it is seperated from the towing vehicle	Service brake shall distribute its action appropriate among the axles	< 12 km/h no service brake actuation is required in differential braking mode	manual compensation of wear required; automatic adjustment is optional	if inertia brake, a 2. coupling is needed (cable, chain) to apply the trailer brakes if coupling seperates	shall be stopped automatically if coupling seperates	flexible hoses and cables shall be part of the towed vehicle not automatically actuated shut-off devices are not permitted	no ABS required	shall be equipped with automatic load-sensing device exception: Ra < 30 km/h and Sa for technical reasons not possible, 3 discrete settings permitted Ra < 30 km/h and Sa allows by design only 'laden' and 'unladen' conditon 2 discrete settings are permitted Category S, which do not contain other load (up to 10% consumable material)
				automatic adjustment	no 2. coupling required				
		Service brake shall distribute its action appropriate among the axles and shall act on at least two wheels of each axle		manual compensation of wear required; automatic adjustment is optional	if inertia brake, a 2. coupling is needed (cable, chain) to apply the trailer brakes if coupling seperates				
				automatic adjustment	no 2. coupling required			> 60 km/h ABS is required	
				manual adjustment; automatic optional	if no brakes or inertia brake, 2. coupling is needed (cable, chain)			no ABS required	
				automatic adjustment	no 2. coupling required			> 60 km/h ABS is required	

Find your components

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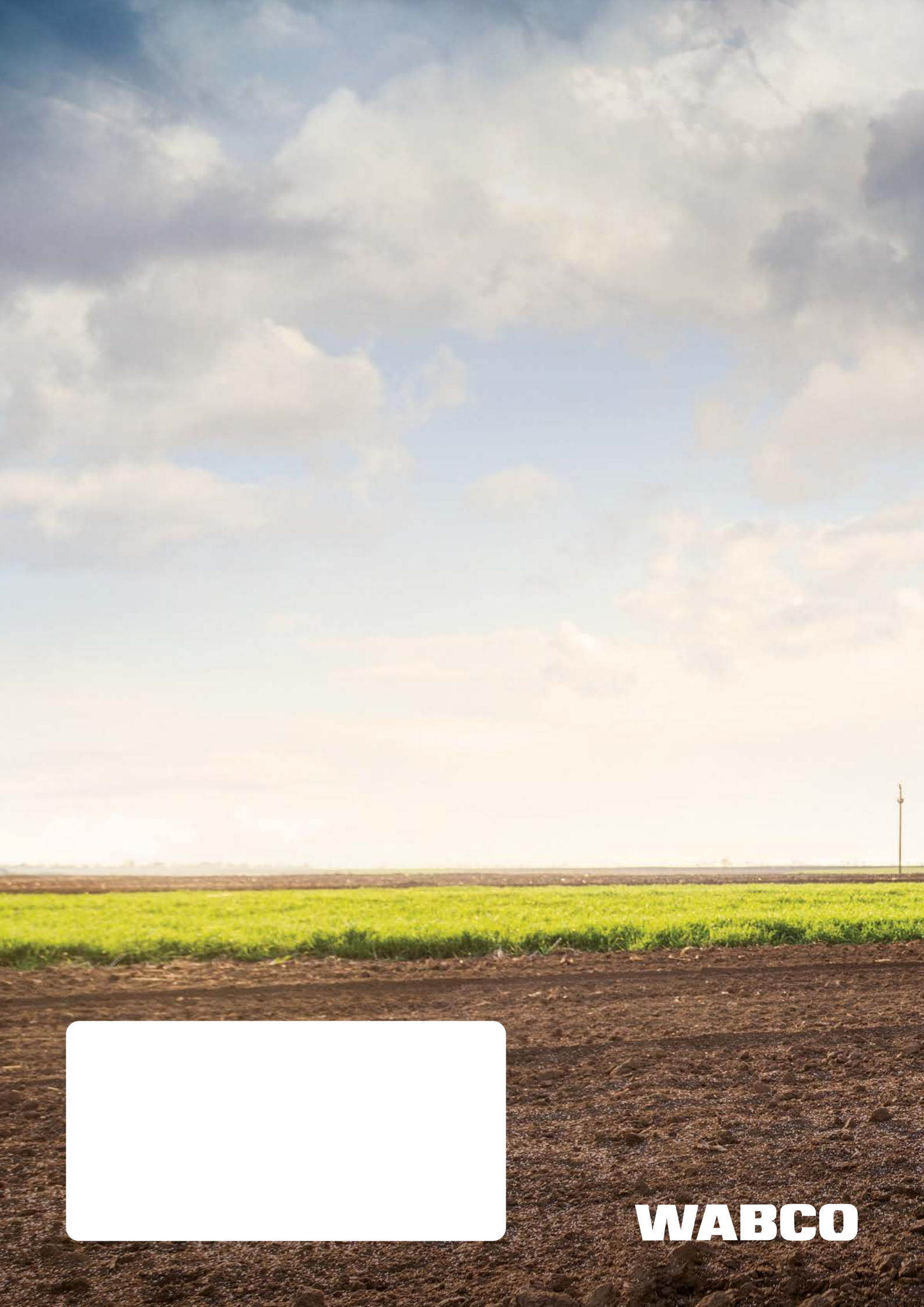
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