PNEUMATIC BRAKING SYSTEM AGRICULTURE AND FORESTRY

PRODUCT CATALOGUE

WABCO

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1 General information

Purpose of this document

This document is a guide that gives workshops an overview of the scope of pneumatic braking systems on tractor-trailer combinations and information about their installation.

Copyright and trademark notice

The content, particularly technical information, descriptions and figures, corresponds to the state current at the time of printing and is subject to change without notice.

Any brand names, even if not indicated as such, are subject to the rules of the trademark and labelling rights.

Symbols used

⚠ WARNING	**Specifies a potentially hazardous situation** Failure to observe the safety instruction can result in severe injuries or death. – *Follow the instructions in this warning to avoid injury or death.*
⚠ CAUTION	**Indicates a potentially hazardous situation** Failure to observe the safety instruction can result in minor or moderately severe injuries. – *Follow the instructions in this warning to avoid any injuries.*
CAUTION	**Specifies possible material damage** Not observing the safety instruction can lead to material damage. – *Follow the instructions in this warning to avoid any material damage.*

! Important information, instructions and/or tips that you must always observe.

Reference to information on the internet

– Action step

⇨ Consequence of an action

■ List

Technical documents

– Open WABCO Customer Centre: https://www.wabco-customercentre.com

– Search for documents by entering the document number.

The WABCO Customer Centre 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.

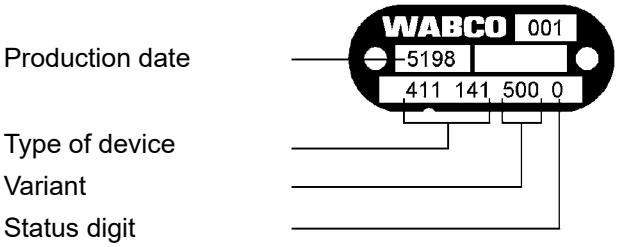
Please note that the publications are not always available in all language versions.

DOCUMENT TITLE	DOCUMENT NUMBER
Pneumatic Braking System – Agriculture and Forestry – Fault-finding	815 XX0 083 3
Pneumatic Braking System – Agriculture and Forestry – Legal Requirements	815 XX0 084 3
Pneumatic Braking System – Agriculture and Forestry – Retrofitting	815 XX0 085 3
Off-highway – Catalogue	815 XX0 217 3
Pneumatic Brake Equipment for Trailer Vehicles	815 XX0 034 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)
1 = New device (subassembly)
2 = Repair kit or subassembly
4 = Component part
7 = Replacement device

Choose genuine WABCO parts

Genuine WABCO parts are made of high quality materials and are rigorously tested before they leave our factories. You also have the assurance that the quality of every WABCO product is supported by an outstanding WABCO customer service network.

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- Access to diagnostics tools and support from the WABCO Service Partner network
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You can find your WABCO partner here:
https://www.wabco-auto.com/Get-in-touch

2 Safety information

Observe all required provisions and instructions:

- Read this publication carefully.
  Adhere to all instructions, information and safety information to prevent injury to persons and damage to property.
  WABCO will only guarantee the safety, reliability and performance of their products and systems if all the information in this publication is adhered to.
- Always abide by the vehicle manufacturer's specifications and instructions.
- Observe all accident regulations of the respective company as well as regional and national regulations.

Provide for a safe working environment:

- Only trained and qualified technicians may carry out work on the vehicle.
- Use personal protective equipment if required (safety goggles, respiratory protection, ear protectors, etc.).
- Pedal actuations can lead to severe injuries if persons are in the vicinity of the vehicle. Make sure that pedals cannot be actuated as follows:
  - Switch the transmission to "neutral" and actuate the hand brake.
  - Secure the vehicle against rolling with chocks.
  - Fasten a visible note to the steering wheel indicating that work is being performed on the vehicle and that the pedals are not to be actuated.

Prevent accidents with regular checks / visual inspections of the pneumatic braking system:

- Regularly check the following components and replace them as soon as you identify wear or damage:
  - Brake pedal (check for slip resistance)
  - Brake shoes, linings and linkage
  - Hoses
  - Compressed air connections (check for leaks)
- Use only original WABCO replacement parts when replacing devices or components.
- Regularly check that the following components of the pneumatic braking system are functioning properly:
  - Air reservoirs (pressure in the air reservoirs must not drop to less than 0.2 bar below the shut-off pressure specified by the vehicle manufacturer within 5 minutes while the engine is idling)
  - Breakaway and parking brake
  - Air reservoir (drain any condensation)
- Never clean the devices of the pneumatic braking system with a high-pressure cleaner to prevent plastic parts and bellows from getting damaged.
- Proprietary trailer constructions, unauthorised modifications of the braking system, as well as poor care and maintenance of the installed tractor and trailer brake, can cause major accidents. Every vehicle that is driven on public roads must comply with all legal requirements. An operating permit

must therefore be granted for each tractor and trailer. For production vehicles, this is the "General Operating Permit (ABE)"; for special vehicles, it is the "General Operating Permit for Individual Vehicles (EBE)". In the case of any modification to the braking system, e.g. that certification becomes invalid.

3 Braking systems

All following pressures are guidelines and can deviate depending on the system.

This chapter contains a description of the functions that are required to meet legal guidelines, such as the ABS, RSS, and other braking control functions.

3.1 Normal pressure pneumatic braking system

3.1.1 Single line braking system

Release position

The compressed air conveyed by the compressor flows into the air reservoir through the unloader valve.

From the air reservoir, the compressed air is conveyed via the trailer control valve, hand brake valve, and coupling heads to the trailer brake valve and into the trailer's air reservoir. The gauge on the tractor's dashboard indicates the pressure in the air reservoir. When the operating pressure of 5.3 bar defined for the single line system has been attained, the unloader valve switches over so that the compressor can run at idling speed. As soon as the pressure in the reservoir falls below 4.8 bar (e.g. due to a brake actuation), the unloader valve switches back again. The reservoir is pressurised again to 5.3 bar.

Braking position

When the driver operates the pedal of the trailer control valve, the duct from the unloader valve to the trailer control line is closed and the line is vented according to the position of the trailer control valve. This causes the duct from the trailer air reservoir to the load-sensing valve to open in the trailer brake valve, and compressed air can flow to the trailer's brake cylinders. The manually adjustable load-sensing valve permits the braking force to be adjusted to the respective trailer load and limits the pressure released by the trailer brake valve. It is also used to release the brake when the unhitched trailer is to be moved. The hand brake valve fitted in the tractor unit between trailer control valve and coupling head, which is mechanically linked with the hand brake lever, enables the compressed air to be used to brake the trailer when the tractor-trailer combination is stationary.

A high-pressure system can be fitted to allow the use of smaller reservoirs. In this case, double V-belt pulleys, a high-pressure reservoir and an additional pressure limiting valve must be installed however.

3.2 High-pressure braking system

In principle, the high-pressure braking system functions in the same way as a conventional pneumatic braking system. The changes only relate to the air reservoir part, i.e. from the compressor up to the air reservoirs in the towing vehicle.

With this design, the maximum pressure level in the air compression system is defined by the unloader valve. A pressure limiting valve fitted downstream from the air reservoir reduces the outlet pressure to 5.3 bar – the normal pressure used for conventional low-pressure systems.

Advantage

If the high-pressure reservoir is drained carefully under normal conditions, no water can intrude into the braking system.

3.2.1 Single line braking system

The trailer brake valve is actuated with dropping pressure and the air reservoir in the trailer is filled when the trailer control valve is not actuated.

3.2.2 Dual line braking system

The trailer brake valve is actuated through a single line with increasing pressure, and the second line continually fills the air reservoir on the trailer when required. This means that the air reservoir in the towing vehicle can be smaller. In contrast to the single line system, two coupling heads and respectively one venting hand brake valve and one trailer control valve are required for this system.

3.3 High-pressure braking system (combined single and dual line system)

3.3.1 Dual line braking system

The compressed air flows from the air reservoir to supply port 1 on the trailer control valve via the pressure reducing valve, to port 11 of the hand brake valve and the automatic coupling head marked red.

When the service braking system is actuated, an air pressure that is proportional to the applied foot force is controlled at port 2 of the trailer control valve and reaches the coupled trailer via the hand brake valve and the automatic coupling head. This process ensures that the trailer is decelerated in a manner that is aligned with the braking condition of the tractor.

The same sequence applied when the tractor's parking braking system is operated via the coupled hand brake valve, only in this case the trailer deceleration cannot be graduated.

3.3.2 Single line braking system

The air from the reservoir flows via the pressure reducing valve to the valves listed under "Dual line braking system" and also to port 1 of the air-controlled trailer control valve, and via the valve to the coupling head of the single line braking system. The outlet pressure at port 2 is limited to 5.2 bar by means of the pressure reducing valve integrated in the trailer control valve.

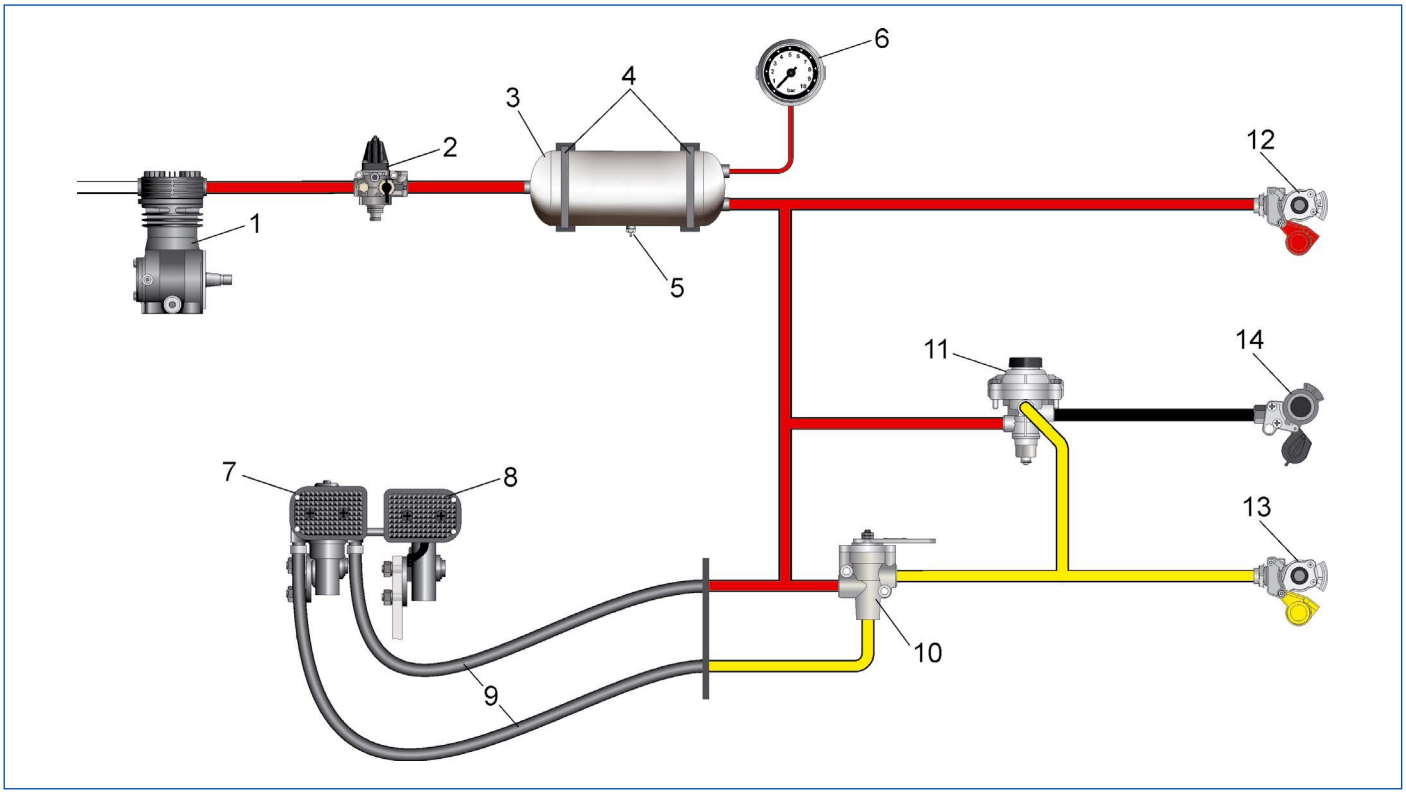
When the service braking system is operated, an air pressure is controlled at port 4 of the trailer control valve that increases proportionally to the applied foot force and, due to the reversing function of the device, a proportionally decreasing air pressure is controlled at port 2. This means that at full brake application, the pressure at port 4 is ≥ 7.2 bar, and at the coupling head it is 0 bar.

The decreasing pressure at the coupling head and its related line again reverses the pressure development in the trailer brake valve, causing the trailer to brake corresponding to the respective braking condition of the tractor.

4 Air compression systems

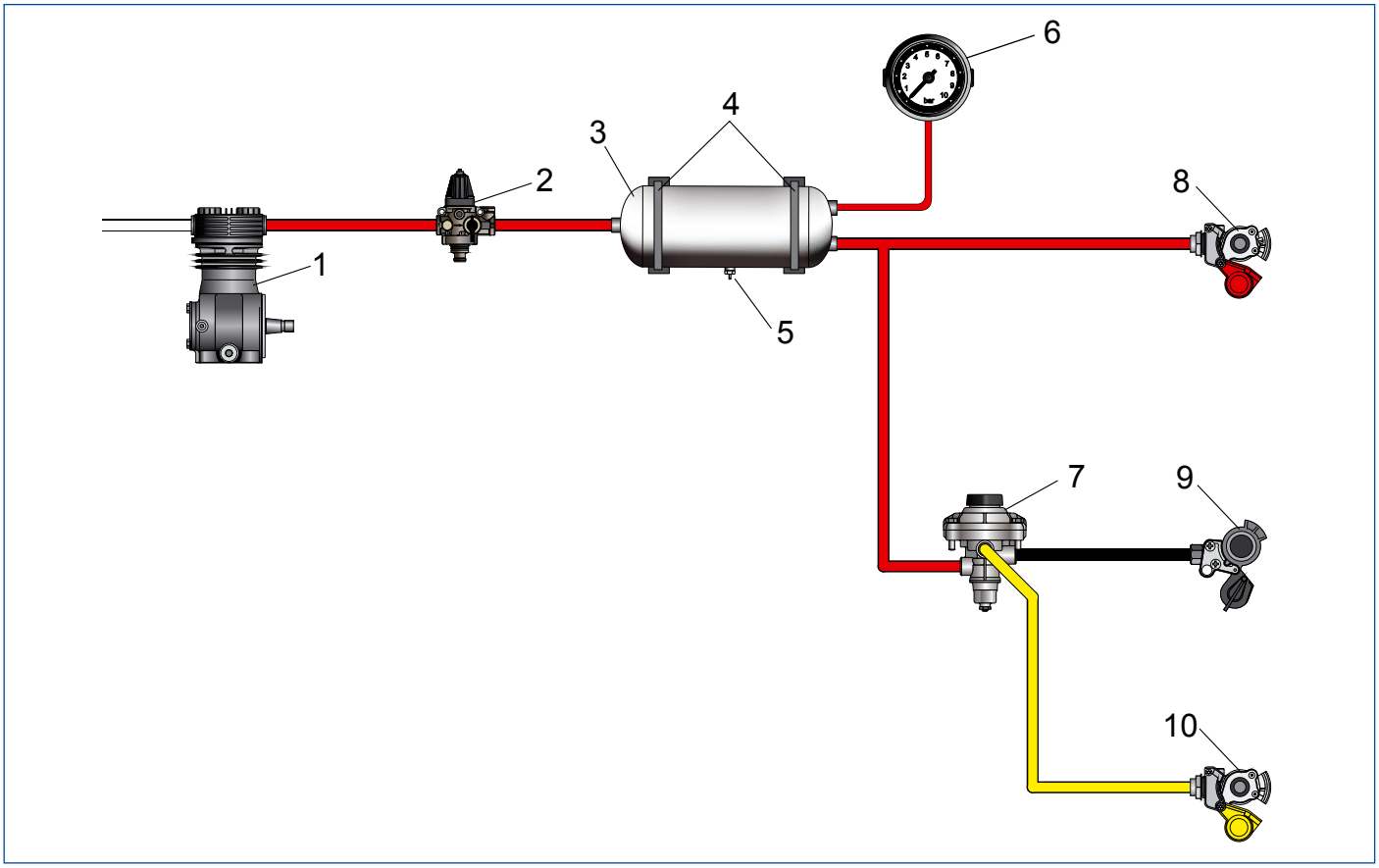
The following schematic diagrams give an overview of all the application possibilities, but do not exempt vehicle manufacturers/workshops from verifying and ensuring compliance with applicable laws and regulations.

Normal pressure – Single and dual line system with pedal valve (schema 841 400 012 0)



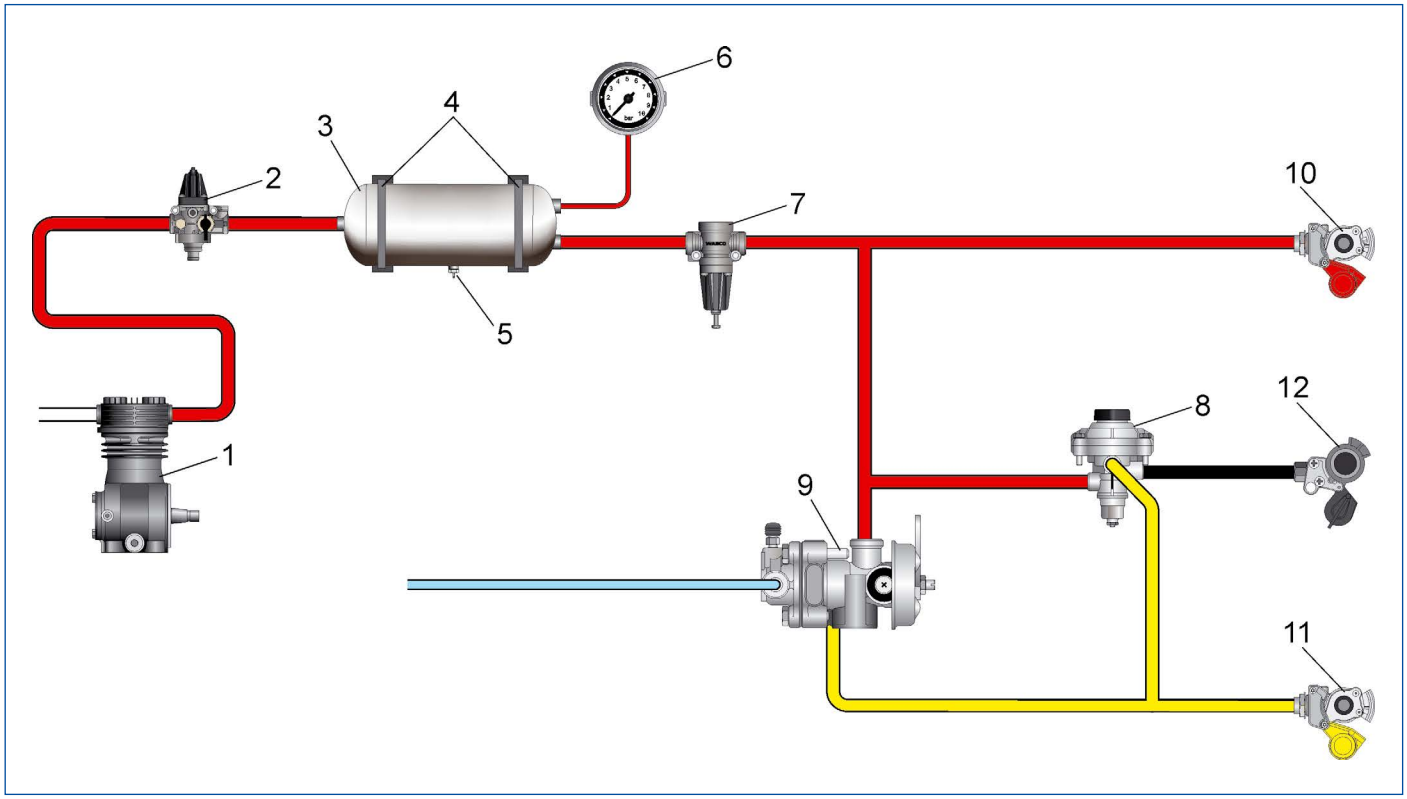
ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Unloader valve	975 303 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve	934 300 XXX 0
6	Pressure gauge	453 002 XXX 0
7	Trailer control valve (power-operated)	961 106 XXX 0
8	Compensator actuation	–
9	Fabric hose	828 876 XXX 6
10	Hand brake valve	461 700 XXX 0
11	Trailer control valve (single line)	471 200 XXX 0
12	Coupling head "supply" (red)	952 200 XXX 0
13	Coupling head "brake" (yellow)	952 200 XXX 0
14	Coupling head "single line" (black)	452 300 XXX 0

Normal pressure – Combined single and dual line system, hydraulically controlled (schema 841 400 013 0)



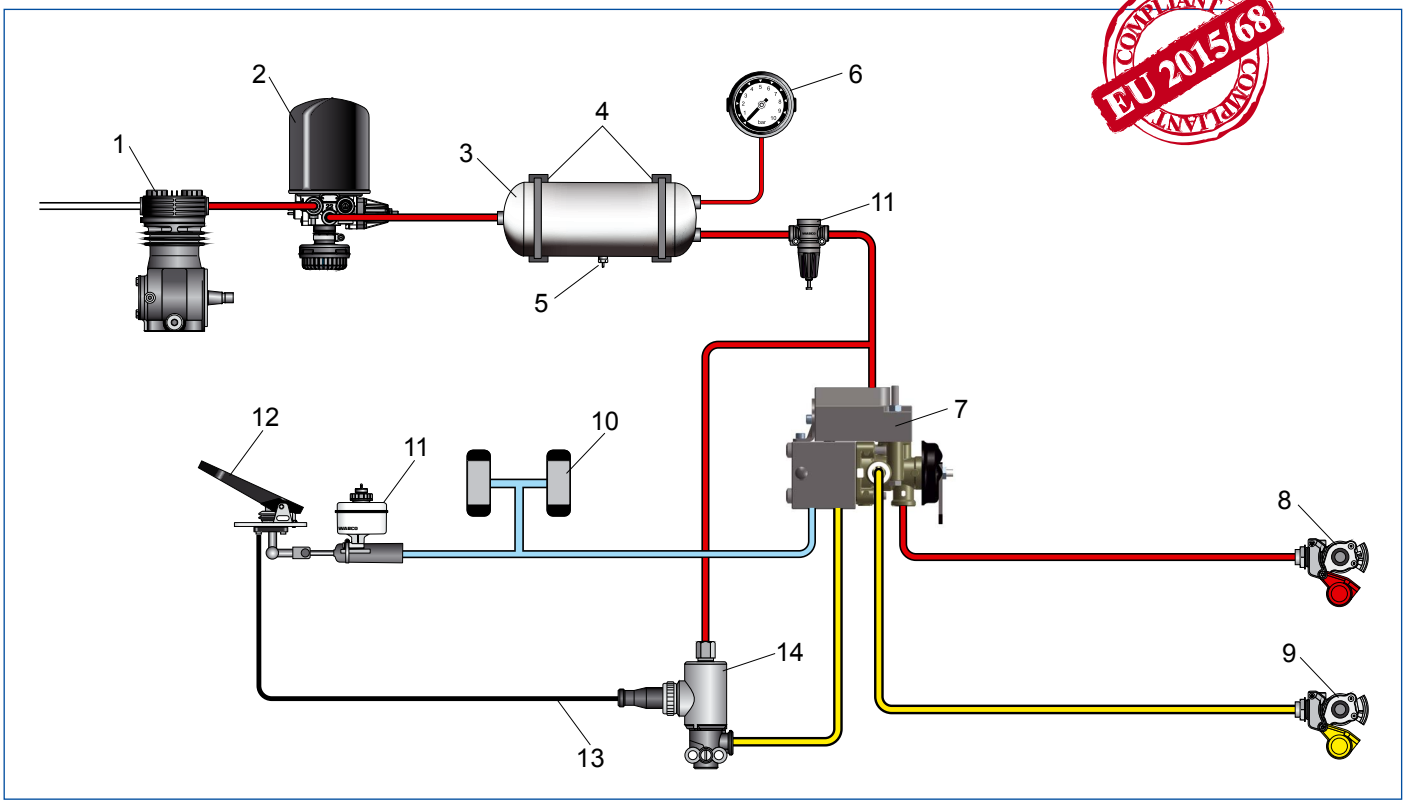
ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Unloader valve	975 303 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve	934 300 XXX 0
6	Pressure gauge	453 002 XXX 0
7	Trailer control valve	470 015 XXX 0
8	Coupling head "supply" (red)	952 200 XXX 0
9	Coupling head "brake" (yellow)	952 200 XXX 0
10	Coupling head "single line" (black)	452 300 XXX 0

High pressure – Combined single and dual line system, hydraulically controlled (schema 841 400 015 0)



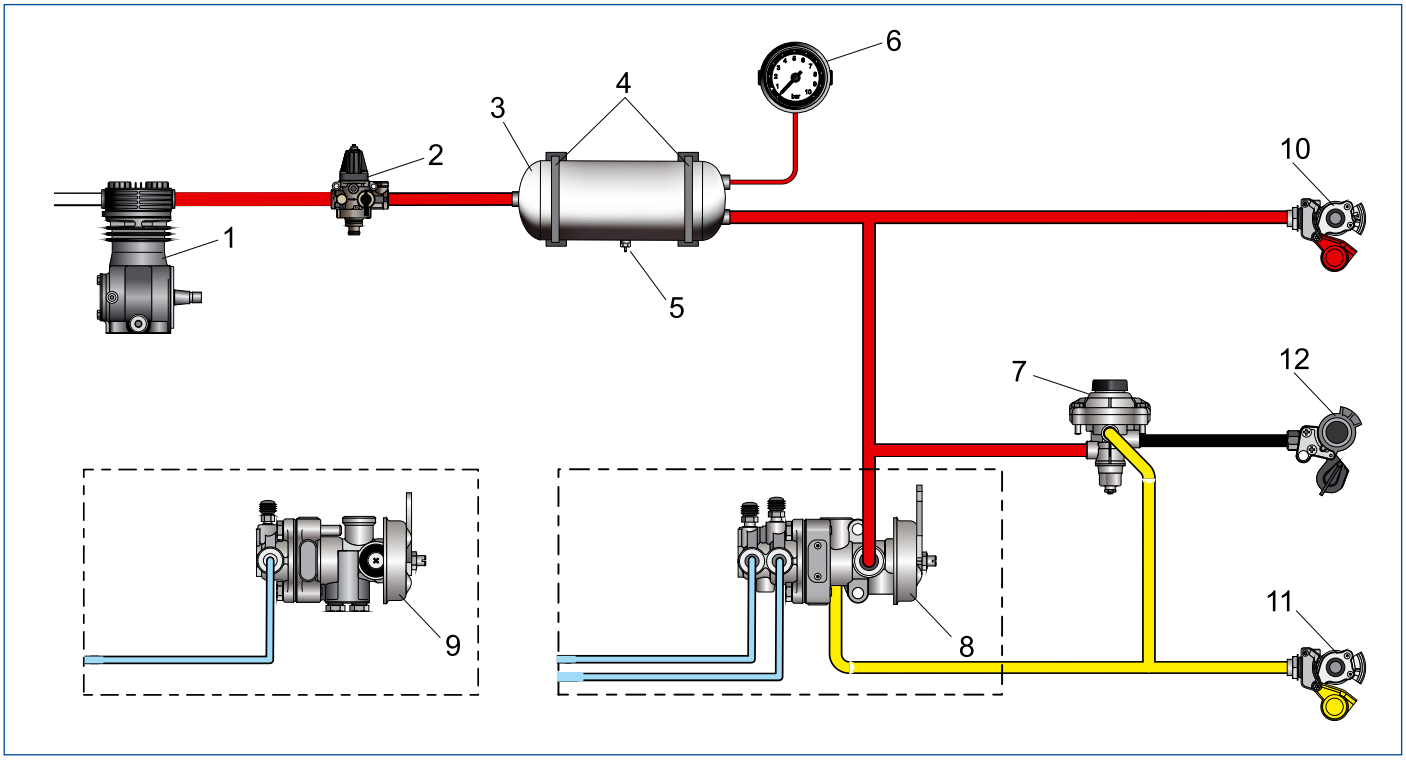
ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Unloader valve	975 303 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve (automatic) Drain valve	934 301 XXX 0 934 300 XXX 0
6	Pressure gauge	453 011 XXX 0
7	Pressure limiting valve	475 010 XXX 0 475 015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

High pressure – Dual line system, hydraulically controlled



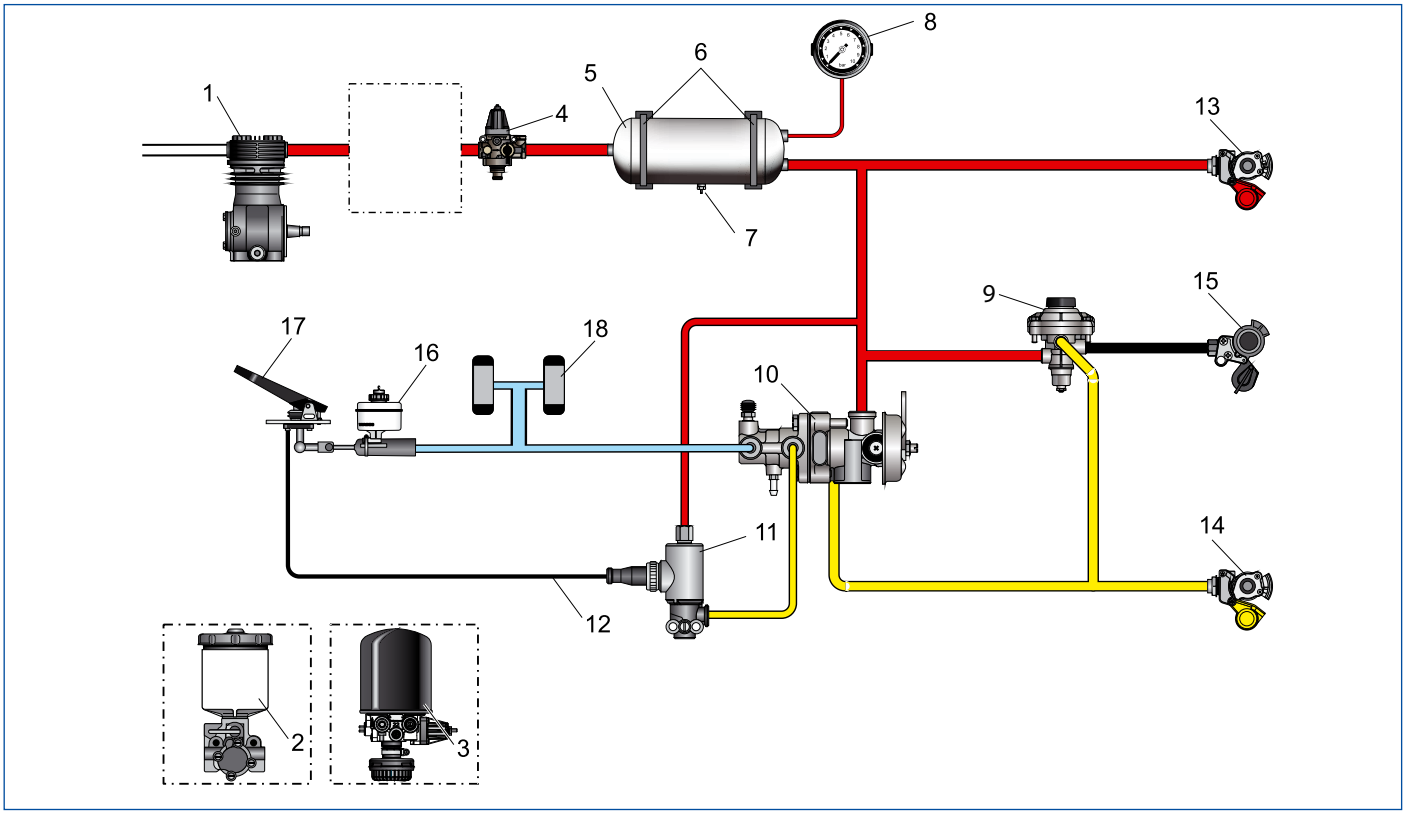
ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Air dryer	432 410 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve (automatic) Drain valve	934 301 XXX 0 934 300 XXX 0
6	Pressure gauge	453 011 XXX 0
7	Conventional trailer control valve	470 015 XXX 0
8	Coupling head "supply" (red)	952 200 XXX 0
9	Coupling head "brake" (yellow)	952 200 XXX 0
10	Solenoid valve	472 170 XXX 0
11	Pressure limiting valve	475 010 XXX 0 475 015 XXX 0
12	Foot brake valve with pedal actuation	461 31X XXX 0
13	Cable for solenoid valve	894 600 451 0
14	Solenoid valve	472 170 XXX 0

Normal pressure – Combined single and dual line system, hydraulically controlled (schema 841 400 017 0), low pressure



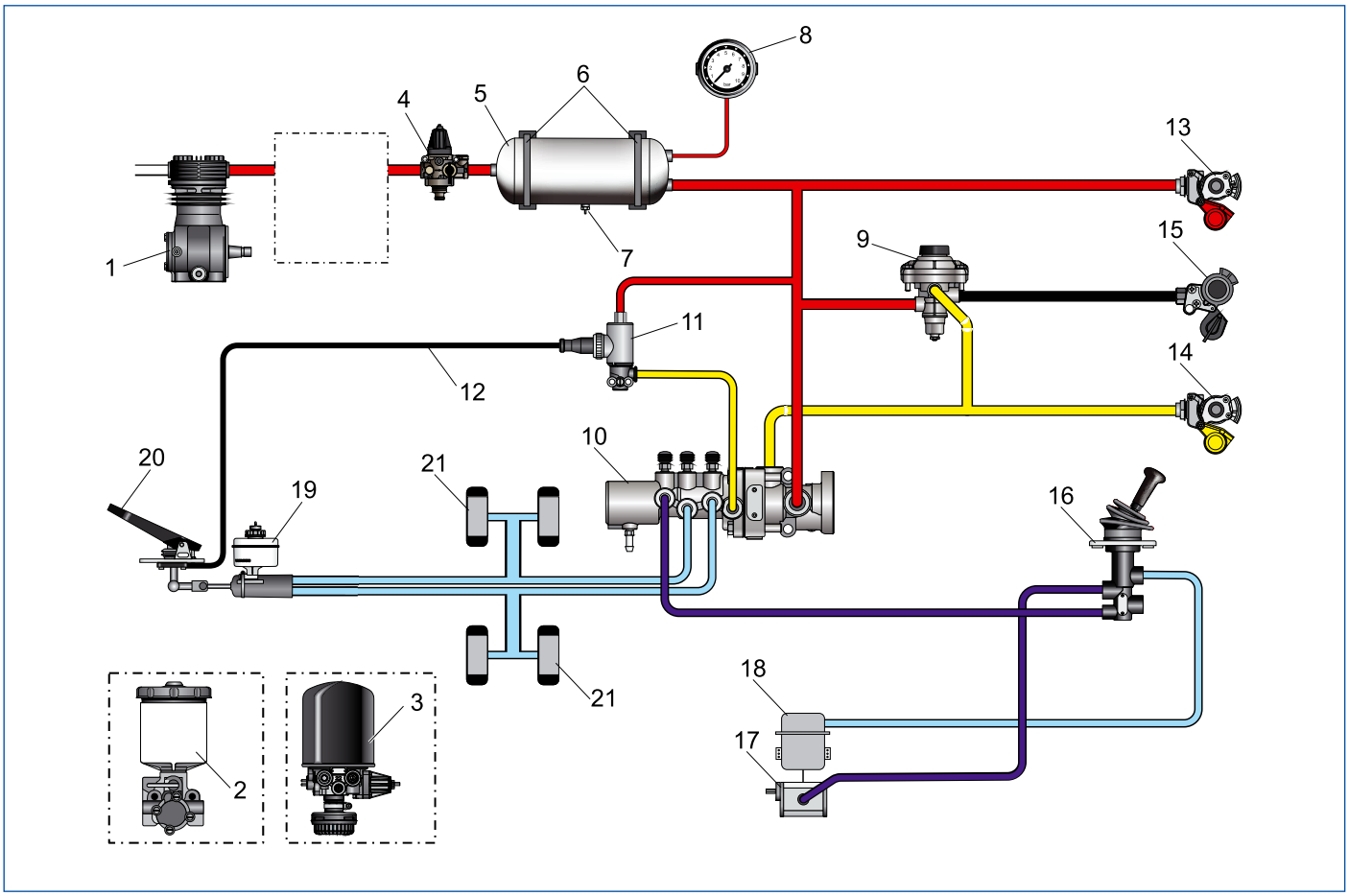
ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Unloader valve	975 303 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve	934 300 XXX 0
6	Pressure gauge	453 002 XXX 0
7	Trailer control valve (single line)	471 200 XXX 0
8	Trailer control valve (alternative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

Normal pressure – Combined single and dual line system, hydraulically controlled, with solenoid valve pilot control (=> pneumatically pilot-controlled) (schema 841 400 018 0)



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

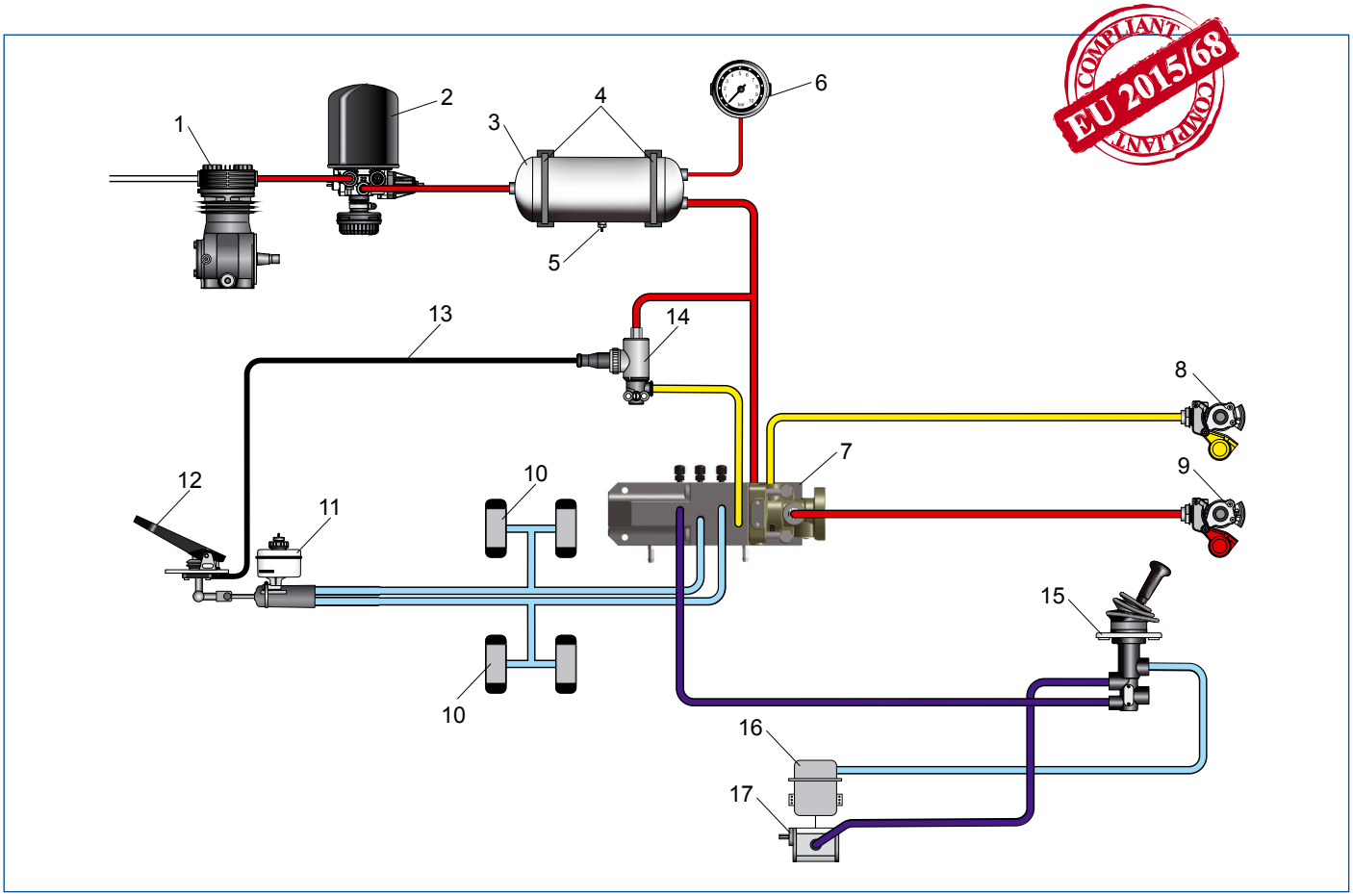
Normal pressure – Combined single and dual line system, hydraulically controlled, pneumatically pilot-controlled, hydraulic hand-braking system, with solenoid valve pilot control and graduated hand brake for vehicles > 30 km/h (schema 841 400 022 0)



ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Anti-freeze pump	932 002 XXX 0
3	Air dryer	432 410 XXX 0
4	Unloader valve	975 303 XXX 0
5	Air reservoir (20 litres)	950 XXX XXX 0
6	Clamp band	451 999 XXX 2
7	Drain valve	934 300 XXX 0
8	Pressure gauge	453 002 XXX 0
9	Trailer control valve (single line)	471 200 XXX 0
10	Trailer control valve (dual line)	470 015 XXX 0
11	Solenoid valve	472 XXX XXX 0
12	Cable for solenoid valve	894 600 451 2
13	Coupling head "supply" (red)	952 200 XXX 0
14	Coupling head "brake" (yellow)	952 200 XXX 0
15	Coupling head "single line" (black)	452 300 XXX 0

ITEM	DESIGNATION	PRODUCT FAMILY
16	Hand brake valve	467 410 XXX 0
17	Pump	–
18	Tank	–
19	Hydraulic master cylinder	468 XXX XXX 0
20	Foot brake valve with pedal actuation	461 31X XXX 0
21	Wheel brake cylinder	–

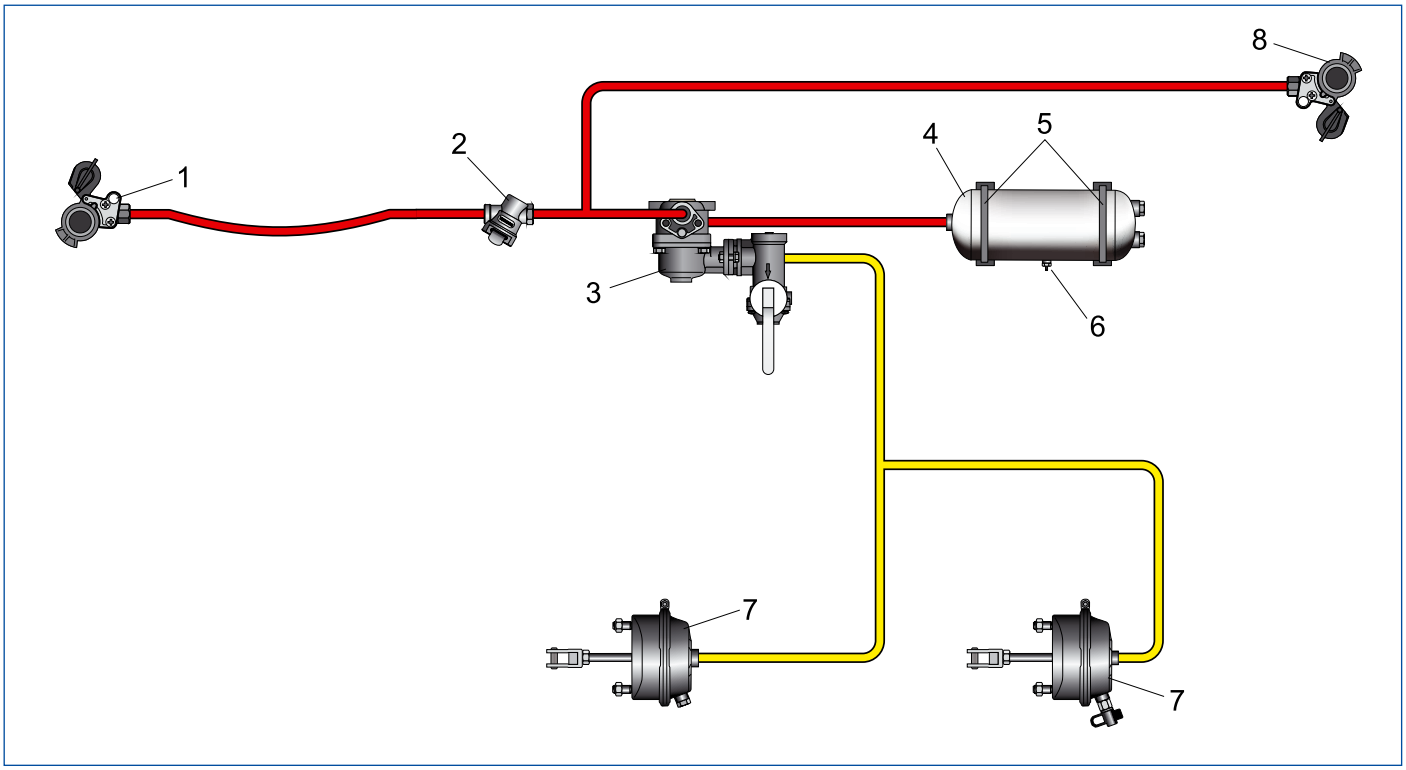
Normal pressure – Combined single and dual line system, hydraulically controlled, pneumatically pilot-controlled, hydraulic hand-braking system, with solenoid valve pilot control and graduated hand brake for vehicles > 30 km/h



ITEM	DESIGNATION	PRODUCT FAMILY
1	Compressor	411 141 XXX 0
2	Air dryer	432 410 XXX 0
3	Air reservoir (20 litres)	950 XXX XXX 0
4	Clamp band	451 999 XXX 2
5	Drain valve	934 300 XXX 0
6	Pressure gauge	453 002 XXX 0
7	Conventional trailer control valve	470 015 XXX 0
8	Coupling head "supply" (red)	952 200 XXX 0
9	Coupling head "brake" (yellow)	952 200 XXX 0
10	Wheel brake cylinder	–
11	Hydraulic master cylinder	468 XXX XXX 0
12	Foot brake valve with pedal actuation	461 31X XXX 0
13	Cable for solenoid valve	894 600 451 2
14	Solenoid valve	472 XXX XXX 0
15	Hand brake valve	467 410 XXX 0
16	Pump	–
17	Tank	–

4.1 Single line pneumatic braking systems

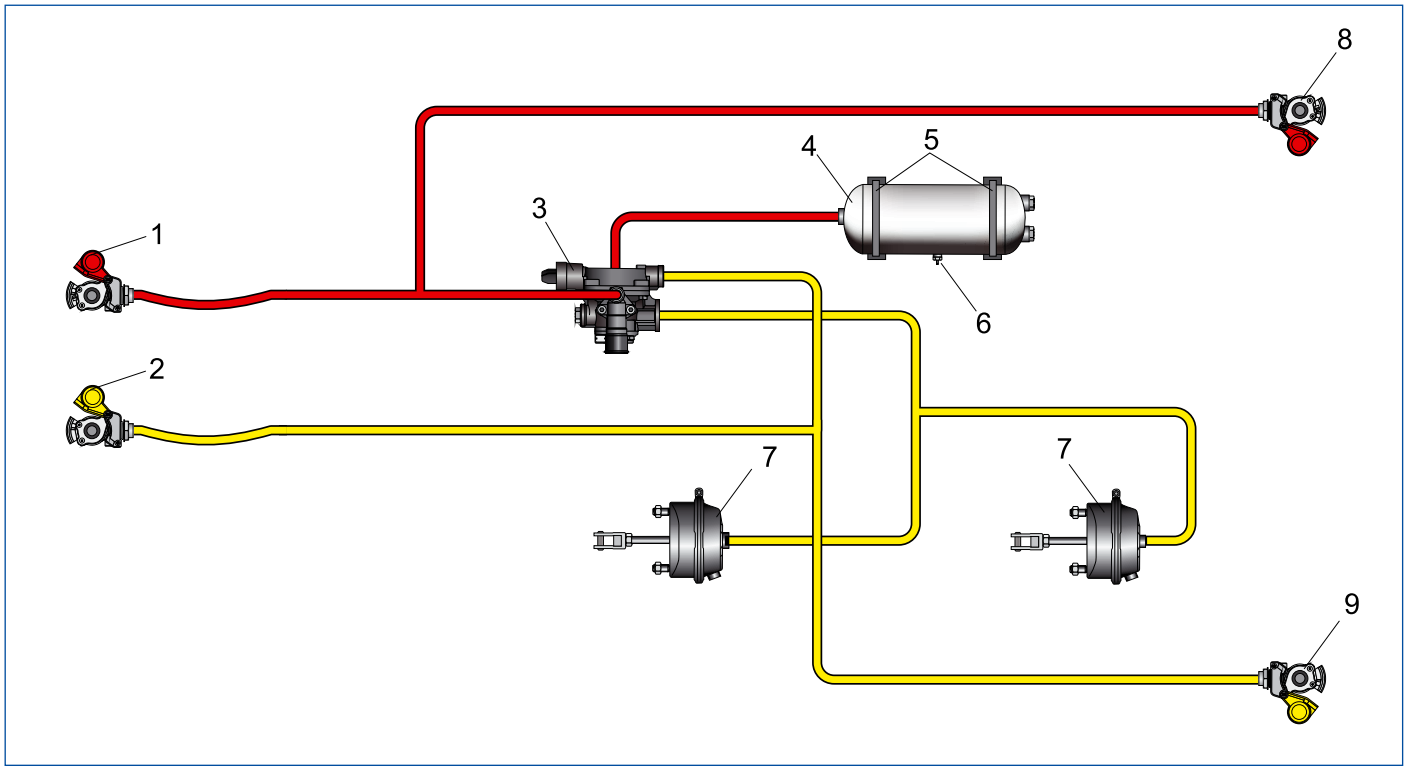
Single line braking system for 2-axle trailers and the central axle trailers (schema 841 500 012 0)



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

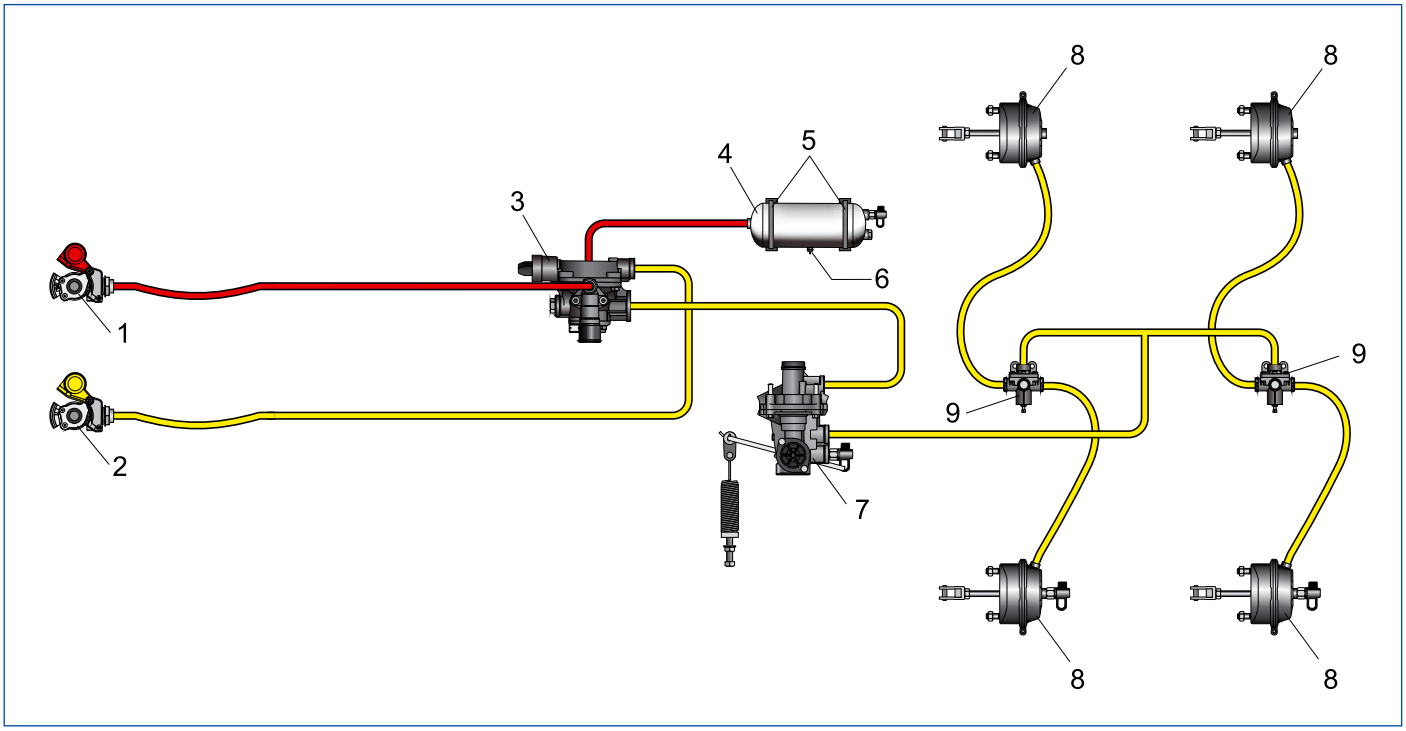
4.2 Dual line pneumatic braking systems

Dual line braking system for 2-axle trailers and central axle trailers (schema 841 500 042 0)



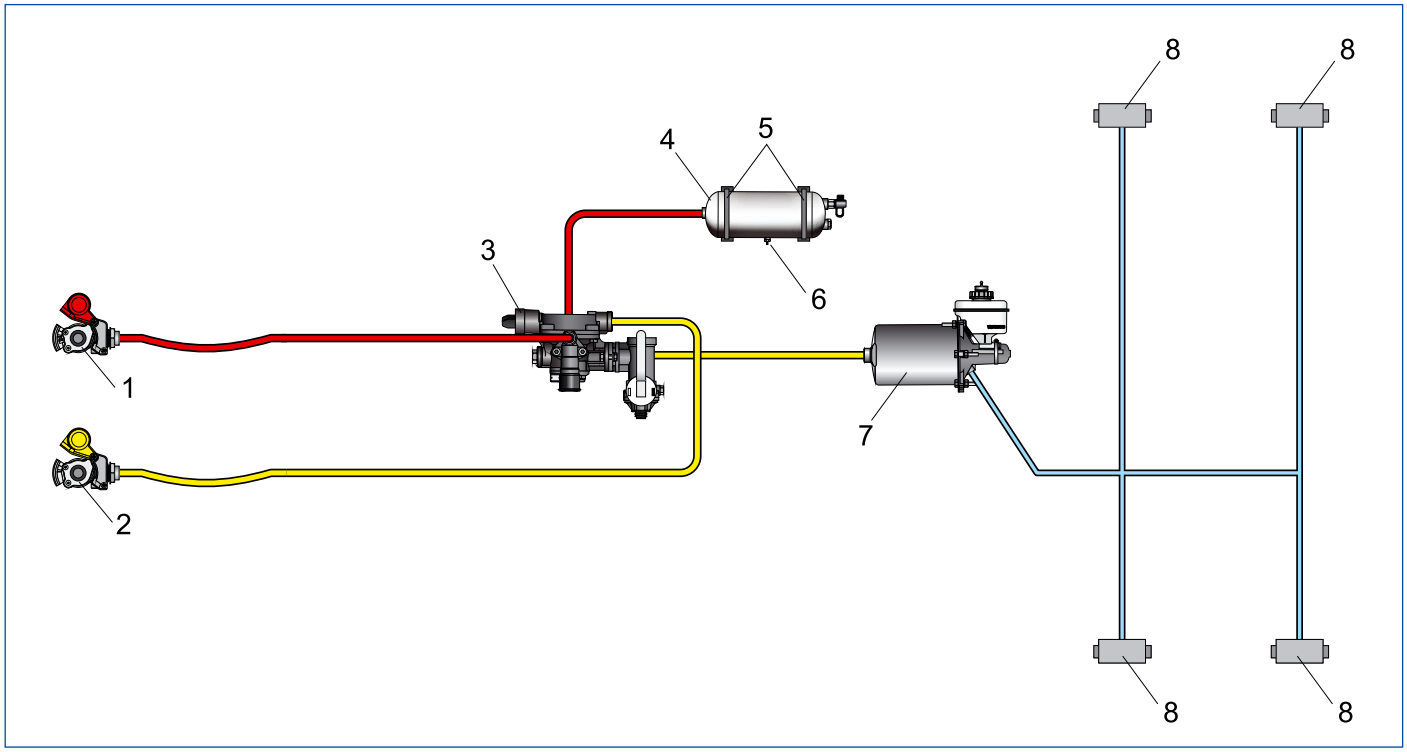
ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer brake valve with load-sensing valve (dual line)	971 002 XXX 0
4	Air reservoir	950 XXX XXX 0
5	Clamp band	451 999 XXX 2
6	Drain valve	934 300 XXX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

Dual line braking system for central axle trailers with LSV controller, mechanical suspension (schema 841 600 259 0)



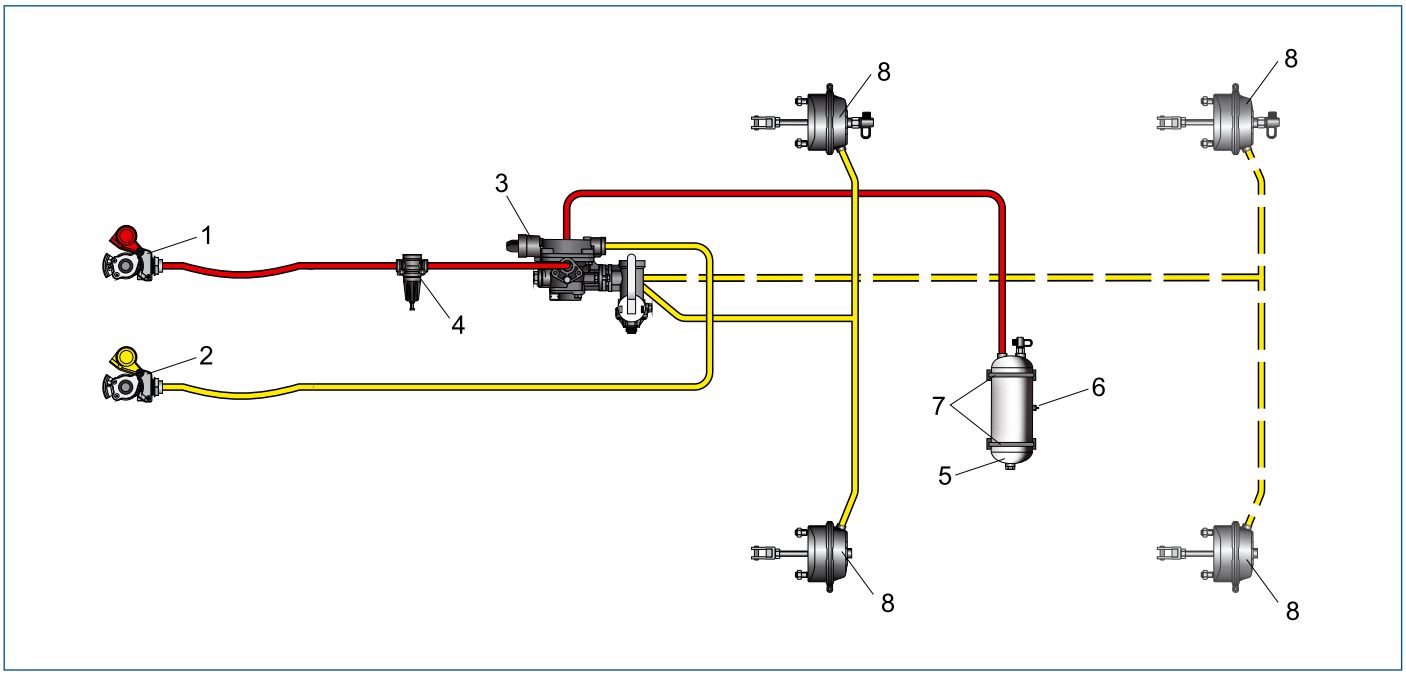
ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer brake valve with load-sensing valve (dual line)	971 002 XXX 0
4	Air reservoir	950 XXX XXX 0
5	Clamp band	451 999 XXX 2
6	Drain valve	934 300 XXX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

Pneumatic/hydraulic dual line braking system for 2-axle trailers or central axle trailers with release valve and load-sensing valve (schema 841 600 797 0)



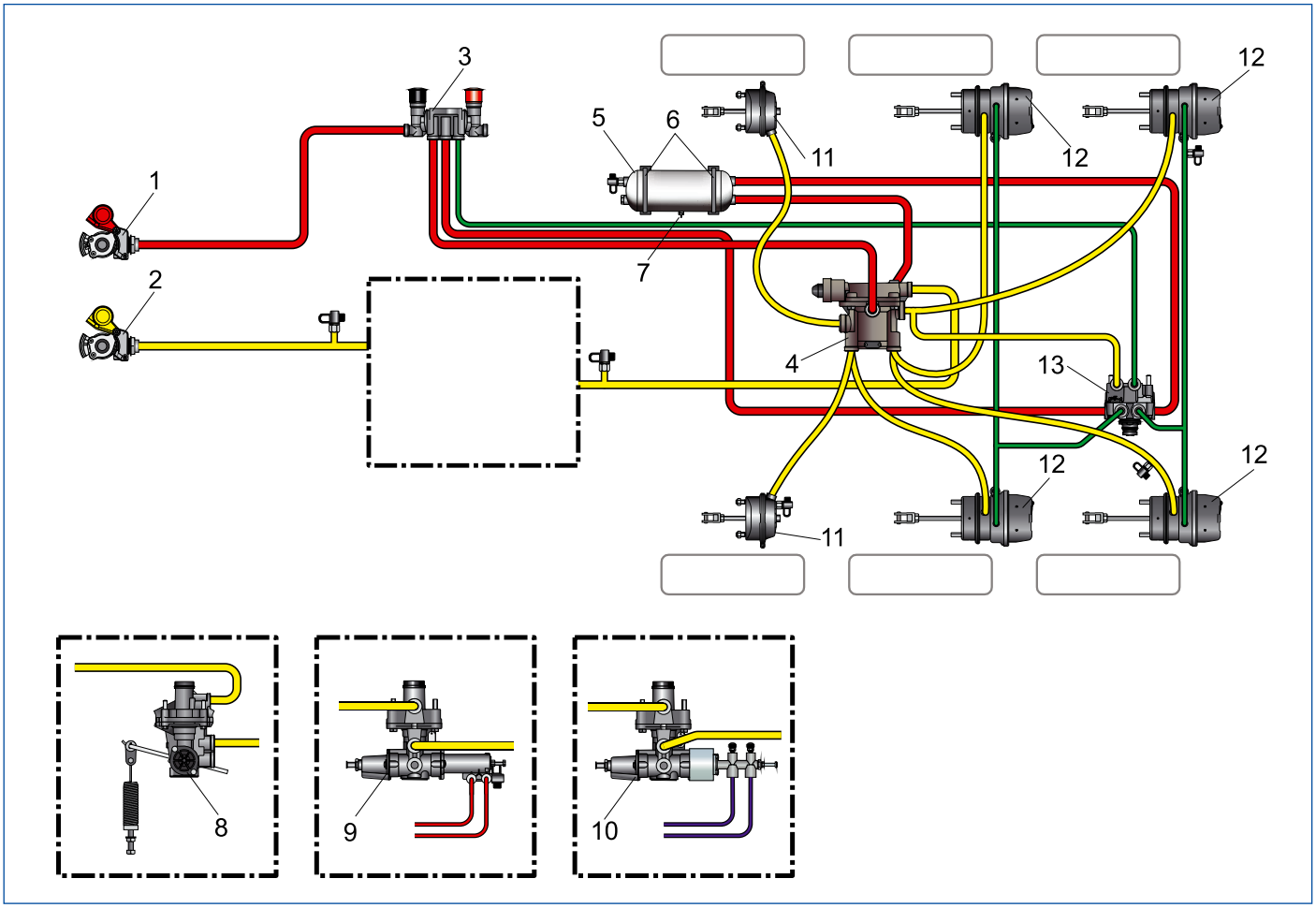
ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer brake valve with load-sensing valve and release valve	971 002 XXX 0
4	Air reservoir	950 XXX XXX 0
5	Clamp band	451 999 XXX 2
6	Drain valve	934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

Conversion from single line to dual line braking system for 2-axle trailers with manual controller
Conversion from single and dual line pneumatic braking system for 2-axle trailers (schema 841 600 557 0)



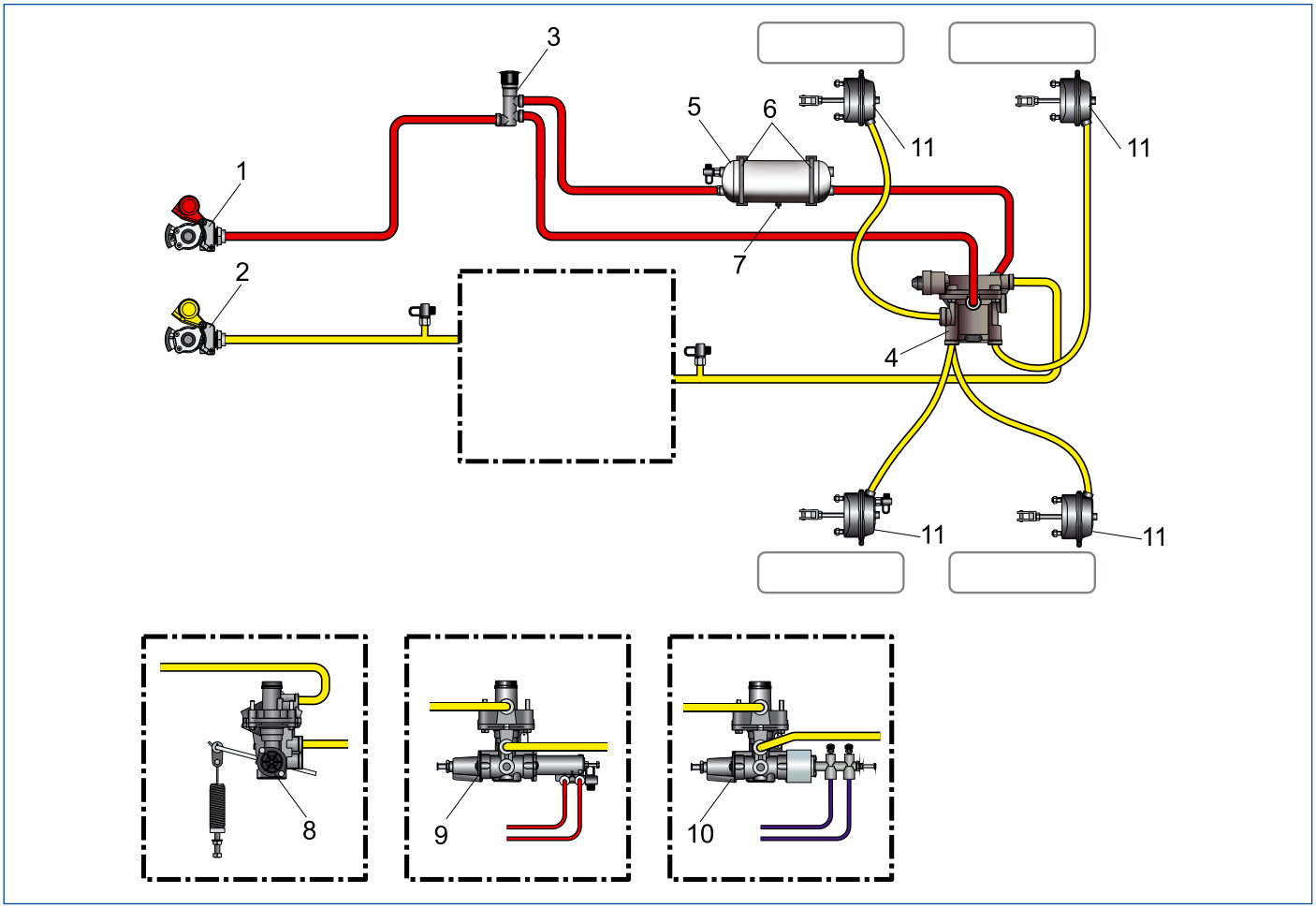
ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer brake valve with load-sensing valve and release valve	971 002 XXX 0
4	Pressure limiting valve	475 010 XXX 0
5	Drain valve	934 300 XXX 0
6	Air reservoir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

Dual line pneumatic braking system for 3-axle central axle trailers, LSV controller, optionally with mechanical / air / hydraulic suspension (schema 841 600 809 0)



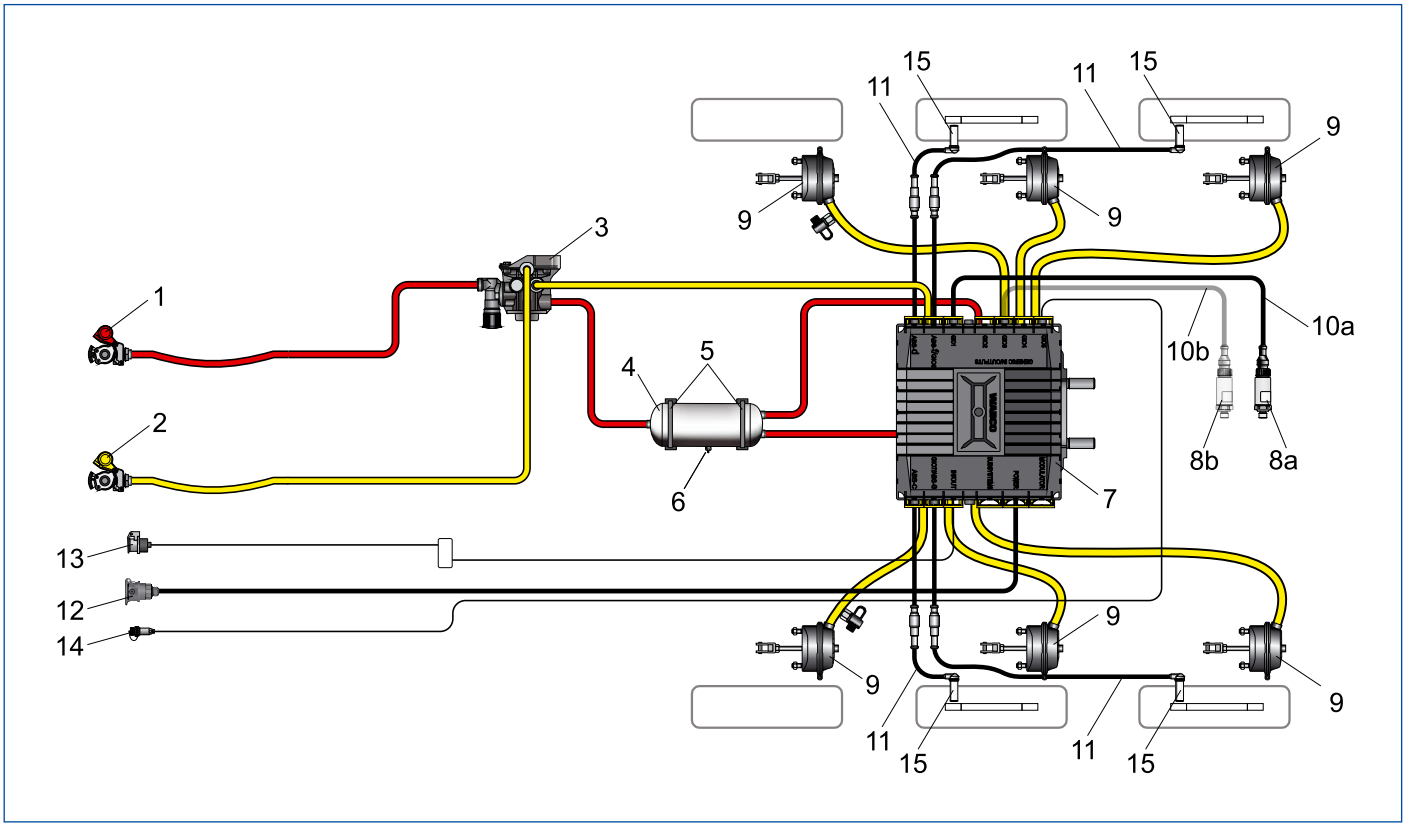
ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer release valve (double release valve)	963 001 XXX 0
4	Trailer brake valve	971 002 XXX 0
5	Air reservoir	950 XXX XXX 0
6	Clamp band	451 999 XXX 2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

Dual line air braking system for 2-axle central axle trailers, LSV controller, optionally with mechanical / air / hydraulic suspension (schema 841 600 817 0)



ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Release valve	963 006 XXX 0
4	Trailer brake valve	971 002 XXX 0
5	Air reservoir	950 XXX XXX 0
6	Clamp band	451 999 XXX 2
7	Drain valve	934 300 XXX 0
8	LSV controller, mechanical	475 713 XXX 0
9	LSV controller, pneumatic	475 714 XXX 0
10	LSV controller, hydraulic	899 144 XXX 4
11	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0

Trailer EBS E for 3-axle central axle trailers, 4S/2M or 2S/2M, multi-voltage modulator (schema 841 601 302 0)

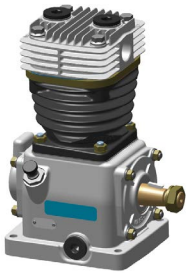


ITEM	DESIGNATION	PRODUCT FAMILY
1	Coupling head with filter "supply" (red)	952 201 XXX 0
2	Coupling head with filter "brake" (yellow)	952 201 XXX 0
3	Trailer brake valve with release valve	971 002 XXX 0
4	Air reservoir	950 XXX XXX 0
5	Clamp band	451 999 XXX 2
6	Drain valve	934 300 XXX 0
7	Trailer EBS E modulator	480 102 XXX 0
8a	Pressure sensor hydraulic oil	–
8b	Pressure sensor hydraulic oil (optional, TEBS E2 or higher)	–
9	UNISTOP™ diaphragm brake cylinder	423 XXX XXX 0
10a	Cable pressure sensor	449 812 XXX 0
10b	Cable pressure sensor (optional, TEBS E2 or higher)	449 812 XXX 0
11	Extension cable sensor	449 723 XXX 0
12	Power 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

5 Device description

5.1 Single cylinder compressor 411 003

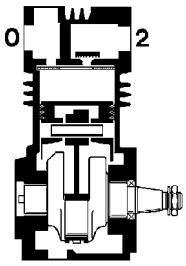
Design



Purpose

Compressors generate compressed air in vehicles, in particular in agricultural tractors, self-propelled or towed work machinery. The compressor is designed as a single-stage piston compressor and its major parts are as follows: Crankcase, air-cooled cylinder head, a crankshaft in composite plain bearings, a connecting rod, a piston with piston rings, the intake and pressure valve, shaft seals for sealing the in-feed and a dip-stick.

Operating principle



As the piston of the compressor moves downwards, fresh air is sucked in through the intake port **0** and the intake vanes. As the piston moves upwards, the air is compressed and forced through the pressure vane and pressure port **2** into the line leading to the air reservoir.
The moving parts are lubricated with engine oil which is filled manually and directly into the crankcase of the compressor through a filler pipe. The oil then flows to the single bearing positions through oil ducts (in the crankshaft) or as oil mist.

Technical data

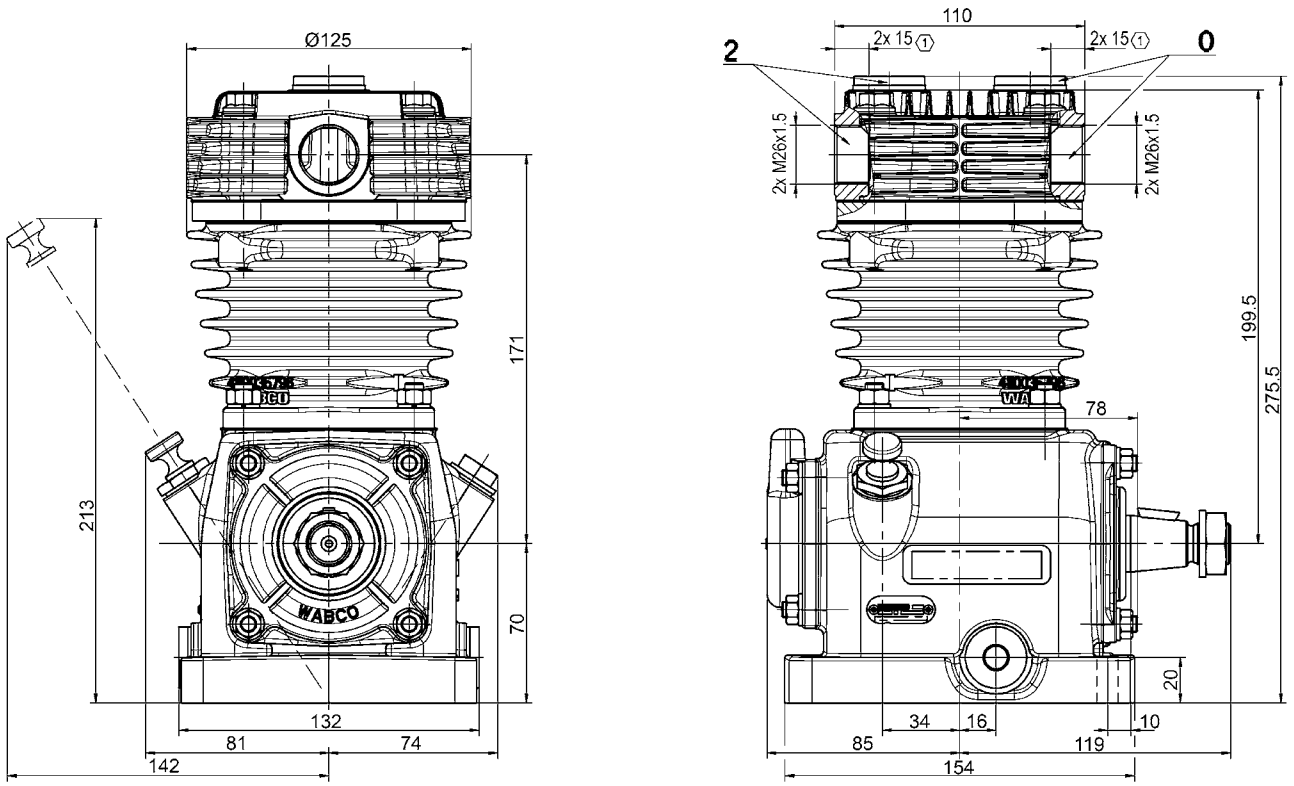
PRODUCT NUMBER	411 003 004 0
Bore diameter [mm]	75
Stroke [mm]	34
Displacement [cm³]	150
Max. operating speed [rpm]	2600
Max. operating pressure [bar]	8.5
Type of lubrication	Splash lubrication (refilled manually)
Weight [kg]	8.2

Installation recommendation

Document "Installation recommendation and maintenance for compressors" (DE/EN)

– Open WABCO Customer Centre:
https://www.wabco-customercentre.com
– Enter the number 826 001 099 3 in the *Product Number* field.
– Click the *Publications* radio button.
– Click the *Start* button.

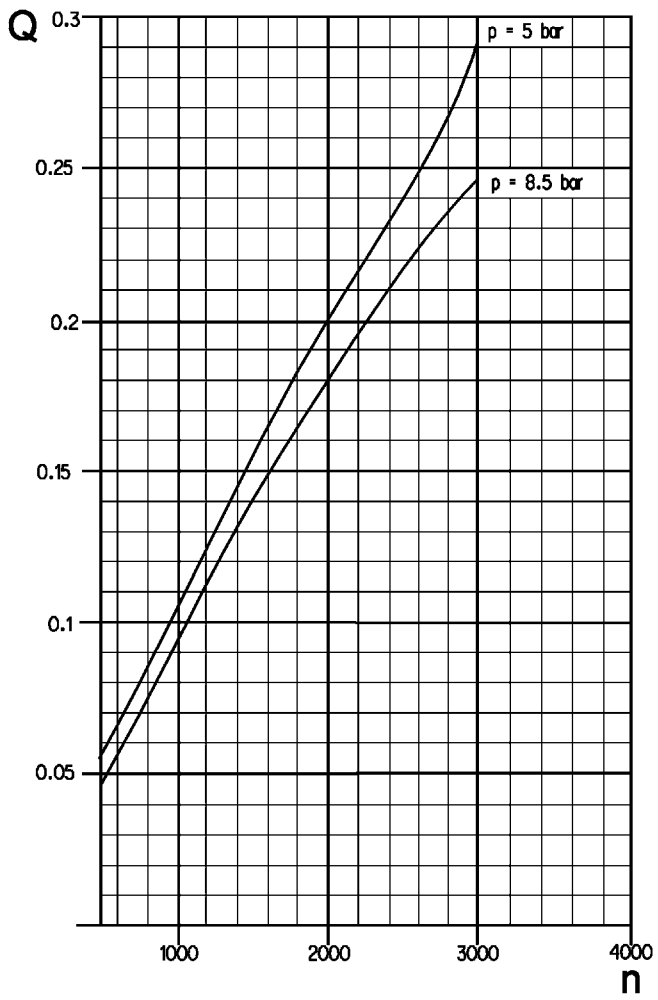
Installation dimensions



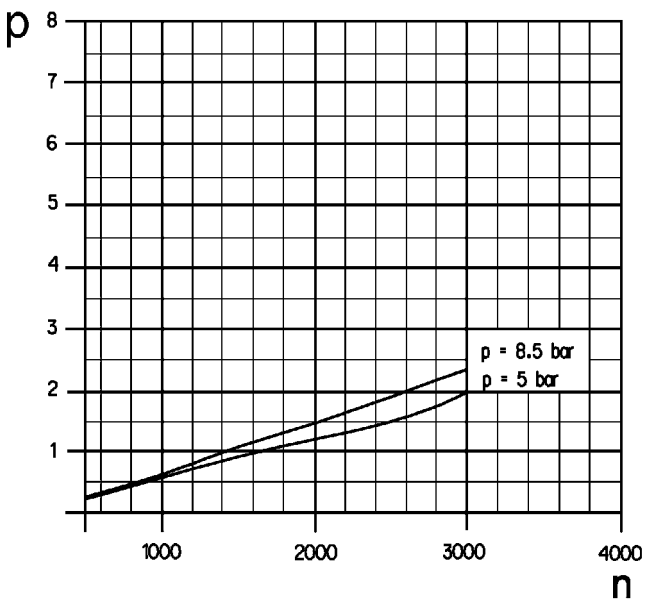
LEGEND			
0	Air intake port M 26x1.5	**2**	Energy discharge (pressure connection) M 26x1.5

Performance diagrams

Air delivery: free air



Power consumption



LEGEND					
Q	Non-pressurised air [m³/min]	**p**	Performance [kW]	**n**	Rotational speed [rpm]

Maintenance

Compressors with manual oil refilling

- Lubrication / filling with single or multigrade oils such as are generally also used for diesel engines. Oil quality according to API classification class CC or CD.
- First oil change after 20 operating hours (or 1,000 km)
- Further oil changes after every 500 operating hours (or 25,000 km)
- Daily check of the oil level in the crankcase and oil refill up to top arrow marking

5.2 Single cylinder compressor 411 141

Design types

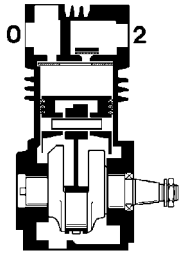
411 141 000 0

411 141 102 0

Purpose

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

Operating principle



As the piston of the compressor moves downwards, fresh air is sucked in through the intake port **0** and the intake vanes. As the piston moves upwards, the air is compressed and forced through the pressure vane and pressure port **2** into the line leading to the air reservoir. To lubricate the moving parts, the compressor is connected to the engine oil circuit to supply it with oil, which flows to the single bearings though oil ducts (in the crankshaft) or as oil mist. The oil is returned either directly into the engine crankcase through the compressor base or through a pipe.

Technical data

PRODUCT NUMBER	411 141 000 0	411 141 102 0
Bore diameter [mm]	75	
Stroke [mm]	36	
Displacement [cm³]	159	
Max. operating speed [rpm]	3000	
Max. operating pressure [bar]	10	8.5
Cooling air speed	≤ 8 bar 4 m/s, > 8 bar 6 m/s	
Weight [kg]	9.5	15.6

Connections

– Open WABCO Customer Centre:
https://www.wabco-customercentre.com

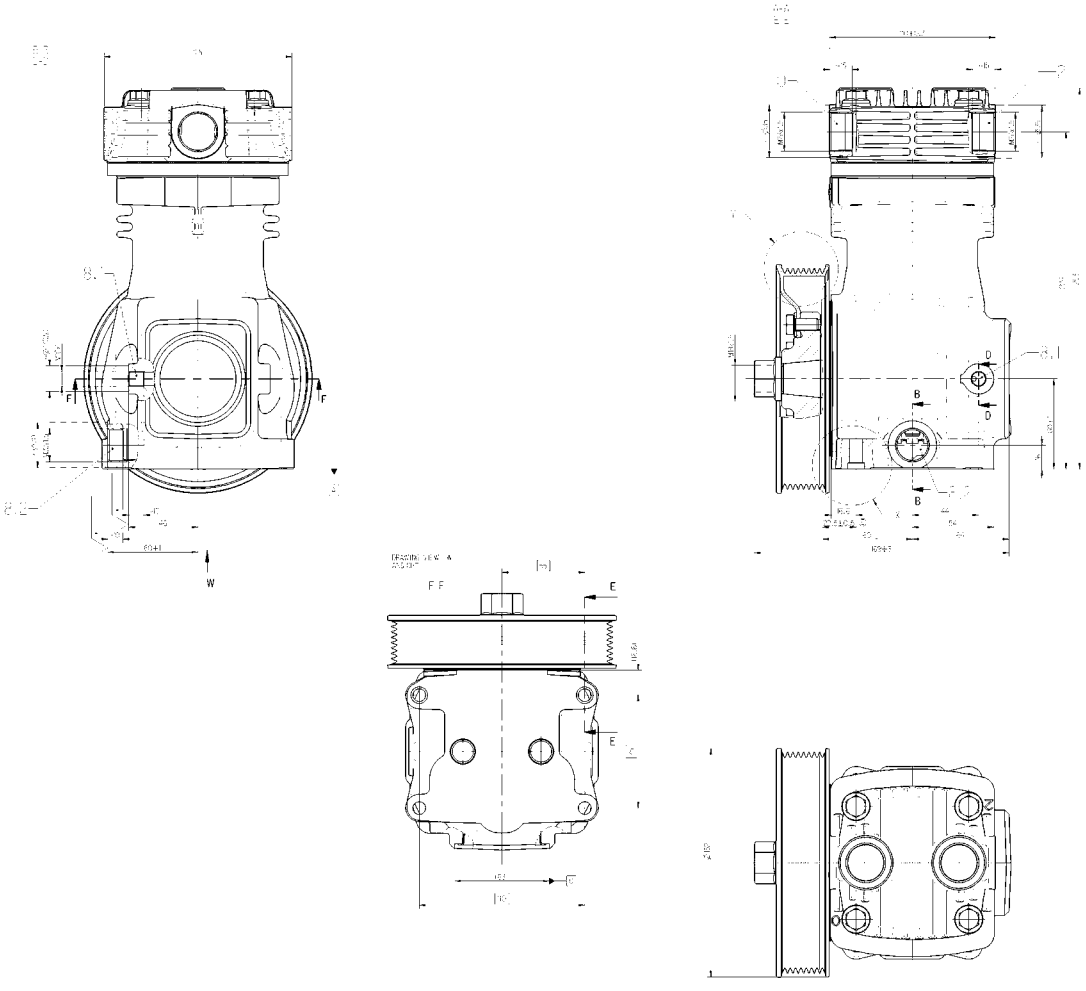
For detailed information about the connections on the single compressors, enter the product number in the *Product Number* search box.

Maintenance and installation recommendations

Document "Installation recommendation and maintenance for compressors" (de/en)

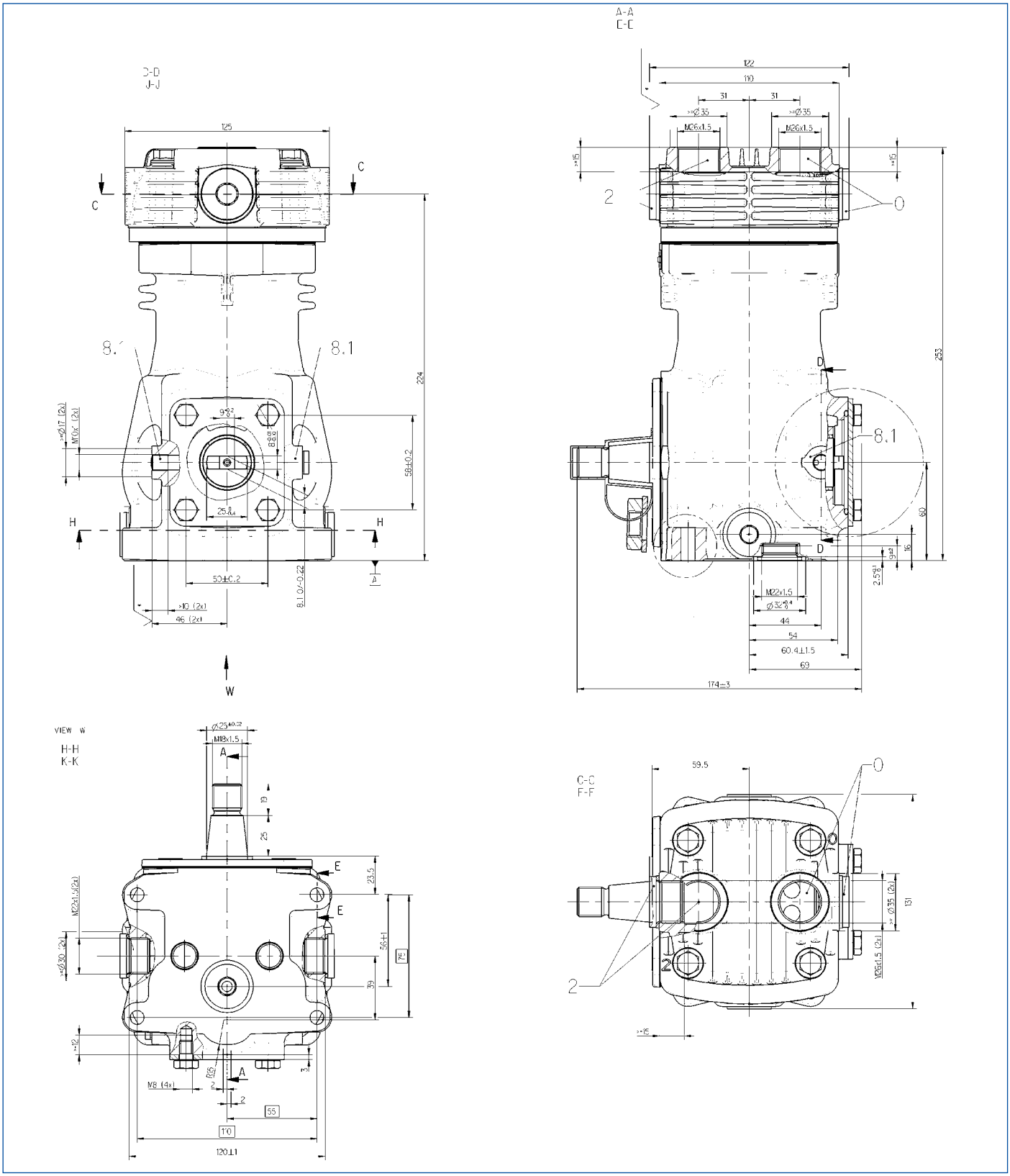
– Open WABCO Customer Centre:
https://www.wabco-customercentre.com
– Enter the number 826 001 099 3 in the *Product Number* field.
– Click the *Publications* radio button.
– Click the *Start* button.

Installation dimensions 411 141 004 0 and 411 141 552 0



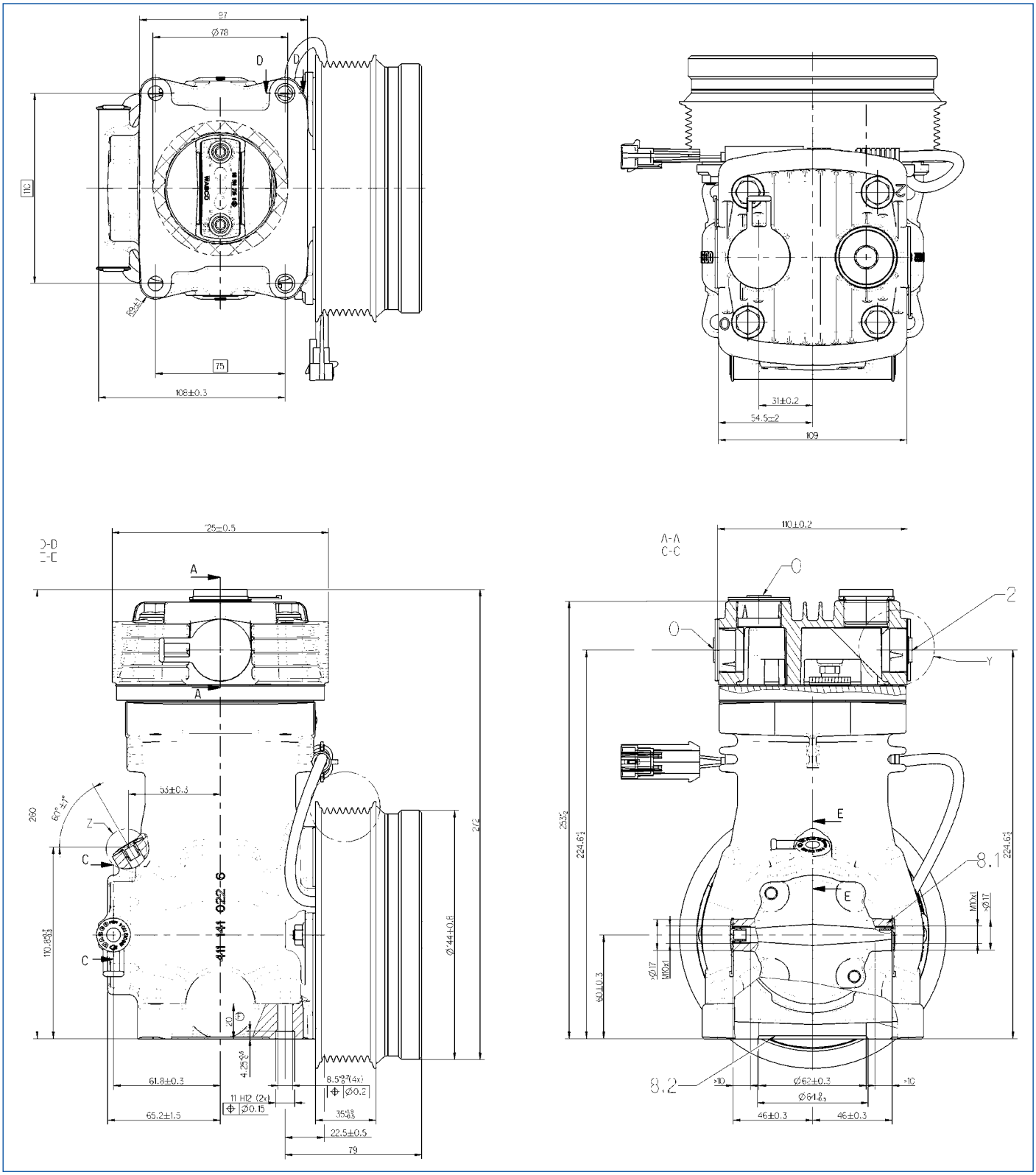
LEGEND							
0	Air intake port M 26x1.5	**2**	Energy discharge (pressure connection) M 26x1.5	**8.1**	Lubricating oil feed M 10x1	**8.2**	Lubricating oil discharge M 22x1.5

Installation dimensions for 411 141 000 0



LEGEND							
0	Air intake port M 26x1.5	**2**	Energy discharge (pressure connection) M 26x1.5	**8.1**	Lubricating oil feed M 10x1 (2x)	**8.2**	Lubricating oil discharge M 22x1.5

Installation dimensions for 411 141 102 0

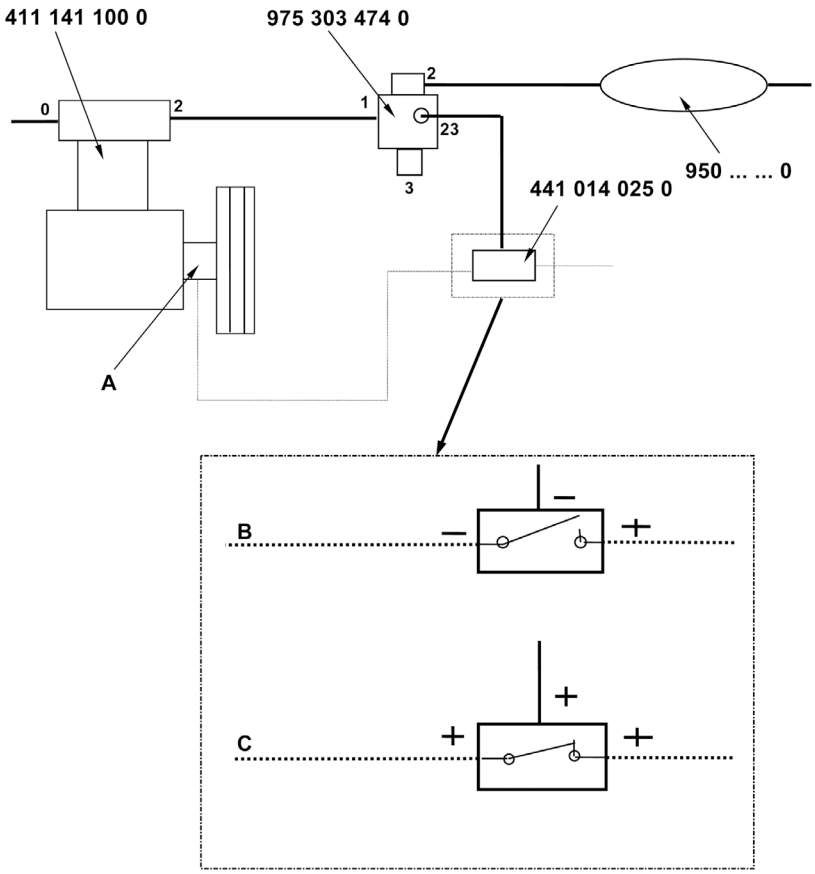


LEGEND					
0	Air intake port M 26x1.5	**2**	Energy discharge (pressure connection) M 26x1.5	**8.1**	Lubricating oil feed M 10x1 (2x)
8.2	Lubricating oil discharge M 26x1.5	**8.3**	Aeration M 10x1.5		

Admissible inclination for installation

PRODUCT NUMBER	α	β	γ	δ
411 141 000 0 411 141 002 0	30°	20°	30°	30°
	20°	20°	15°	45°
	20°	20°	45°	15°
411 141 004 0	20°	20°	15°	45°
411 141 005 0	30°	20°	30°	30°
	20°	20°	45°	15°
411 141 006 0 411 141 007 0	20°	20°	45°	15°
411 141 102 0	20°	20°	45°	45°
411 141 552 0	20°	20°	15°	45°
411 141 845 0	30°	20°	30°	30°

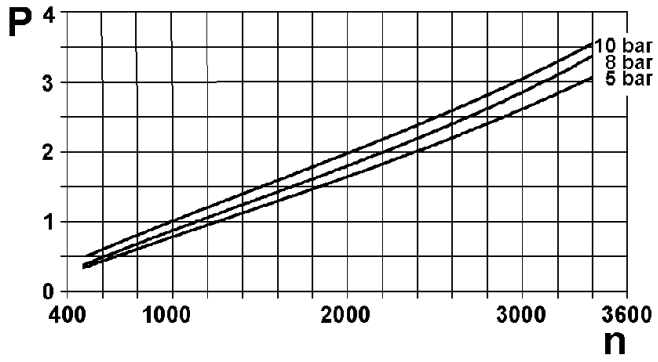
Installation of compressors with electrical coupling (schematic diagram)



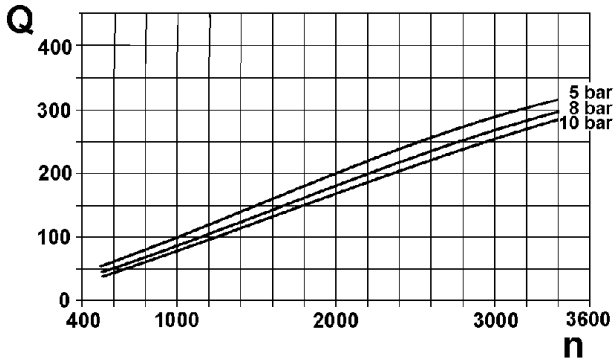
LEGEND					
A	Electrical coupling	**B**	Coupling disengaged Compressor is idling	**C**	Coupling applied Compressor is conveying air
411 141 100 0 = compressor; 975 303 474 0 = unloader valve; 441 014 025 0 = pressure switch; 950 XXX XXX 0 = reservoir					

Performance diagrams

Flow rate



Average rated performance

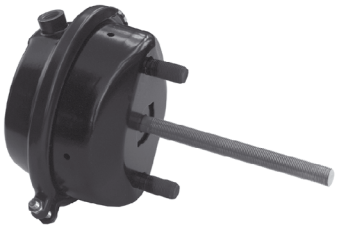


LEGEND					
Q	Non-pressurised air [l/min]	**p**	Performance (kW)	**n**	Rotational speed [rpm]

5.3 Diaphragm cylinder 423 XXX

Design types

Cam brake

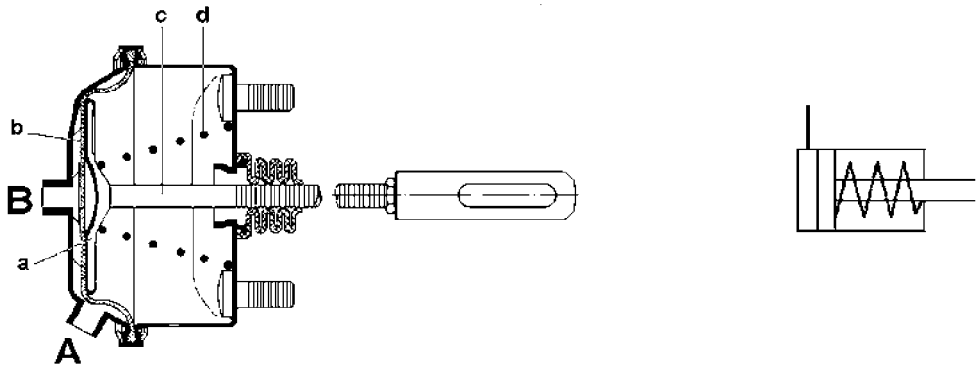


Disc brake

Purpose

Diaphragm cylinders generate the braking force for the wheel brakes. They are also used to actuate different mechanisms (e.g. clamp, raise and switch).

Operating principle

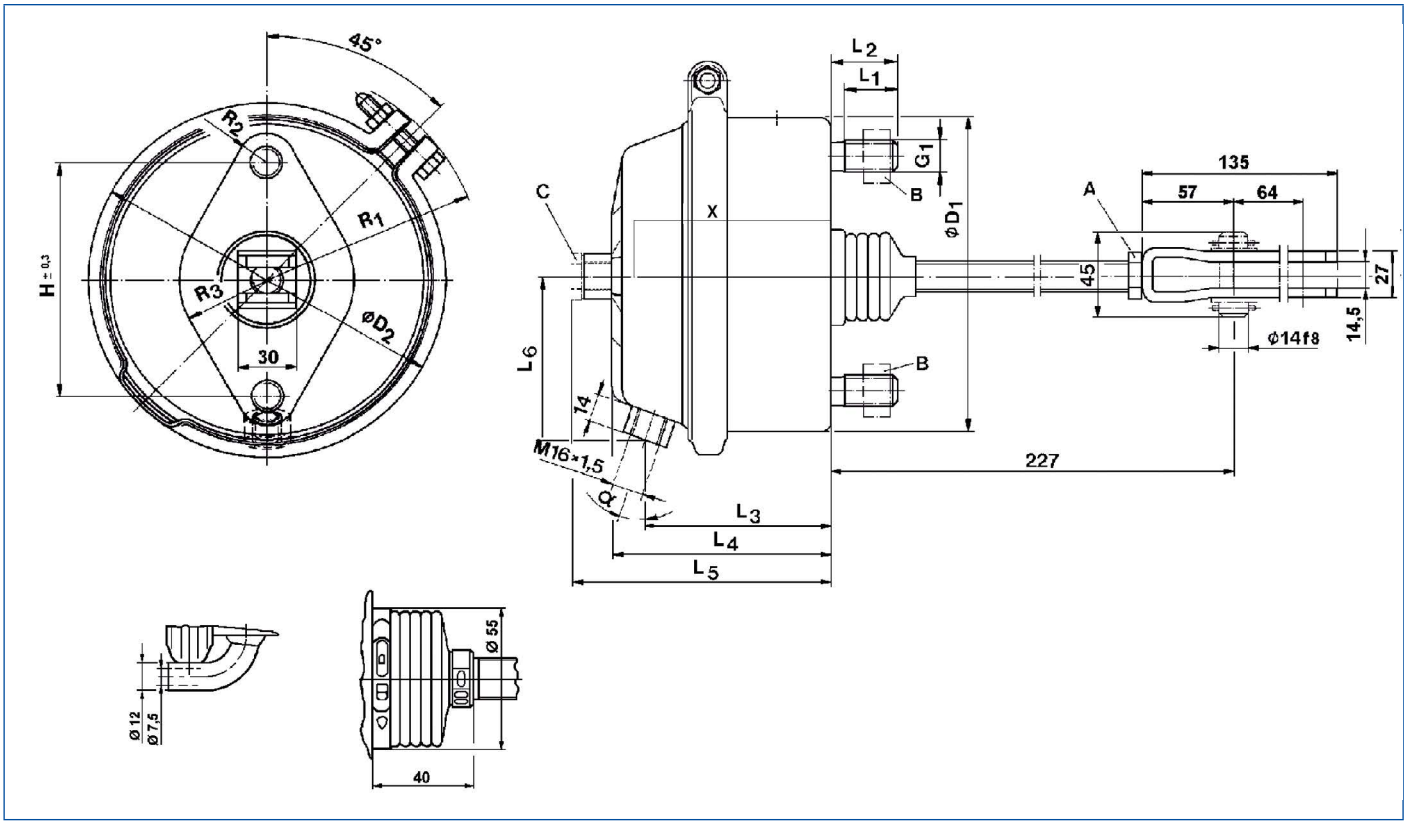


If compressed air is applied to the diaphragm (**b**) via connection **A** or **B**, it moves to the right together with the piston (**a**). The generated piston force is applied via the push-rod (**c**) to the hinged brake lever (slack adjuster) and therefore onto the wheel brake. When draining the brake cylinder, the spring (**d**) presses the piston (**a**) and the diaphragm (**b**) back into the rest position. The force output of the diaphragm cylinder depends on the effective diaphragm surface – which can vary in size depending on the camber – and the pressure applied on the diaphragm (**b**).

Technical data – Diaphragm cylinder for the cam brake (with bellows)

PRODUCT NUMBER	423 106 905 0	423 008 919 0
Max. operating pressure [bar]	8.5	
Thermal range of application [°C]	-40 to +80	
Deflection of the push rod	Z: 3° on all sides	
Type	24	36
Max. stroke [mm]	75	76
Capacities at 2/3 stroke [litres]	0.93	1.65
Tightening torque [Nm]	80 ± 10	
Tightening torque B [Nm]	180 +30	
Tightening torque C [Nm]	45 ± 5	60 ± 5
Accessories pack	423 000 533 2	–
Weight [kg]	3.9	6.9
Comment	Fording ability: Venting with pipe; Supplied with accessories pack	The diaphragm cylinder type 36 (thread M 22x1.5) is delivered complete with fastening nuts and screw plug, but without a yoke joint (see table "Accessories pack" below).

Installation dimensions – Diaphragm cylinder for the cam brake (with bellows)



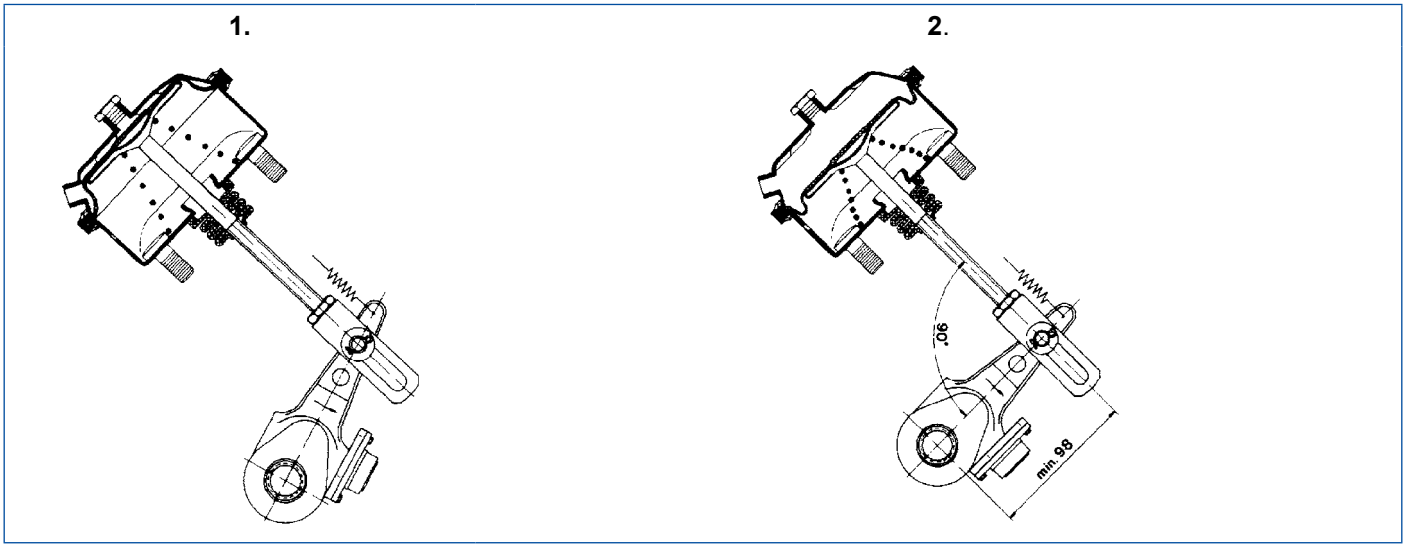
TYPE	Installation dimensions [mm]														
	D_1	D_2	G_1	H	L_1	L_2	L_3	L_4	L_5	L_6	R_1	R_2	R_3	X	α
24	161	185	M 16x1.5	120.7	27	34	96	113	134	85	112	15	45	96	19.5°

Installation recommendation

- Install the diaphragm cylinder at an upward slant to the yoke joints so that any penetrating water can run out again.
- Make sure that the brake line is not lower than the cylinder heads when installing, so that the brake line and the connection points will not be damaged (by ground contact).
  Two couplings on the diaphragm cylinder simplify the line route, which can be used optionally by implementing the screw-plug.
  When installing the cylinder or when adjusting the brake, the push-rod cannot be pulled out.
- Make sure that in the rest position the piston and the diaphragm are pressed against the housing by the spring built into the device (see the following installation diagram).
- To prevent damage to parts of the cylinder, make sure that a rod that is acting on the brake lever does not pull out the mechanical parking brake assembly for the push-rod when operating the mechanism.
  Instead of the round-hole yoke joint, equip the diaphragm cylinder with a yoke joint with a slot. This enables a separate actuation of the parking brake assembly over 2/3 of the maximum cylinder stroke.

The axle manufacturers recommend using the sealed version for trailing steering axles with vertically installed diaphragm cylinders (piston rod points upwards): Order number 24": 423 106 905 0 (with accessories pack)

Installation diagram

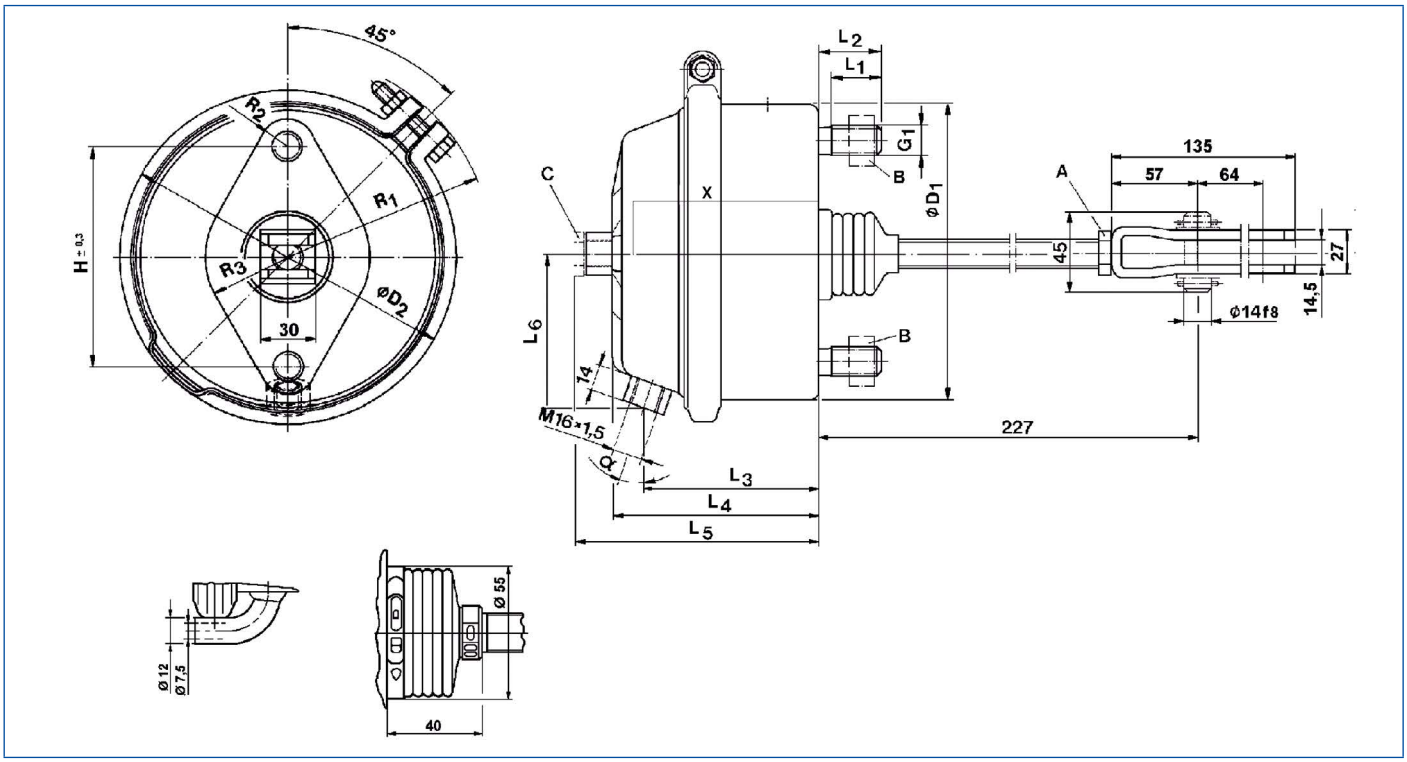


LEGEND	
1. Rest position: no play permitted between piston and diaphragm	2. Operating position: at maximum stroke

Technical data – Diaphragm cylinder for cam brake (with bellows)

PRODUCT NUMBER	423 106 905 0	423 008 919 0
Max. operating pressure [bar]	8.5	
Thermal range of application [°C]	-40 to +80	
Deflection of the push rod	Z: 3° on all sides	
Type	24	36
Max. stroke [mm]	75	76
Capacities at 2/3 stroke [litres]	0.93	1.65
Tightening torque [Nm]	80 ± 10	
Tightening torque B [Nm]	180 +30	
Tightening torque C [Nm]	45 ± 5	60 ± 5
Accessories pack	423 000 533 2	–
Weight [kg]	3.9	6.9
Comment	Fording ability: Venting with pipe; supplied with accessories pack	The diaphragm cylinder type 36 (thread M 22x1.5) is delivered complete with fastening nuts and screw plug, but without a yoke joint (see table "Accessories pack" below).

Installation dimensions – Diaphragm cylinder for cam brake (with bellows)

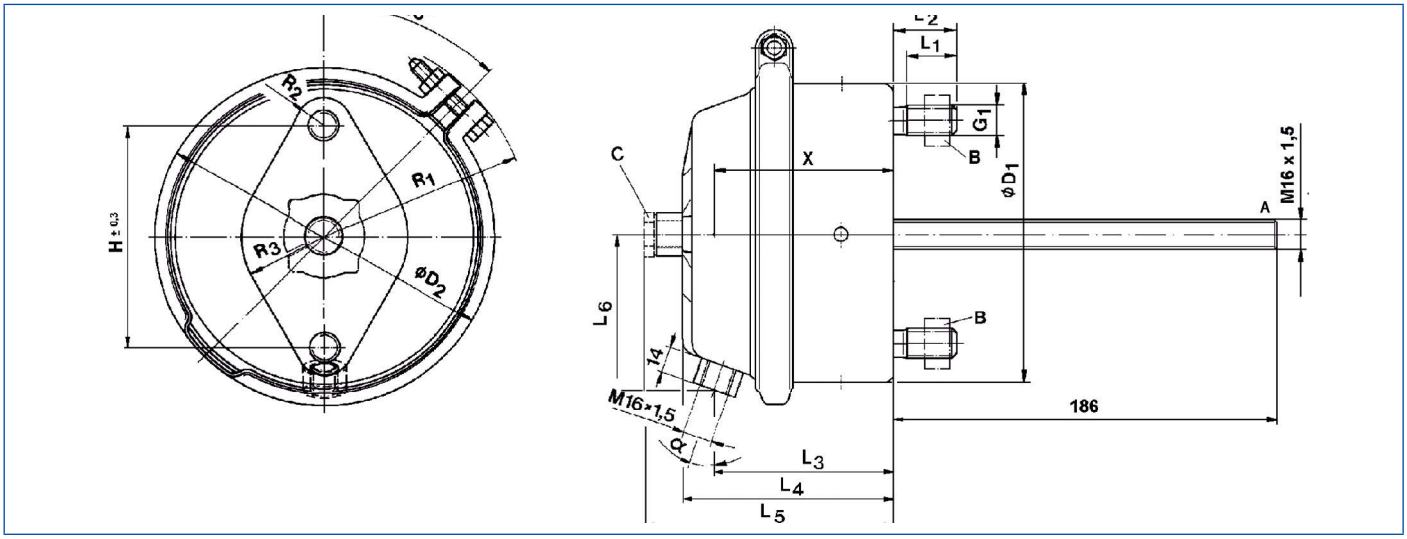


TYPE	Installation dimensions [mm]														
	D_1	D_2	G_1	H	L_1	L_2	L_3	L_4	L_5	L_6	R_1	R_2	R_3	X	α
24	161	185	M 16x1.5	120.7	27	34	96	113	134	85	112	15	45	96	19.5°
36	–	230	M 16x1.5	120.7	27	33	136	152	176	112	133	21.5	55	134	15°

Technical data – Diaphragm cylinder for cam brake (with sealing washers)

PRODUCT NUMBER	423 102 900 0 TYPE 9	423 103 900 0 TYPE 12	423 104 900 0 TYPE 16	423 105 900 0 TYPE 20	423 106 900 0 TYPE 24	423 107 900 0 TYPE 30
Max. stroke [mm]	57		75			
Max. capacities at 2/3 stroke [litres]	0.28	0.40	0.75	0.85	0.93	1.15
Tightening torque [Nm]	80 ± 10					
Tightening torque B [Nm]	70 +16			180 +30		
Tightening torque C [Nm]	–	40 ± 5				
Order number for "Round hole" accessories pack	423 902 537 2	423 902 533 2		423 000 534 2		
Order number for "Slotted hole" accessories pack	423 902 536 2	423 902 534 2		423 000 535 2		
Weight [kg]	2.0	2.5	2.8	3.1	3.5	4.5
Gaiter	Yes		No			

Installation dimensions – Diaphragm cylinder for cam brake (with disc seal)



TYPE	Installation dimensions [mm]														
	D_1	D_2	G_1	H	L_1	L_2	L_3	L_4	L_5	L_6	R_1	R_2	R_3	X	α
9	112	135	M 12x1.5	76.2	20	25	97	108	–	63	86	23	32	91	22.5°
12	123	144	M 12x1.5	76.2	20	25.5	103	114	136	66	94	22	34	98	22.5°
16	141	166	M 12x1.5	76.2	20	25.5	96	112	133	75	101	17	35	96	20.5°
20	151	174	M 16x1.5	120.7	27	34	96	112	134	80	105	15	45	96	20.5°
24	161	185	M 16x1.5	120.7	30	34.5	96	113	134	85	111	15	45	103	19.5°
30	162	209	M 16x1.5	120.7	27	34.5	104	113	134	92	123	15	45	102	30°

Characteristic curves of diaphragm cylinder for cam brake (with disc seals), types 9 to 30

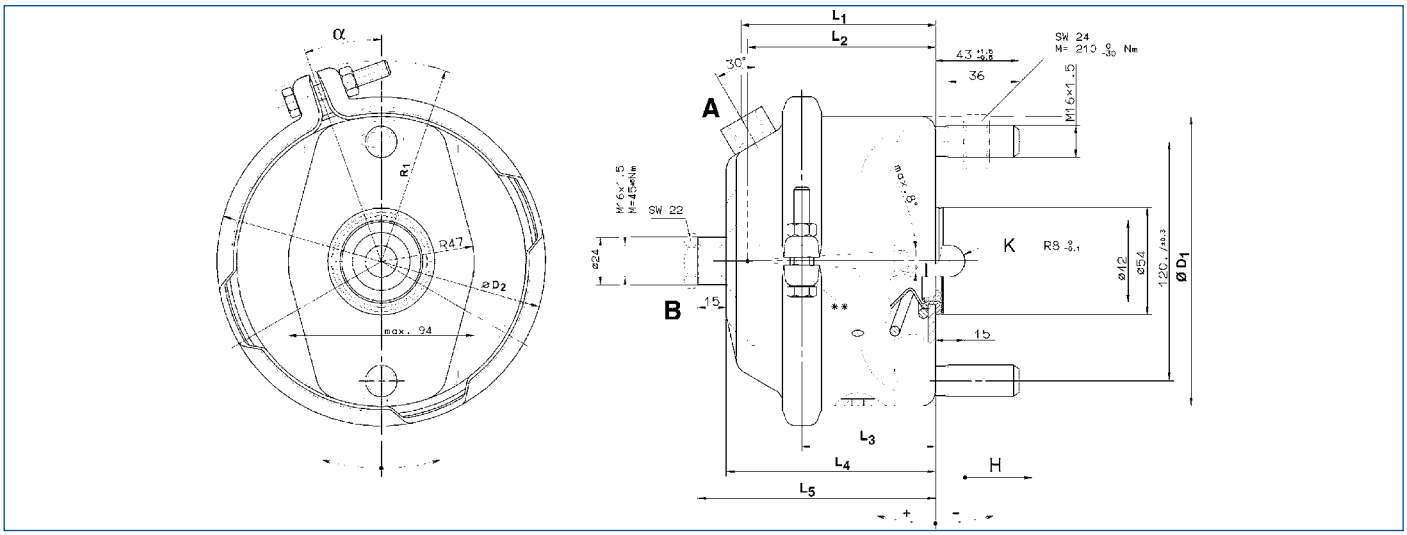
LEGEND			
F	The average piston force is the force determined with half an integration of the values between 1/3 and 2/3 of the overall piston stroke (h_{max}).	**p**	Pressure in brake cylinder
h	The usable piston stroke is the stroke at which the piston force is 90% of the average piston force F.	**t**	Type

TYPE	F [N]	h [mm]	h_{max} [mm]
9	606 x p - 242	0.64 x p + 44	60
12	766 x p - 230	0.57 x p + 46	60
16	1056 x p - 317	0.86 x p + 68	75
20	1218 x p - 244	0.74 x p + 69	75
24	1426 x p - 285	0.56 x p + 70	75
30	1944 x p - 389	0.67 x p + 62	75

Technical data – Diaphragm cylinder for disc brake

PRODUCT NUMBER	423 114 710 0 TYPE 14	423 104 710 0 423 104 715 0 423 104 716 0 423 504 003 0 TYPE 16	423 112 710 0 TYPE 18	423 505 000 0 TYPE 20	423 110 710 0 TYPE 22	423 506 001 0 TYPE 24
Max. deflection of the push rod	8° (with 0 mm stroke)					
Max. stroke [mm]	57		62			64
Capacities at 2/3 stroke [litres]	0.60		0.68	0.71	0.81	
Max. operating pressure [bar]	10			10.2		
Thermal range of application [°C]	-40 to +80					
Weight [kg]	3.0		3.1	3.3	3.5	3.7

Installation dimensions – Diaphragm cylinder for disc brake

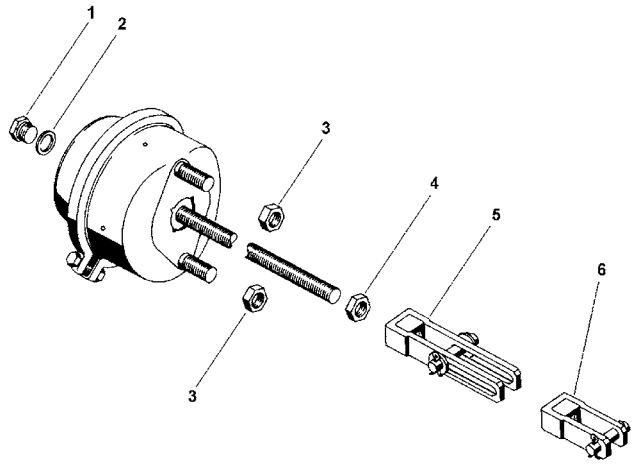


LEGEND			
K	Ball	**H**	Stroke

PRODUCT NUMBER	TYPE	Installation dimensions [mm]									CONNECTION	
		D_1	D_2	L_1	L_2	L_3	L_4	L_5	R_1	α	A	B
423 114 710 0	14	146	166	98	95	67	106	121	101	20°	x	1)
423 104 710 0	16	146	166	98	95	67	106	121	101	20°	x	x
423 104 715 0	16	146	166	100	94	66	104	119	103	0°	1)	x
423 104 716 0	16	146	166	100	94	66	104	119	103	90°	1)	x
423 504 003 0	16	146	166	98	92	64	102	117	101	0°	1)	x
423 112 710 0	18	175	175	94	92	65	103	117	106	20°	x	x
423 505 000 0	20	153	175	94	92	65	102	117	106	20°	x	x
423 110 710 0	22	163	185	94	92	65	102	117	111	20°	x	x
423 506 001 0	24	163	185	99	94	65	106	120	112.5	20°	x	x

LEGEND	
1)	with screw plug M 16x1.5

Accessories packs for diaphragm cylinder



ITEM	DESIGNATION		PRODUCT NUMBER	423 000 531 2	423 000 532 2	423 000 533 2	423 000 534 2	423 000 535 2	423 002 530 2	423 103 532 2	423 901 533 2	423 901 538 2	423 902 532 2	423 902 533 2	423 902 534 2	423 902 535 2	423 902 536 2	423 902 537 2	423 903 530 2
1	Screw plug	M 16x1.5	893 011 710 4	1	1	1	1	1		1			1	1	1				
2	Ring seal	A 16x20	811 401 057 4	1	1	1	1	1		1			1	1	1				
3	Hexagon nut	M 12	810 304 026 4	2	2				2	2									
		M 12x1.5	810 304 027 4										2	2	2	2	2	2	
		M 16x1.5	810 304 031 4			2	2	2				2							2
4	Hexagon nut	M 14x1.5	810 306 013 4						1	1									1
		M 16x1.5	810 319 029 4	1	1		1	1						1	1		1	1	
5	Yoke joint with bolt Ø 14	M 16x1.5	895 801 310 2		1			1							1		1		
		M 14x1.5	895 801 312 2						1	1									
6	Yoke joint with bolt Ø 14	M 16x1.5	895 801 513 2	1			1							1				1	
		M 14x1.5	895 801 511 2																1
		M 14x1.5	810 612 020 2																
-	Pins	14x45x35.6	810 601 100 4			1						1	1						
		14x45x31.2	810 601 097 4								1								
		12x45x34	810 601 084 4													1			
-	Washer	15	810 403 011 4			2						2	2						
-	Split pin	4x22	810 511 034 4			2					2	2	2			2			

Maintenance

Remove the diaphragm cylinder, even if it is functioning properly (no leaks, actuation pressure not greater than 0.5 bar) at least every 2 years. Remove and clean the diaphragm cylinder. Replace the worn parts.

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.4 Air dryer 432 410 / 432 415 / 432 433

5.4.1 Single chamber air dryer 432 410 / 432 415

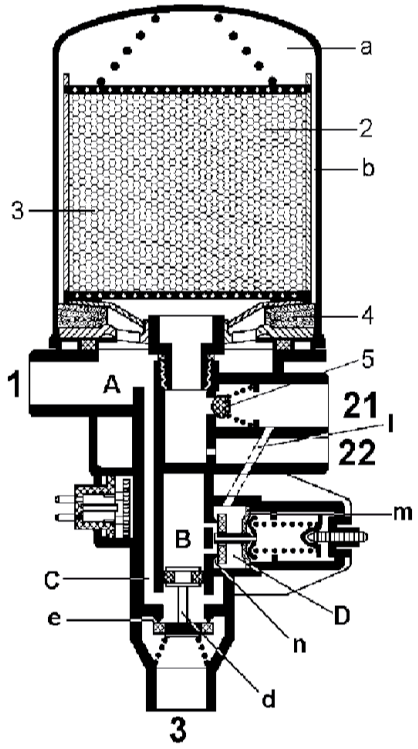
Design

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.

Operating principle



The compressed air entering the air dryer at port **1** and chamber **A** flows via the fine filter **4** and the annular duct **b** to the upper side of the granulate cartridge **2**. From here (chamber **a**), the compressed air flows through the cartridge **2**, and the moisture is absorbed by the surface of the granulates **3**. Dried compressed air then flows via the opening check valve **5** to port **21** and from there to the downstream components of the compressed air supply system. At the same time, compressed air flows through the throttle bore (**c**) and port **22** to the regenerating reservoir. The cut-off pressure reaches chamber **D** via the bore **l** and acts on the diaphragm (**m**). After the spring force has been overcome, the inlet (**n**) opens and the piston (**d**), which is now pressurised, opens the outlet (**e**). The air delivered by the compressor now escapes via chamber **A**, duct **C** and vent **3**. Piston (**d**) simultaneously acts as a relief valve. In the event of overpressure, the piston (**d**) automatically opens the outlet (**e**). If air consumption causes the supply pressure within the system to fall below the cut-in pressure, the inlet (**n**) closes and the pressure from chamber **B** is reduced through the vent of the unloader valve. The outlet (**e**) closes and the drying process begins again.

Technical data

PRODUCT NUMBER	432 410 064 0	432 410 221 0	432 415 921 0
Retrofitter	John Deere	AGCO	CNH/SDF
Max. operating pressure [bar]	13		
Thermal range of application [°C]	-40 to +65		
Current type	Direct current		
Voltage [V]	–	12	
Max. permitted frequency [Hz]	50		
Heater "switch-on point" [°C]	–	7 ± 6	
Heater "switch-off point" [°C]	–	29.5 ± 3	
Performance "without current" [W]	–	100	
Performance "at 12 V" [W]	–	95 +0/-5	
Cut-off pressure [bar]	8.2 ± 0.2	8.1 ± 0.2	8.3 +0.4
Operating range [bar]	0.6 +0.4		0.7 +0.5
Return limit valve (no regeneration reservoir required)	No		Yes
Heater plug	–	Bayonet	Kostal
Silencer	Yes	No	Yes
Weight [kg]	3.7		4.6

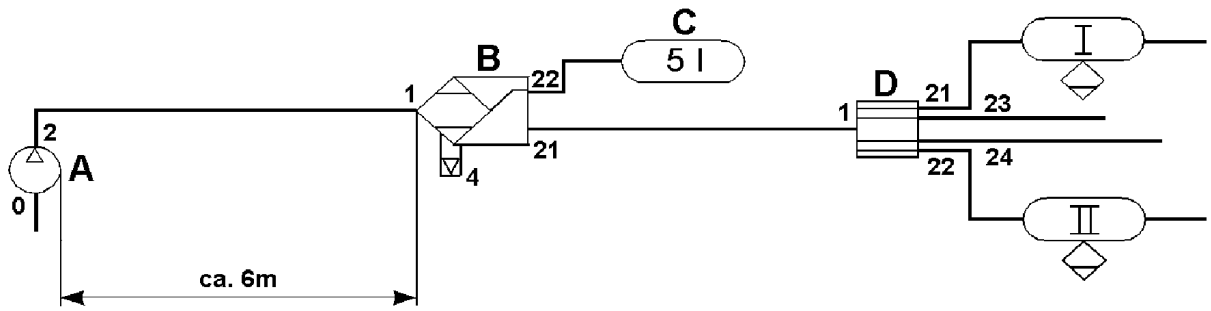
Replacement cartridges: 432 410 020 2, 432 901 223 2

HEATER	CABLE	CONNECTION	LENGTH
894 260 044 2	894 600 454 2	M 27x1.5	5 m
894 260 044 2	894 600 458 2	M 27x1.5	10 m

Installation recommendation

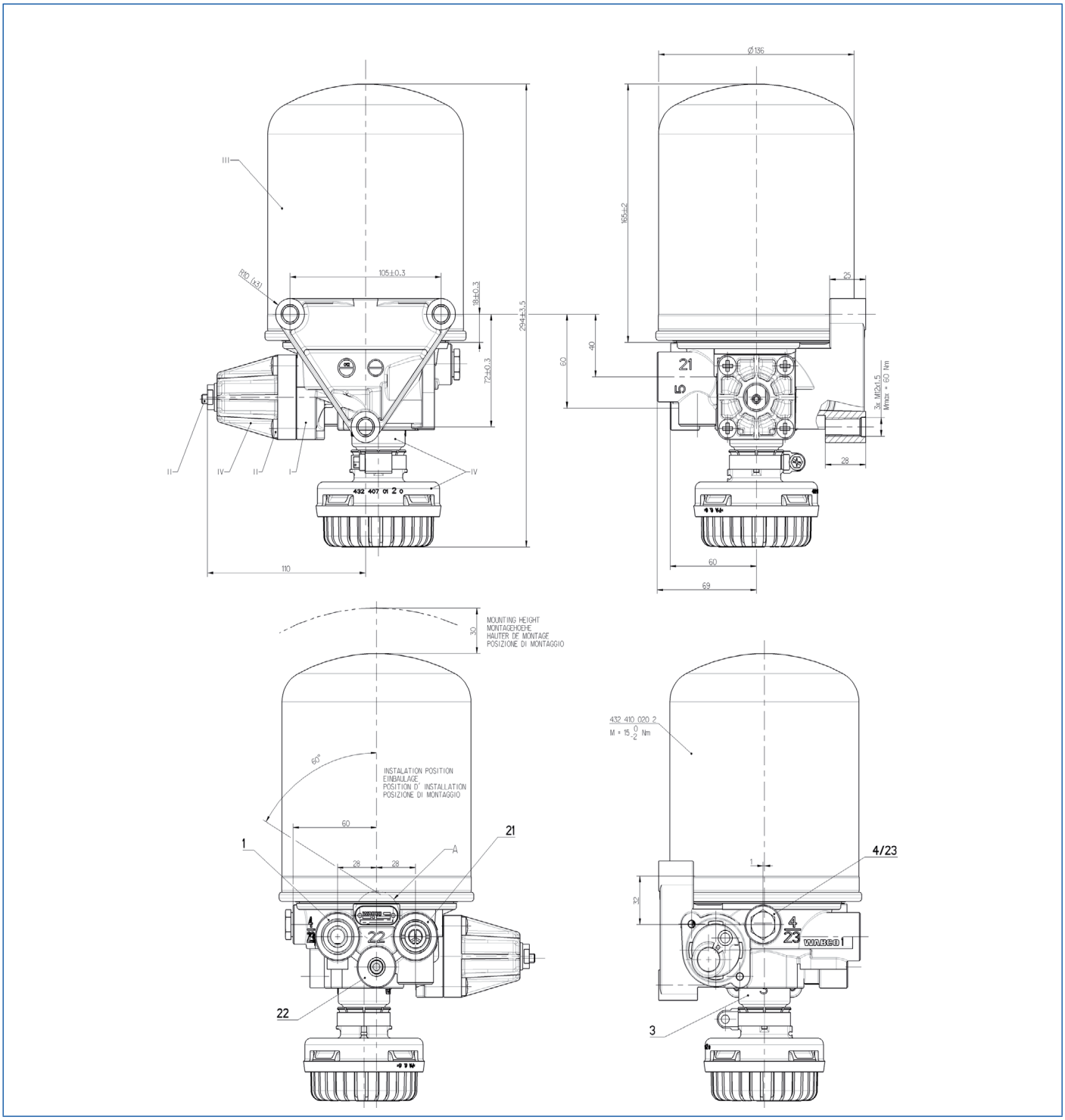
The air dryer must be installed vertically, i.e. with the filter box at the top.

Installation diagram



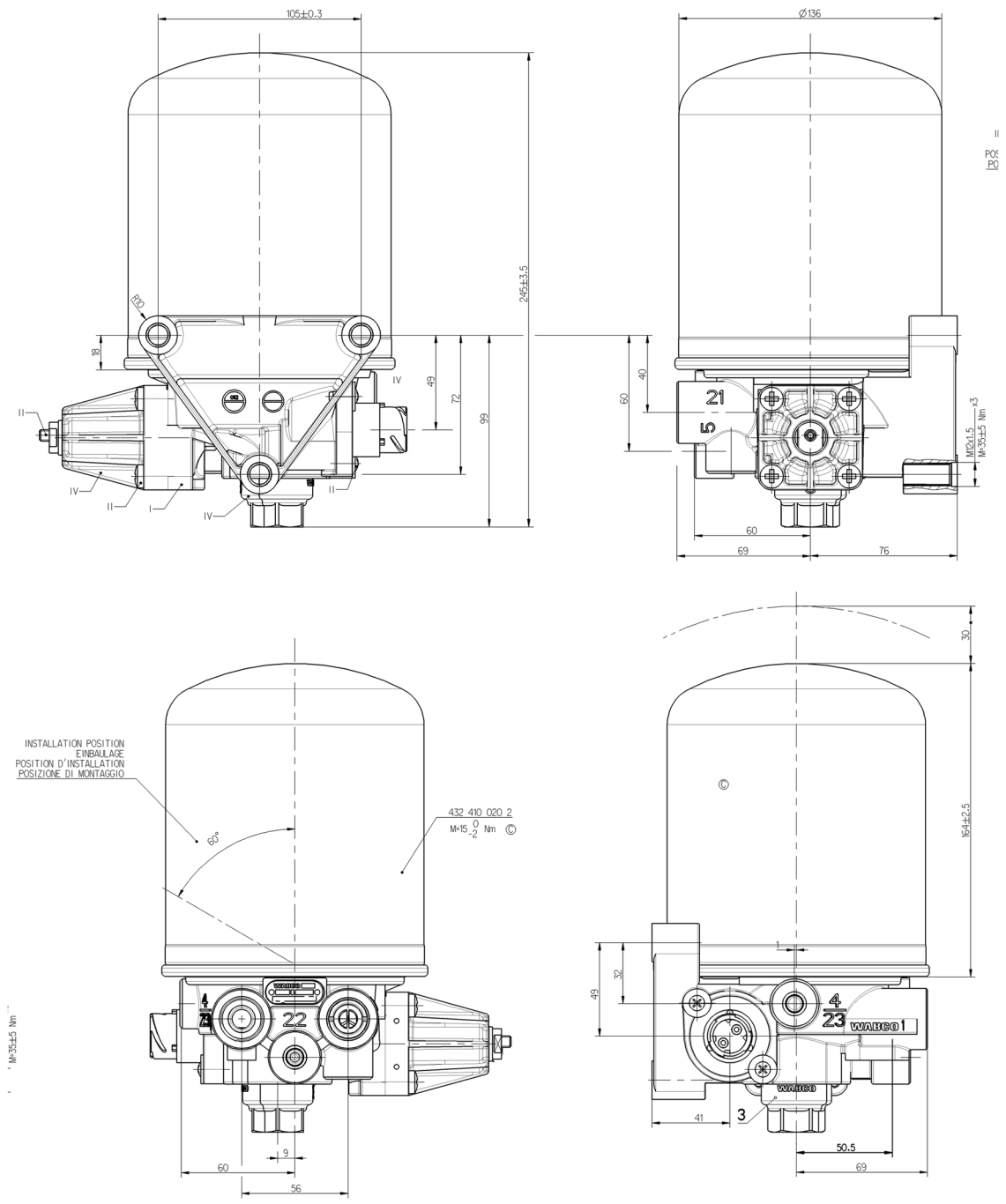
LEGEND							
A	Compressor	**B**	Single chamber air dryer with unloader valve	**C**	Regenerating air reservoir	**D**	Four-circuit safety valve

Installation dimensions for 432 410 064 0



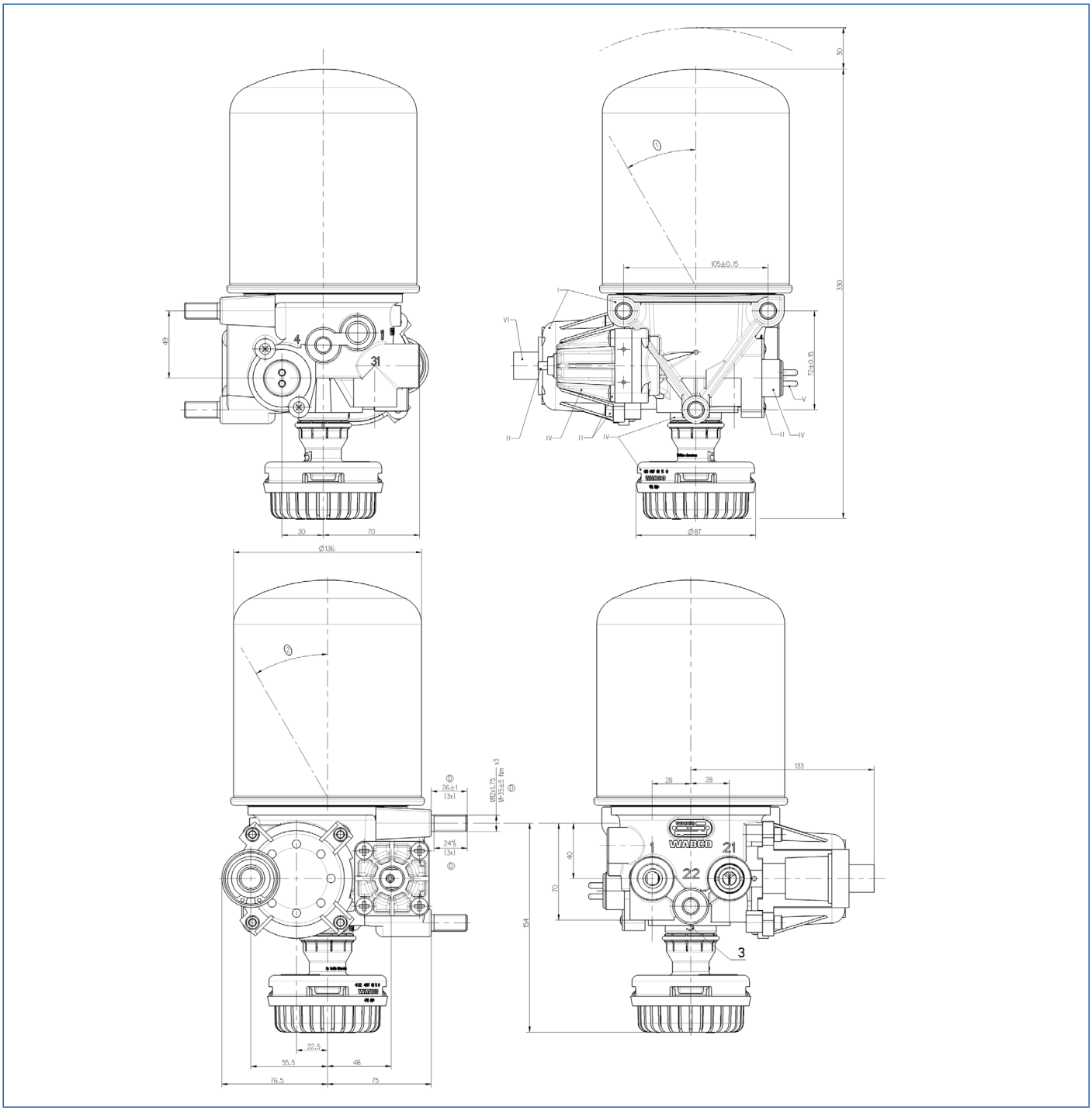
LEGEND			
1	Energy supply from compressor M 22x1.5	**21**	Energy discharge to air reservoirs M 22x1.5
22	Energy discharge to regenerating air reservoir M 12x1.5	**4/23**	Control connection / to compressor M 12x1.5
3	Venting for compressed air		

Installation dimensions for 432 410 221 0



LEGEND			
1	Energy supply from compressor M 22x1.5	**21**	Energy discharge to air reservoirs M 22x1.5
22	Energy discharge to regenerating air reservoir M 12x1.5	**3**	Venting for compressed air

Installation dimensions for 432 415 921 0



LEGEND			
1	Energy supply from compressor M 22x1.5	**21**	Energy discharge to air reservoirs M 22x1.5
3	Venting for compressed air		

Test

Check that the air dryer is leak-tight and the regeneration is functioning correctly. To do this, fill the compressed air system until the unloader valve switches off and then shut down the engine. The regenerating air must flow out of the air dryer vent for approx. 10 seconds.

Maintenance

Regularly check the air reservoirs for condensation when the vehicle is being driven. If any condensation is detected, check the regenerating functionality and, if necessary, replace the granulate cartridge. Experience has shown that it may be necessary to replace the granulate after approx. 2 years. Full cartridges or granulate are hazardous waste. Spent cartridges are taken back when they are replaced.

5.4.2 Dual chamber air dryer 432 433

Design

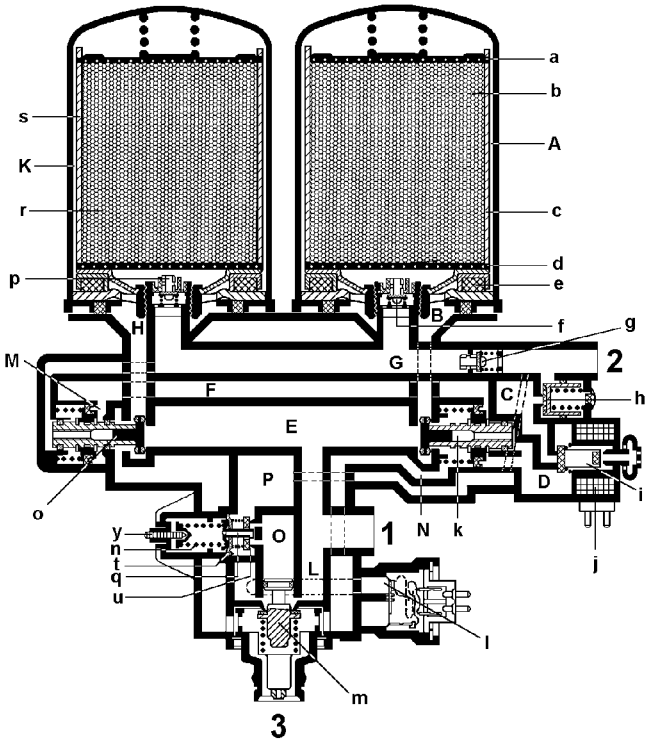
Purpose

Air dryers can be fitted in all air compression systems. Their purpose 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.

Operating principle



Controlling without an integral unloader valve

The compressed air conveyed by the compressor flows through the port **1** into the bore **E**. The fall in temperature can cause condensation to accumulate in the bore **E**, which seeps through the bore **L** to the idle valve (**m**). The compressed air flows from the bore **E** past the opened valve (**k**) into the chamber **B**, and on through the fine filter integrated in the cartridge (**e**) and the annular chamber **A** on the top of the granulate cartridge (**c**). The pre-cleaned compressed air flows through the sieve plate (**a**) from top to bottom through the granulate sewn into a filter bag (**b**) in the cartridge (**c**), and then passes through the sieve plate (**d**) and check valve (**f**) into the bore **G**. As the air passes through the granulate (**b**), any moisture it contains is retained in the fine ducts of the extremely porous granulate. After opening the check valve (**g**), the compressed air flows from the bore **G** via the port **2** into the air reservoirs. Some of the dried compressed air from the bore **G** passes through the throttle bore of the valves (**f** and **p**), which is designed to accommodate the respective flow rate of the compressor, up to the underside of the cartridge (**s**), and then permeates the granulate (**r**) from the bottom to the top (backflow).

In this process, the dried air absorbs the moisture captured in the fine ducts of the extremely porous granulate (**r**), before flowing through the annular chamber **K**, the chamber **H**, and past the open rear side of the valve (**o**) on to the vent **3**.

The additional charging valve (**h**) ensures that the control valves (**k** and **o**) do not switch over when beginning to fill the system. The valve (**h**) does not open to allow the compressed air to enter the chamber **C** until a supply pressure of > 5 bar is attained at the port **2**. If the power supply to the magnetic coil (**j**) is released by the time switch element integrated in the solenoid valve, the armature (**i**) is retracted. Compressed air from the chamber **C** now flows into the chamber **D**, as well as through the bore **F** into the chamber **M**, and presses the control valves against the spring force into their left-hand end positions.

The passage from the bore **E** to the chamber **B** is closed. The compressed air in the chamber **B** now escapes past the open rear side of the control valve (**k**), through the bore **N**, on to the port **3**, and into the open air. The check valve (**g**) closes and the pressure in the system remains upheld. The drop in pressure in the chamber **B** causes the check valve (**f**) to close as well.

The compressed air conveyed by the compressor now flows from the bore **E** through the chamber **H**, the annular chamber **K**, and the granulate (**r**) in the cartridge (**s**). The drying process for the compressed air is as previously described. After opening the valve (**p**) and the check valve (**g**), the dry air flows via the port **2** on to the reservoirs. Dry air passes through the throttle bore of the valve (**f**) on to the underside of the granulate (**b**), so that backwashing takes place here as well.

After approx. 1 minute, the time switch element breaks the current supply to the magnetic coil. The armature (**i**) closes the passage from the chamber **C** and opens the vent with which the pressure in the chambers **D** and **M**is relieved. The spring force and pressure in the bore **G** causes the control valves to move back to their right-hand end positions. The control valve (**o**) closes the passage to the chamber **H**, and the control valve (**k**) opens the passage to the chamber **B**. The compressed air conveyed by the compressor is now fed back to the granulate (**b**), and the drying process takes place as previously described, whereby switching between the chambers continues to take place in minute cycles. When the unloader valve switches to idle once the defined cut-off pressure has been attained, pressure is fed in at the port **4**, and pressure is applied to the piston (**m**) so that it moves downwards, causing the idle valve opens. The accumulated condensation and dirt, together with the air conveyed during the idle phase, escapes into the open air through the vent **3**. When the unloader valve switches to the load cycle, the port **4** is vented, and the idle valve closes the passage to the vent **3**. Any malfunctioning due to icing in extreme conditions in the area of piston (**m**) can be prevented by fitting a heating cartridge (**l**), which switches on at temperatures below 6 °C, and switches off again when the temperature reaches approx. 30 °C.

Control with the integral unloader valve

The air is dried as described above. The pressure that builds up at the port **2** when the pneumatic system is being filled is also present in chamber **P**, and is applied to the underside of diaphragm (**t**). As soon as the resultant force is greater than the force of the compression spring (**n**) set with the screw (**y**), the diaphragm (**t**) arches and moves the piston (**q**) accordingly. This opens the inlet (**u**), and the pressurised piston (**m**) is moved downwards, opening the idle valve. The accumulated condensation and dirt, together with the air conveyed during the idle phase, escapes into the open air through the vent **3**. The compressor runs at idle speed until the pressure in the system has fallen below the activation pressure of the unloader valve. The pressure in the chamber **P** underneath the diaphragm (**t**) is relieved as well. The compression spring (**n**) moves the piston (**q**) and diaphragm (**t**) back to their original positions. The inlet (**u**) closes, and the pressure from chamber **O** is relieved through the unloader valve vent. The idle valve with piston (**m**) closes again. The compressed air now flows again into the bore **E**, and is conveyed as dried air to the air reservoirs through one of the desiccant cartridge (**b** or **r**) and the port **2**. The system is subsequently filled once again up to the cut-off pressure of the unloader valve.

Technical data

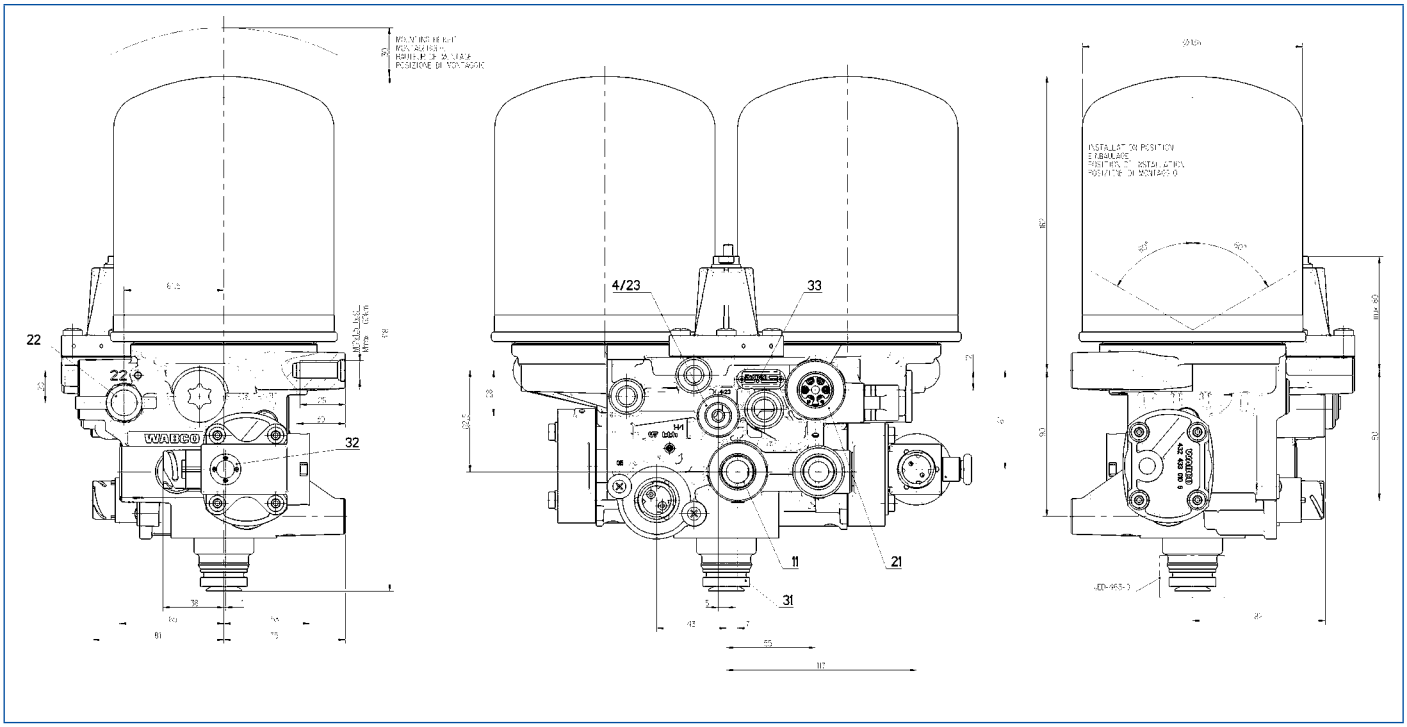
PRODUCT NUMBER	432 433 297 0
Retrofitter	AGCO
Max. operating pressure [bar]	13
Thermal range of application [°C]	-40 to +65
Current type	Direct current

PRODUCT NUMBER	432 433 297 0
Voltage [V]	12
Max. permitted frequency [Hz]	50
Heater "switch-on point" [°C]	7 ± 6
Heater "shut-off point"	29.5 ± 3
Performance "without current" [W]	100
Performance "at 12 V" [W]	95 +/-5
Cut-off pressure [°C]	8.5 ± 0.2
Operating range [bar]	0.6 +0.7
Return limit valve (no regeneration reservoir required)	No
Heater plug	Bayonet
Silencer	No
Weight [kg]	8.8

Installation recommendation

The air dryer must be installed vertically, i.e. with the filter box at the top.

Installation dimensions



LEGEND					
11	External filling (alternative: compressor) M 22x1.5	**21**	To safety valve M 22x1.5	**22**	Tyre valve
4/23	Control connection M 16x1.5	**31/32/33**	Venting for compressed air		

Test

Check that the air dryer is leak-tight and the regeneration is functioning correctly. To do this, fill the compressed air system until the unloader valve switches off and then shut down the engine. The regenerating air must flow out of the air dryer vent for approx. 10 seconds.

Maintenance

Regularly check the air reservoirs for condensation when the vehicle is being driven. If condensation is detected, check the regeneration function and replace the granulate cartridge if necessary.

Experience has shown that it may be necessary to replace the granulate after approx. 2 years. Full cartridges and the granulate are hazardous waste. Spent cartridges are taken back when they are replaced.

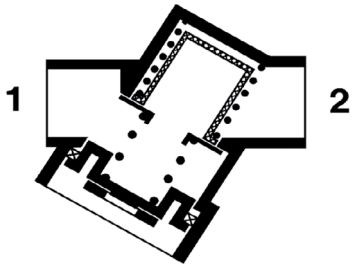
5.5 Line filter 432 500

Design

Purpose

Line filters protect the pneumatic braking system against impurities. The are fitted for single and dual line brakes on all trailers in the vicinity of the coupling to the towing vehicle. If there are no filters already integrated in the hose couplers, line filters are inserted into the brake line and the supply line.

Operating principle



The compressed air delivered to the line filter via the port **1** flows through the filter cartridge. This causes any dirt particles to be retained, and the cleaned compressed air is conveyed to the downstream appliances from the port **2**. The filter cartridge is pushed upward against the force of the compression spring if the line filter is blocked. The compressed air then passes uncleaned through the line filter. If the port **1** is vented while the filter cartridge is clogged, the pressure in the port **2** can push the cartridge downwards against the force of the compression spring. This ensures a backflow from the port **2** to the port **1**.

Technical data

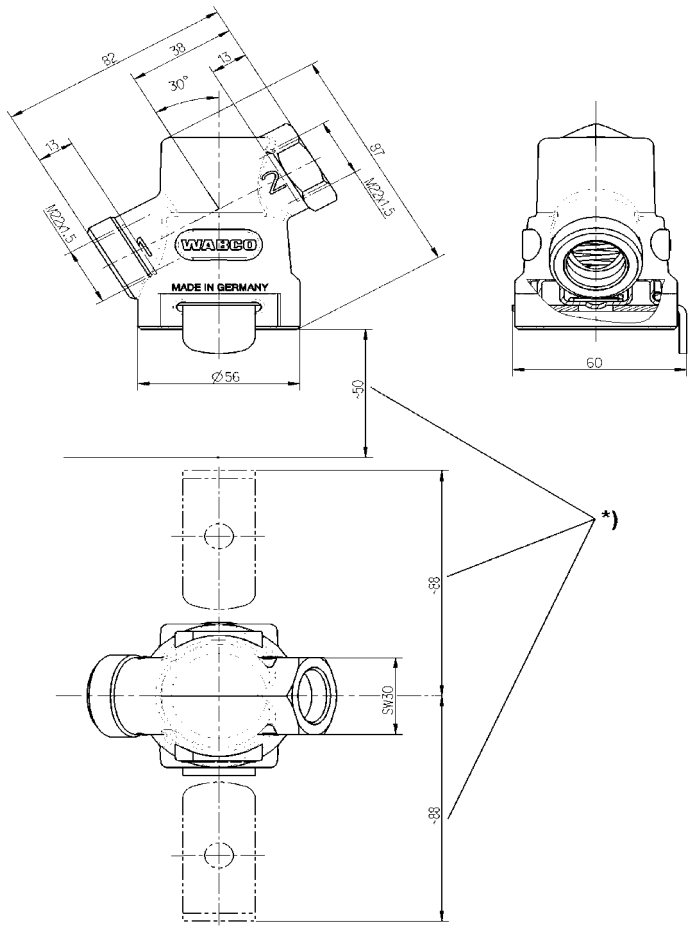
PRODUCT NUMBER	432 500 020 0	432 500 021 0
Maximum operating pressure [bar]	20	
Free passage	Ø 12 mm = 1.13 cm^2	
Pore size of filter [µm]	80 to 140	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	0.26	0.28

Installation recommendation

Install the line filter in the pipe system without fastening it with a bulkhead screw connector.

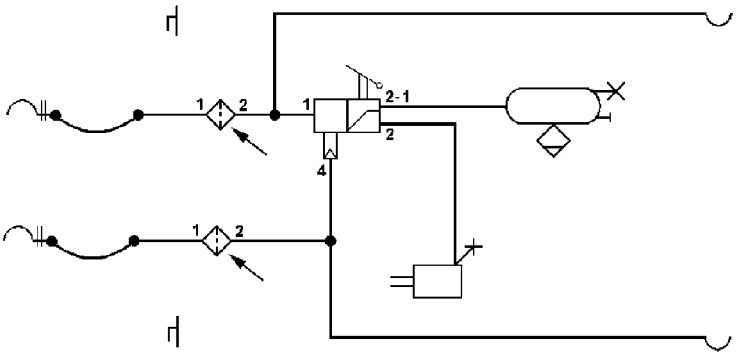
Note: Make sure that there is sufficient space for removing the filter insert (see illustration below).

Installation dimensions



LEGEND					
*)	Space required for removing filter cartridge	1	Energy supply	2	Energy discharge

Installation diagram



Maintenance

Clean the line filter – depending on the operating conditions – every 3 to 4 months. This is done by removing the filter cartridge and flushing out with compressed air. Replace damaged filter cartridges.

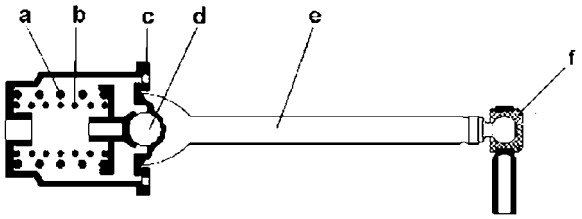
5.6 Knuckle joint 433 306

Design types

Purpose

Knuckle joints prevent damage to load-dependent control valves or automatic load-sensing valves when the axle suspension is compressed or extended past the normal distance. They are only suitable for vehicles with a leaf-spring suspension, and are used in conjunction with mechanical LSV controllers.

Operating principle



In the event of large axle oscillations in excess of the range of movement of the load-sensing valve, the rocker arm (**e**), which is horizontal in the rest position, is deflected around a fixed point in the housing (**c**). Compression springs (**a** and **b**) exert pressure on ball (**d**) providing constant tensional contact with the housing (**c**) until the rocker arm (**e**) returns to its normal horizontal position where it is again in full contact with the front face of the housing. Twisting of the connecting linkage to the load-sensing valve is prevented by being mounted in a ball joint (**f**) at the rocker arm (**e**).

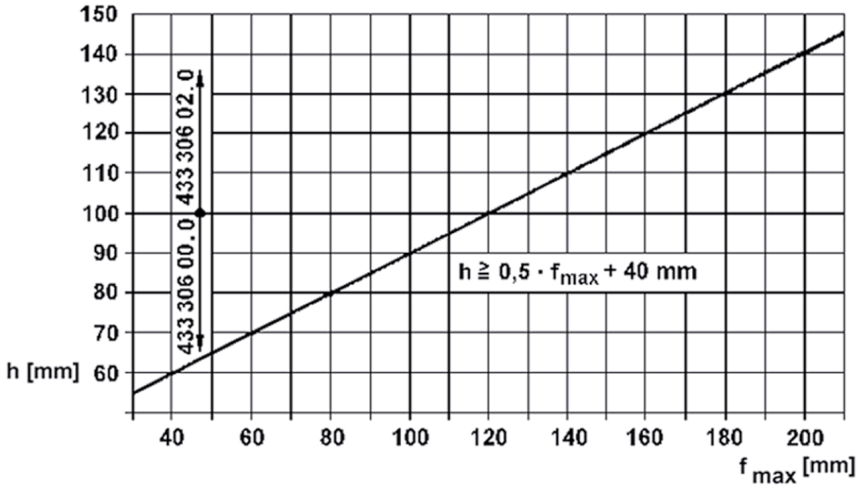
Technical data

PRODUCT NUMBER	433 306 002 0
Length L [mm]	260
Deflection h [mm]	100
Deflection force "F_1" [N] see installation dimensions	90
Deflection force "F_2" [N] see installation dimensions	190
Weight [kg]	0.52

Installation requirements

– Choose the knuckle joint that guarantees that the path exceeding the adjustment range of the controller is not greater than the possible deflection h.

– For trailers – single and dual axle – take the dimension for the deflection h from the following diagram:



– Fasten the knuckle joint to the single axle or between the two axles of the dual axle assembly.

Note: Observe the respective instructions of the vehicle manufacturer in this regard.

– Install the knuckle joint so that its ball joint is seated in the neutral point of the axle or axles.

The neutral point is the point that is free of outside influence:

- Twisting movement of the axle during braking procedure,
- Wandering in curves with steering axles,
- One-sided load on the axle with uneven streets.

Note: Only the static and dynamic axle changes are permitted to be the reason for adjusting the automatic load-sensing valve.

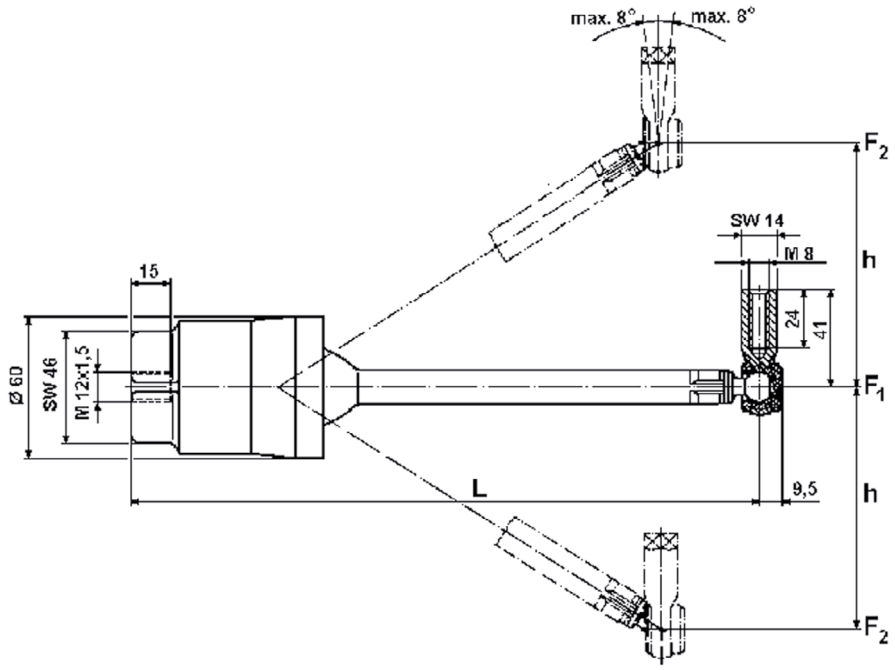
– Connect the knuckle joint through a round rod with an M8 thread and hexagon nut M8 DIN 934 (not included in delivery) with the adjustment lever of the automatic load-sensing valve. The length of this connecting rod depends on the mounting of the devices on the vehicle.
Depending on the existing fastening capabilities for the connecting rod of the load-sensing valve to be used, either leave the connecting rod smooth or apply an M8 thread of approx. 25 mm in length.

– Screw an M8 DIN 934 hexagon nut onto the thread.

– Screw the other end into the ball joint and secure it with the hexagon nut.

– Carefully deburr the smooth ends so that the rubber pressure pads are not damaged.

Installation dimensions



LEGEND			
h	Deflection	f_{max}	Max. spring deflection according to the specifications of the axle manufacturer

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.7 Linkage 433 401

Design

Purpose

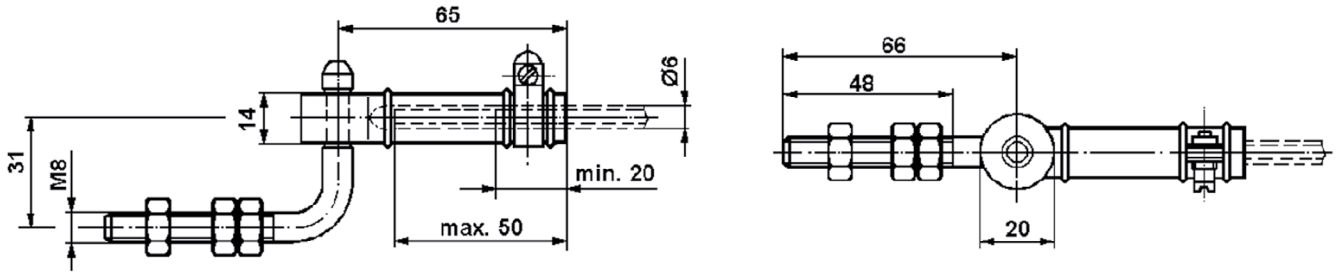
Linkages are flexible connections for coupling levelling valves or for coupling LSV controllers on dual axle power units.

Installation recommendation

Use a flat iron to fasten the linkage on the vehicle axle.

The ø 6 pipe for the connection between the two rubber sleeves (adjustment lever of the levelling valve and the linkage) is not included in the scope of delivery.

Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

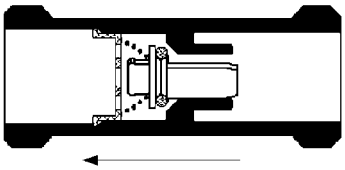
5.8 Check valve 434 014

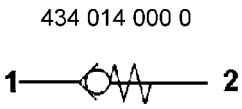
Design

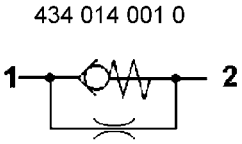
Purpose

Check valves of this type prevent pressurised lines from being unintentionally vented. They are used for many purposes in pneumatic systems.

Operating principle







Air can only pass in the direction indicated by the arrow on the housing. Air backflow is prevented by the check valve, which closes the inlet in the event of pressure loss in the supply line. If the pressure in the supply line increases, the spring-loaded check valve unblocks the air passage again so that a pressure compensation can take place.

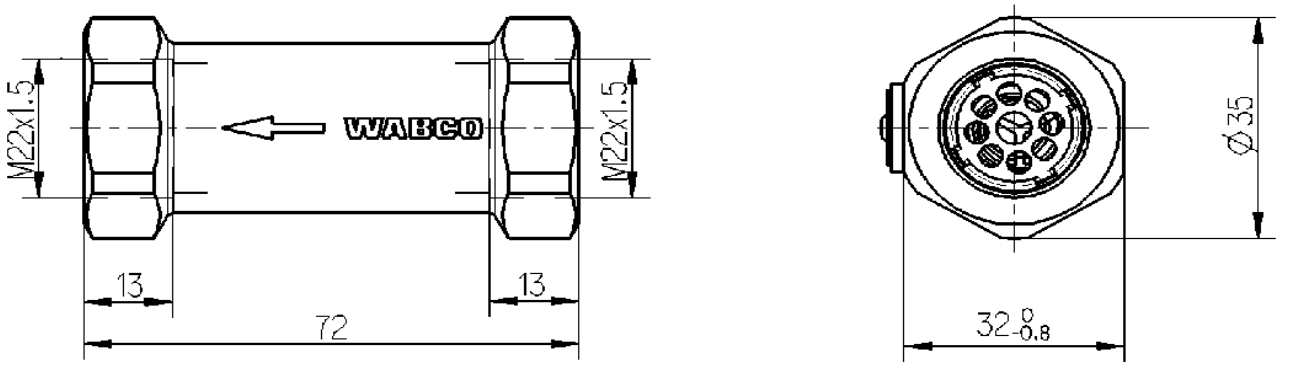
Technical data

PRODUCT NUMBER	434 014 000 0	434 014 001 0
Max. operating pressure [bar]	18	
Nominal width [mm]	Ø 8	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	0.17	0.16

Installation recommendation

Install the valve anywhere in the piping.
Pay attention to the arrow on the housing that shows the direction of flow.

Installation dimensions

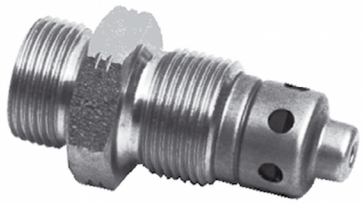


Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.9 Check valve 434 021

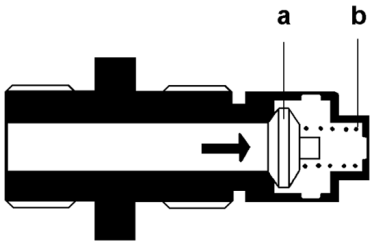
Design



Purpose

Check valves of this type prevent pressurised air reservoirs from being unintentionally vented.

Operating principle



The compressed air delivered through the supply line opens the valve (**a**) and flows into the air reservoir, provided its pressure is greater than the pressure in the reservoir. The valve (**a**) remains open until the pressures in the supply line and reservoir are the same. Any backflow of air from the reservoir is prevented by a valve (**a**), which is closed when the pressure drops in the supply line by the compression spring (**b**) and the now greater pressure in the reservoir. In the check valve, the air can only flow in the direction from the supply line to the reservoir.

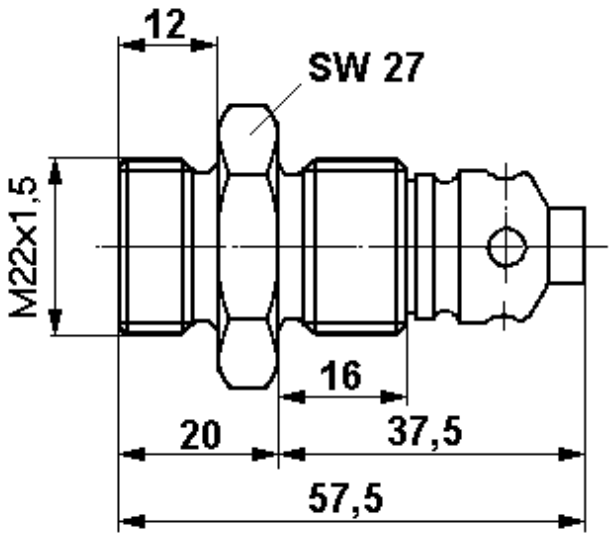
Technical data

PRODUCT NUMBER	434 021 000 0
Max. operating pressure [bar]	18
Thermal range of application	-30 °C to 80 °C
Weight [kg]	0.11

Installation recommendation

Bolt the check valve directly into one of the pipe connections for the air reservoir. Seal it with a suitable ring seal (A 22x27 DIN 7603 Fi).

Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.10 Charging valve 434 100

Design

Purpose

Charging valves are used for many purposes in pneumatic systems.

Charging valve with backflow

The passage for the air to the second compressed air reservoir is only released after the rated pressure for the braking system is attained in the 1st reservoir. As a result, the service braking system is operational more quickly. If the pressure in the first compressed air reservoir falls below that of the second reservoir, air is fed back to it out of the second reservoir.

Charging valve without backflow

The residual pressure is maintained in the lifting bellow of a lifting axle to prevent the bellows from creasing when the lifting axle is lowered. The passage for compressed air to consumers (e.g. door actuation, auxiliary and parking brake system, servo clutch, etc.) is only unblocked when the rated pressure for the braking system has been attained.

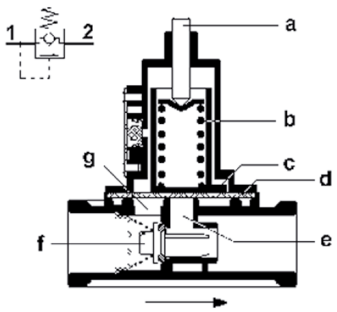
Charging valve with limited backflow

The passage for the compressed air to the trailer or consumers (e.g. auxiliary and parking brake system) is only unblocked when the rated pressure for the braking system has been attained. The required pressure for the towing vehicle is also assured in the event of a problem with the trailer supply line.

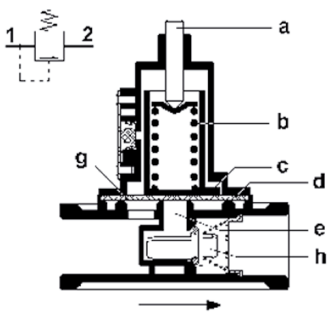
If the pressure in the air reservoirs for the service braking system drops, some of the compressed air flows back until the closing pressure (which is dependent on the charging pressure) is attained.

Operating principle

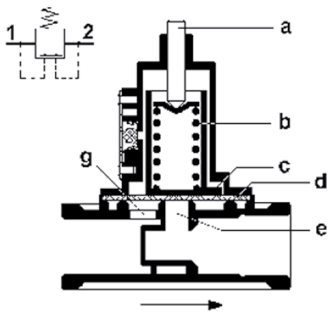
with backflow



without backflow



with limited backflow



1 = energy delivery; **2** = energy discharge

With all charging valves, the compressed air passes in the direction of the arrow into the housing and through the bore (**g**) underneath the diaphragm (**d**), which is pressed into its seat by the adjusting spring (**b**) and piston (**c**). When the charging pressure has been attained, the force of the adjusting spring (**b**) is overcome so that the diaphragm (**d**) is lifted from its seat and unblocks the bore (**e**). The air flows directly or after opening the check valve (**h**) to the reservoirs or consumers in the direction of the arrow.

With **charging valve with backflow**, the compressed air can flow out of the second reservoir after opening the check valve (**f**) if the pressure in the first reservoir has dropped by more than 0.1 bar.

With the **charging valve without backflow**, a backflow is not possible because the check valve (**h**) is kept closed by the higher pressure in the second reservoir.

With the **charging valve with limited backflow**, the air can flow back until the closing pressure of diaphragm (**d**) is attained. When this pressure is attained, the adjusting spring (**b**) presses the diaphragm (**d**) into its seat with the piston (**c**), thus preventing any further pressure compensation in the opposing direction to the direction of the arrow.

The charging pressure can be adjusted on all types by turning the adjusting screw (**a**). Turning it clockwise increases the charging pressure, turning it anti-clockwise has the opposite effect.

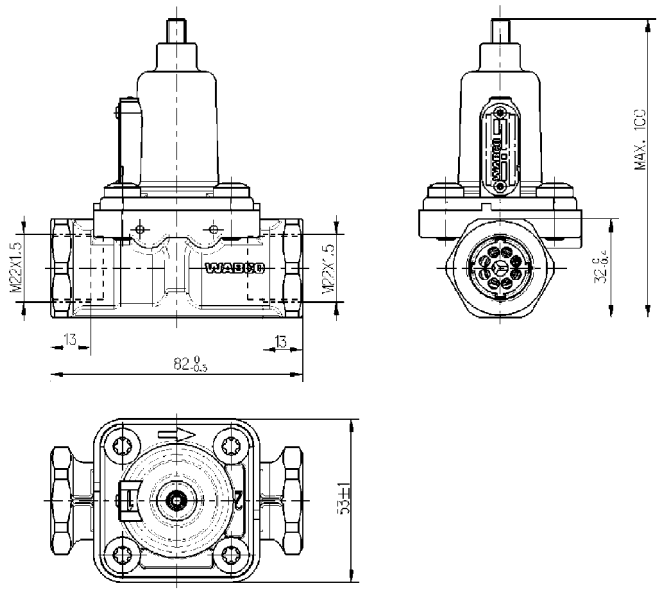
Technical data

PRODUCTNUMBER	434 100 024 0	434 100 027 0	434 100 122 0	434 100 124 0	434 100 125 0	434 100 126 0	434 100 222 0
Max. operating pressure [bar]	10						13
Nominal width [mm]	Ø 8						
Thermal range of application [°C]	-40 to +80						
Weight [kg]	0.43						
Valve type	with backflow		without backflow				with limited backflow
Charging pressure [bar] (tolerance -0.3)	6.0	0.5	4.5	5.5	6.0	6.5	6.2

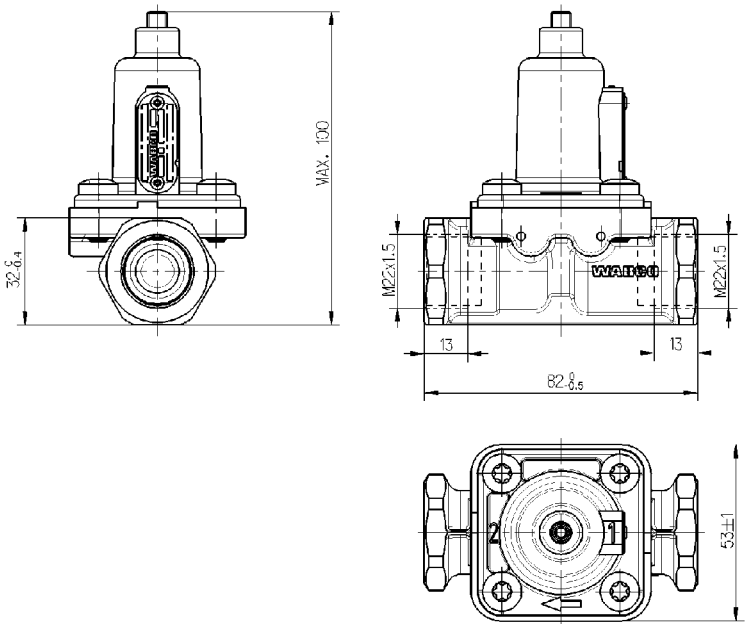
Installation recommendation

- Install the charging valve (floating) anywhere in the piping.
- Pay attention to the arrow on the housing, which shows the flow direction, when installing the valve.

Installation dimensions for charging valve with backflow 434 100 0XX 0



Installation dimensions for charging valve without backflow 434 100 1XX 0



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

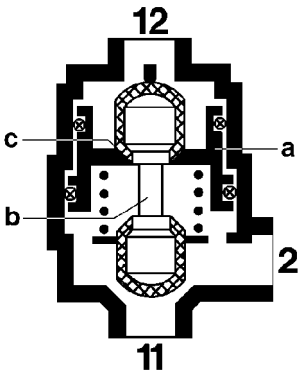
5.11 Two-way valve with pressure reducer 434 200

Design

Purpose

Two-way valves with a pressure reducer alternately charge one line of two separate lines or circuits, whereby the pressure applied via the port **12** is reduced.

Operating principle



If charging takes place via the port **11**, the piston (**a**) is pressed against the top end stop in the housing. The input pressure reaches the line leading from connection **2** without being reduced.

When charging via the port **12**, the piston (**a**) is pressed downwards. The valve body (**b**) closes the port **11** and opens the inlet (**c**). The compressed air now flows into the chamber **A** to the downstream devices via the port **2**. If the same force is now exerted on the bottom end of the piston (**a**), whose surface is 1.3 times greater than that of the top end, as is being exerted on the top end, the piston (**a**) move to its final position and the inlet (**c**) is closed. The compressed air only continues flowing again when the pressure drops at the port **2**.

Technical data

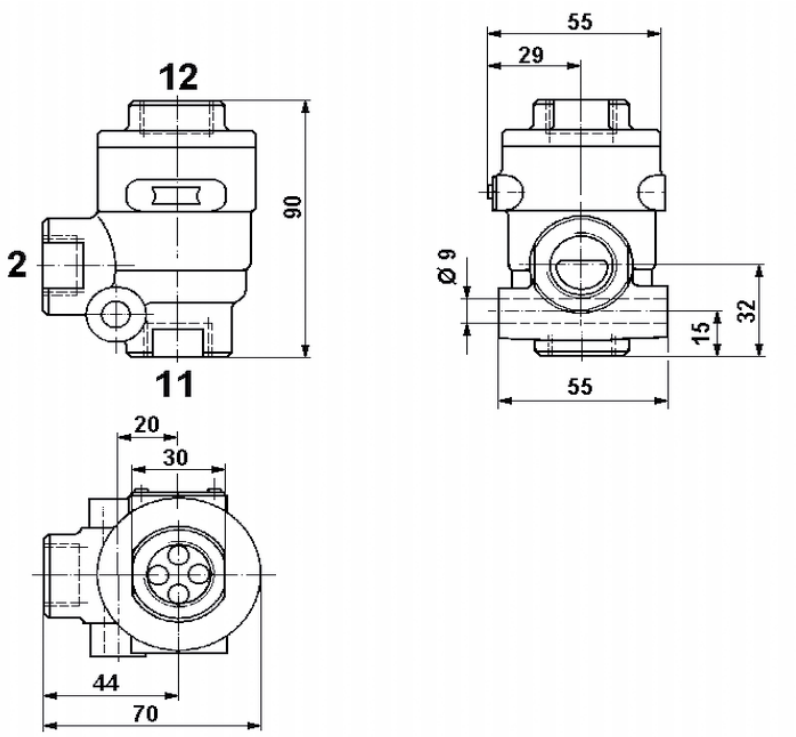
PRODUCT NUMBER	434 200 000 0
Max. operating pressure [bar]	10
Thermal range of application [°C]	-40 to +80
Nominal width [mm]	11.3
Pressure reduction **12** => **2**	i = 1.3 : 1
Weight [kg]	0.36

Installation recommendation

- Install the two-way valve in any position.
- Fasten the two-way valve with one M8 bolt.

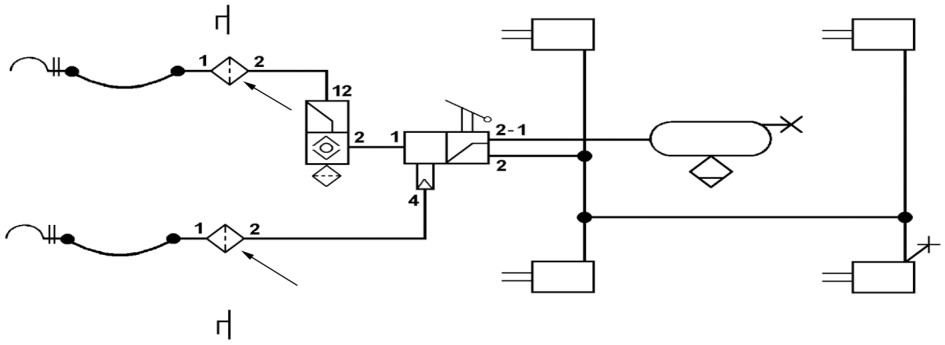
Installation dimensions

Suction filter arrangement – optionally I or II



LEGEND					
2	Energy discharge	**11**	Energy supply: non-reduced passage	**12**	Energy supply: reduced passage

Installation diagram



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.12 "Agriculture" compressed air test kit 435 002 011 0

Design

Purpose

The "Agriculture" compressed air test kit can be used to test pneumatic braking systems on agricultural or forestry trailer vehicles.

Test kit contents

QUANTITY	COMPONENTS
2	Pressure gauge "16 bar"
1	Test hose "blue"
1	Test hose "white"
2	Test connection M 16x1.5
2	Test connection M 22x1.5
1	Coupling head "red" M 16x1.5
1	Coupling head "yellow" M 16x1.5
1	Coupling head "1 line" M 22x1.5
1	Document "815 XX0 083 3 Agriculture and Forestry Pneumatic Braking System – Maintenance, Testing & Troubleshooting" (GER, ENG)

Documents attached to this kit include:

- Instructions on maintenance and leak tests
- Diagrams for pinpointing and remedying faults
- Instructions on setting the predominance of the trailer brake valve
- Settings for the LSV controller/manual controller
- A description of how to convert a single line into a dual line compressed air supply system.

5.13 Pressure switch 441 009

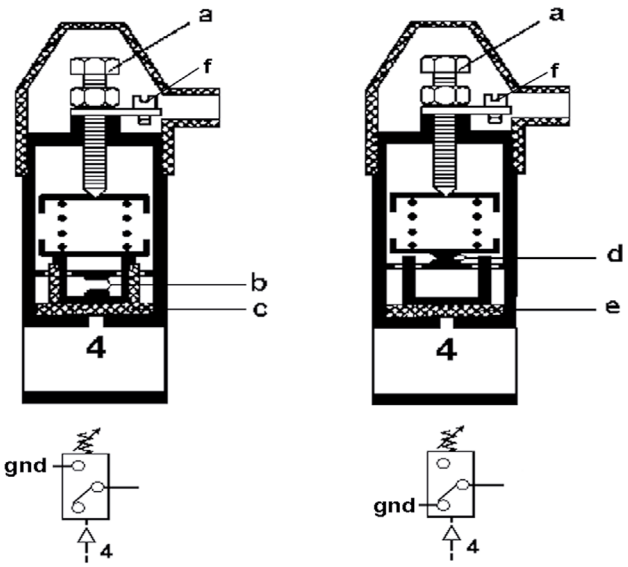
Design

Purpose

The pressure switch is used for switching electrical devices or indicator lights on and off.

Operating principle

On switch (working contact sensor) **Shut-off switch (idle contact sensor)**



On switch (unpressurised open)

If the pressure set at the switch is reached, the contacts (**b**) are closed by the diaphragm (**c**) as it arches upwards. If the pressure drops at the port **4**, the contacts (**b**) open again.

Shut-off switch (unpressurised closed)

If the pressure set at the switch is reached, the contacts (**d**) are opened by the diaphragm (**e**) as it arches upwards. If the pressure drops at the port **4**, the contacts (**d**) close again.

To adapt to the different switching tasks, the actuation pressure values for both switch types can be changed within certain ranges with the set screw (**a**). Connection (**f**) is for the cable connection.

LEGEND	
gnd	Ground

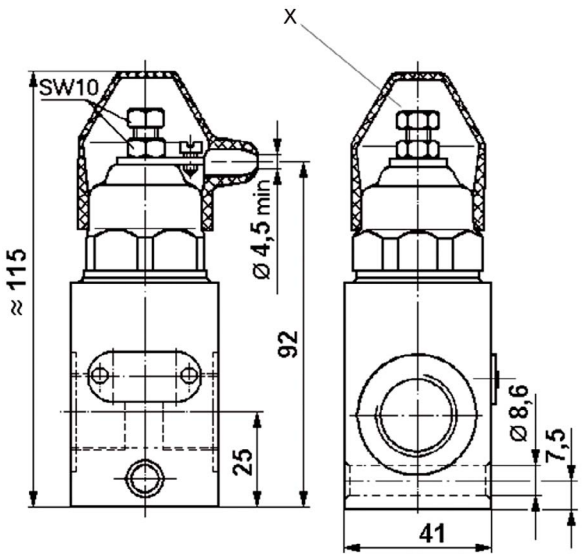
Technical data

PRODUCT NUMBER	441 009 001 0 ON SWITCH	441 009 101 0 SHUT-OFF SWITCH
Max. operating pressure [bar]	10	
Switching pressure "set to" [bar]	5.0 ± 0.2	
Switching pressure "adjustable from" [bar]	1.0 to 5.0	
Max. operating voltage (DC voltage) [V]	30	
Max. electrical switching capacity with inductive load and direct current [A]	2	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	0.26	

Installation recommendation

- Install the 1-pin pressure switch in any location in the pressure line.
- Fasten the pressure switch with one M8 bolt. Make sure that there is a good ground contact (do not fasten to plastic parts).
- Attach a cable eyelet to the cable to be connected.

Installation dimensions



LEGEND	
X	Adjusting screw

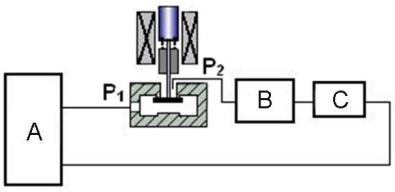
Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

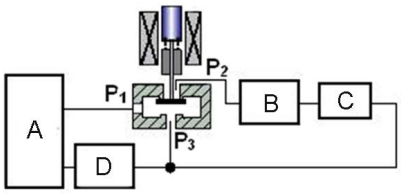
5.14 SCR valve 446 091

Design types

2/2 directional control valve



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.

Operating principle

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

PRODUCT NUMBER	446 091 303 0	446 091 307 0	446 091 310 0	446 091 305 0
Rated voltage [V]	12			
Function	2/2 directional control		3/2 directional control	
Connections	2x Voss 246	2x Norma (PS3 connection)	3x Voss 246	2x Norma (PS3 connection) 1x Voss 246
Electronic connector	Tyco HDSCS			
Weight [kg]	0.63		0.39	-

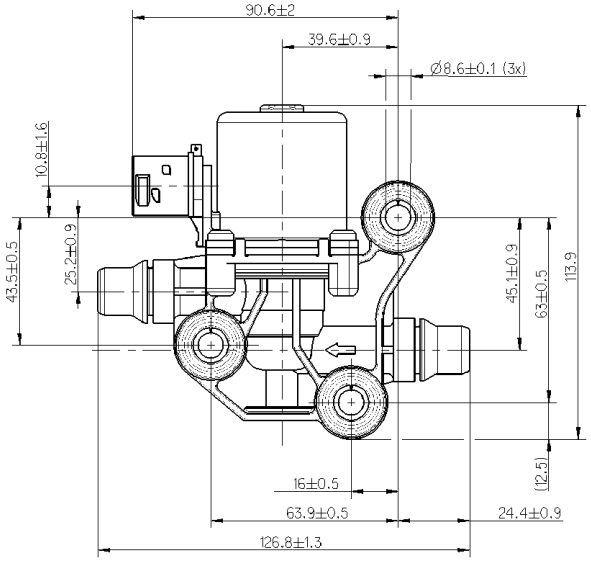
Installation recommendation

Install the valve in upright position with a maximum angle of 30° to the perpendicular.

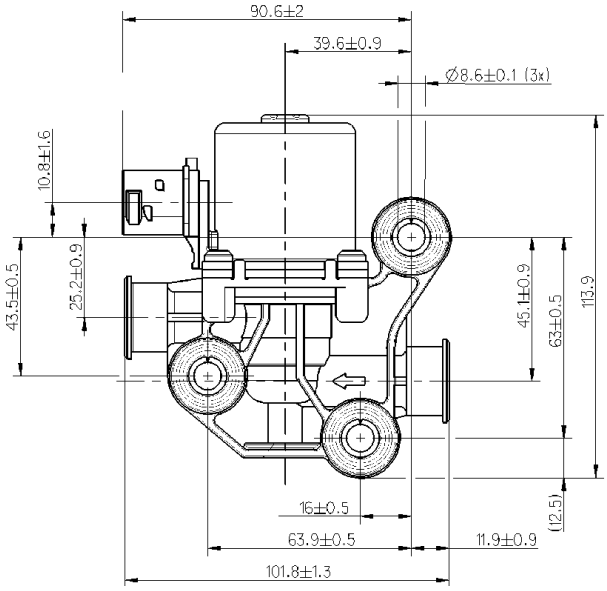
Installation dimensions

2/2 directional control valve

446 091 307 0

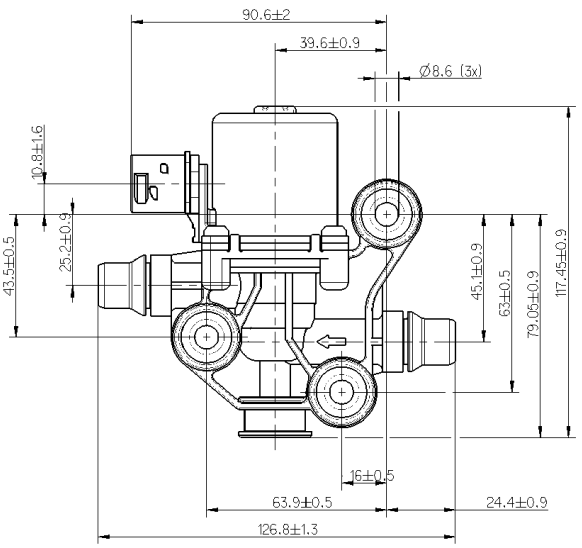


446 091 303 0

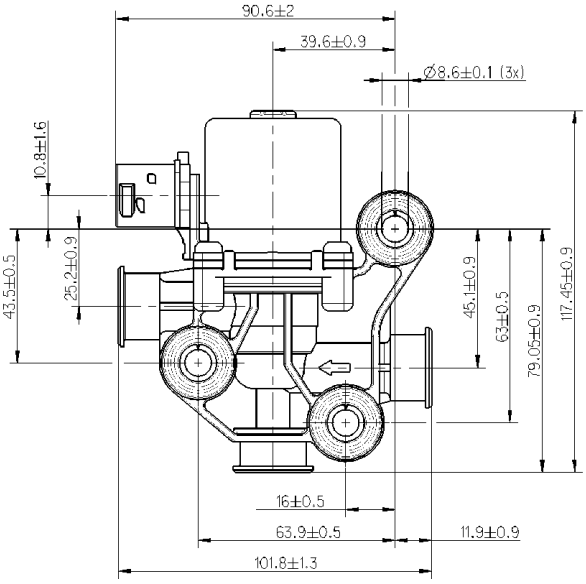


3/2 directional control valve

446 091 305 0



446 091 310 0



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.15 Accessories for hose couplings 452 000

5.15.1 Dummy coupling with fastening

Design

Purpose

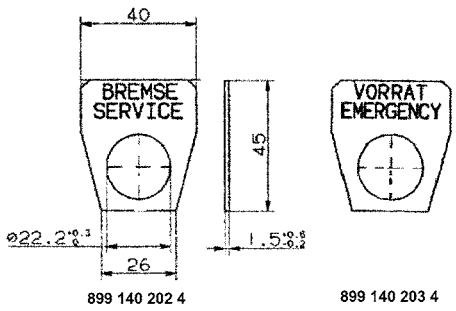
Dummy couplings with a fastening are mounts for uncoupled brake lines with coupling head. They are used on tractor units and drawbar trailers.

Technical data

PRODUCT NUMBER	452 402 000 0
For coupling heads	452 200 / 952 200 / 952 201
Corresponds to standard	VDA 74 344
Weight [kg]	0.14

5.15.2 Identification plates

Design



Technical data

PRODUCT NUMBER	899 140 202 4	899 140 203 4
Identification plate	Brake	Supply
Colour	yellow	red
Corresponds to standard	VDA 74 345	
Weight [kg]	0.005	0.002

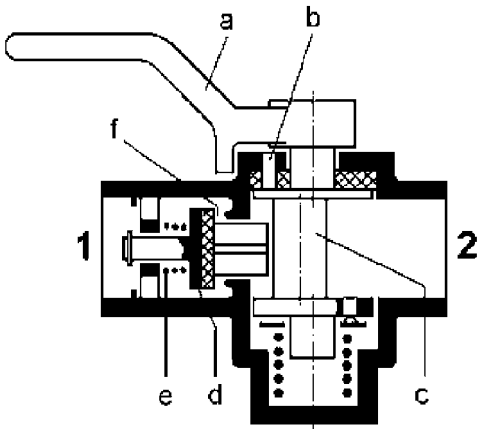
5.16 Shut-off valve with venting 452 002 / 952 002 000 0

Design

Purpose

Shut-off valves with venting are for sealing off compressed air lines. They are used in various parts of pneumatic systems.

Operating principle

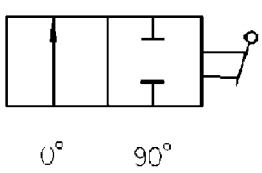
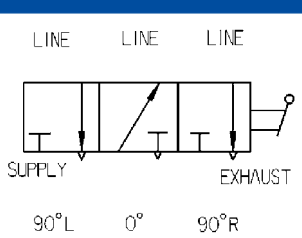
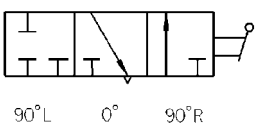


1 = energy supply; **2** = energy discharge

When the lever (**a**) is positioned parallel to the longitudinal axis of the shut-off valve, the eccentric shaft (**c**) presses the valve (**d**) to the left against the compression spring (**e**). The compressed air is routed unreduced from the port **1** through the inlet (**f**) into the line leading from the port **2**.

If the lever (**a**) is turned 90° up to the end stop, the compression spring (**e**) moves the valve (**d**) to the right and the inlet (**f**) is closed. The line leading from the port 2 is vented via the outlet bore (**b**).

Technical data

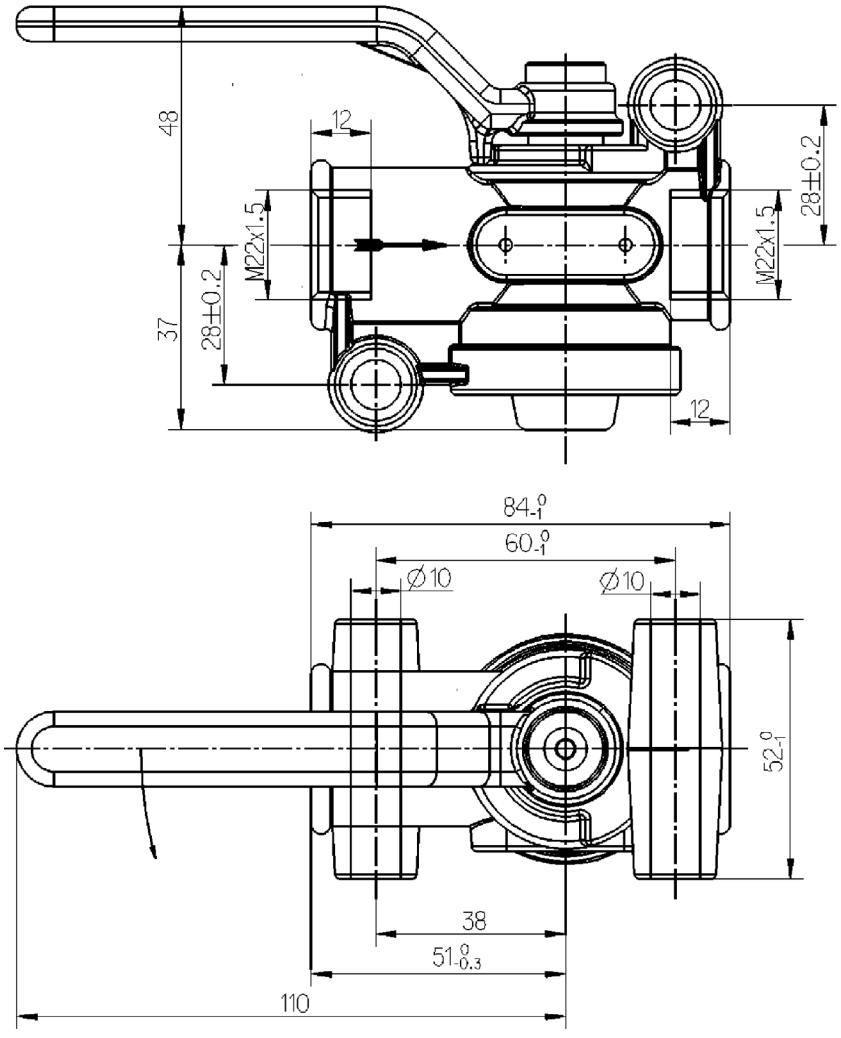
PRODUCT NUMBER	452 002 131 0	452 002 132 0	452 002 133 0
Symbol			
Max. operating pressure [bar]	10		
Lever actuation a/b	90°		
Thermal range of application [°C]	-40 to +80		
Weight [kg]	0.26		

PRODUCT NUMBER		452 002 131 0	452 002 132 0	452 002 133 0
Position	90° left	closed	vented	closed
	0°	open	charged	
	90° right	closed	vented	

Installation recommendation

- Fasten the shut-off valve with two M8 screws.
- Pay attention to the flow direction (arrow direction) when installing the valve and make sure that there is sufficient room for actuating the lever (**a**).

Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

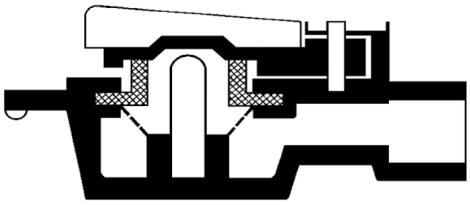
5.17 Coupling head with pin 452 201

Design

Purpose

In single line braking systems, coupling heads with pins connect the pneumatic braking system of the towing vehicle with the trailer's braking system.

Operating principle



When the systems are coupled, the pin pushes up the spring-loaded valve of the towing vehicle's coupling head to establish a connection between the braking systems of both vehicles.

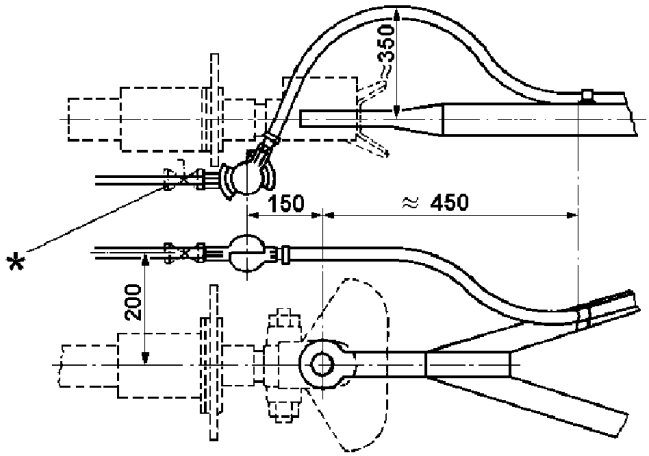
Technical data

PRODUCT NUMBER	452 201 010 0
Max. operating pressure [bar]	8.0
Corresponds to standard	DIN 74 294
Thermal range of application [°C]	-40 to +80
Weight [kg]	0.26

Installation recommendation

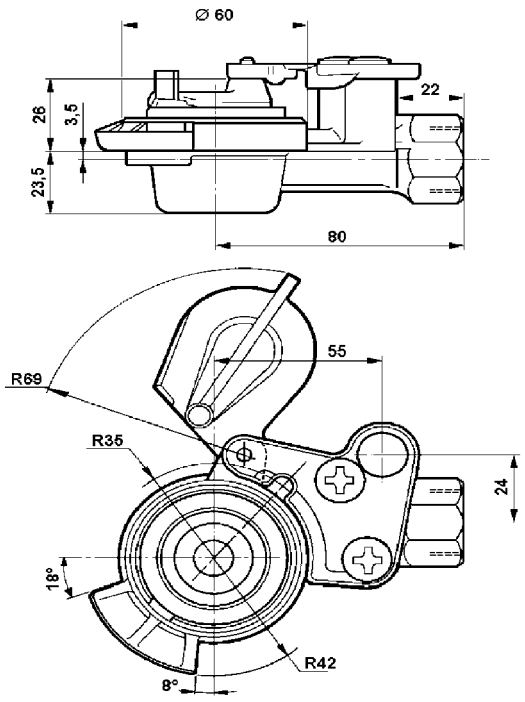
- Install the coupling head with the pin on the coupling hose of the trailer so that the opening points to the right.
- The coupling heads have to interlock so that they uncouple automatically if the trailer breaks away.

Installation diagram



LEGEND	
*	Shut-off valve is not required with automatic coupling head.

Installation dimensions



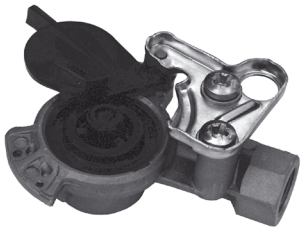
Maintenance

Make sure that the washer is clean and undamaged when the connection is made. Then check the leak-tightness of the connection.

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.18 Coupling head with valve 452 300

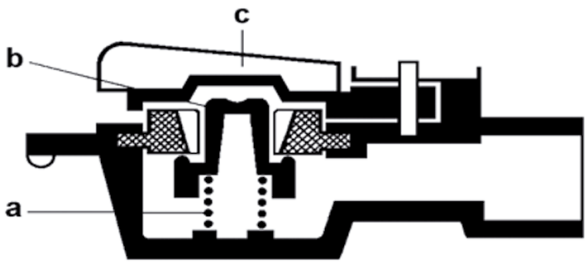
Design



Purpose

In single line braking systems, coupling heads with valves connect the pneumatic braking systems of the towing vehicle with the trailer's braking system.

Operating principle



The valve (**b**) is held closed by the force of the compressed spring (**a**) and the compressed air acting on the underside of the valve. When the trailer hose connection is attached, the pin of the matching coupling head forces the valve (**b**) downwards so that the compressed air can flow from the towing vehicle to the trailer.

Due to the smaller pressurised surface, the valve (**b**) of the automatic coupling head also has to be opened when it is under pressure. This means that if this type of coupling head is used, no shut-off valve needs to be fitted for releasing the pressure in the connected piping.

When disconnecting the trailer hose connection, the valve (**b**) is pushed upwards by the force of the compression spring (**a**) and the passage is closed. If the coupling head is not being used, the cover plate (**c**) must be pushed over its opening to prevent dirt from entering the compressed air line.

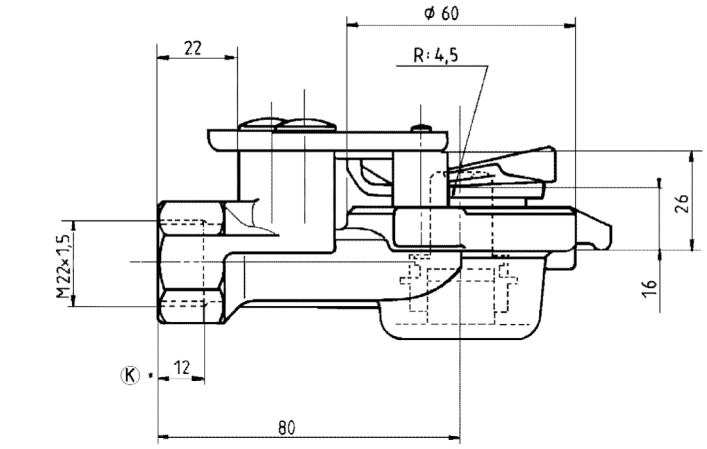
Technical data

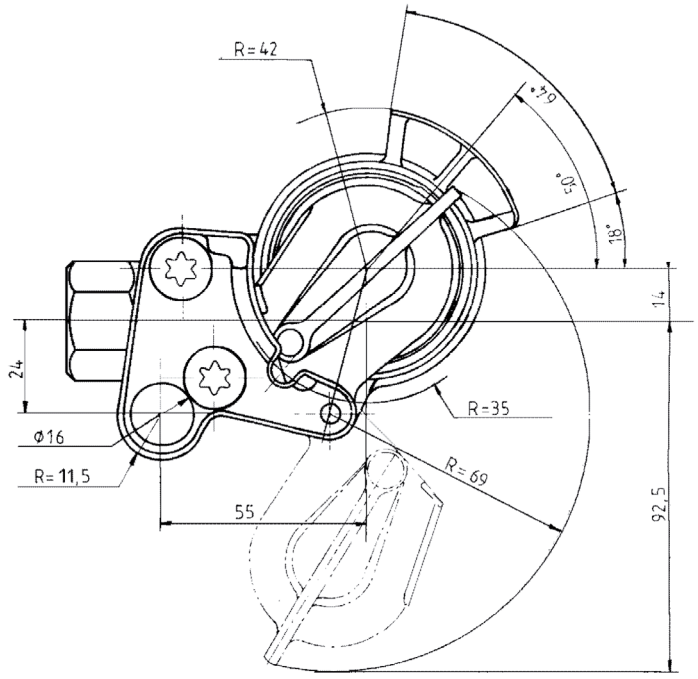
PRODUCT NUMBER	452 300 031 0
Max. operating pressure [bar]	8.5
Thermal range of application [°C]	-40 to +80
Corresponds to standard	DIN 74 294
Thread of pipe connections	M 22x1.5
Weight [kg]	0.26

Installation recommendation

Attach the coupling head at the rear of the tractor vehicle on the right of the trailer coupling so that the opening points to the left.

Installation dimensions





Maintenance

When connecting make sure all the sealing surfaces are clean. Replace damaged ring seals.

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.19 Duo-Matic fast-action coupling 452 80X

Design

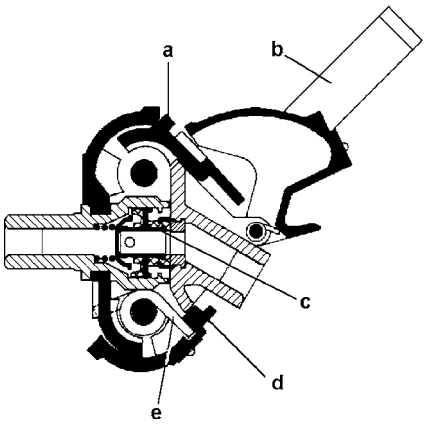
452 802 009 0

452 804 012 0

Purpose

The Duo-Matic fast-action coupling connects the pneumatic braking system of the towing vehicle with the braking system of the drawbar trailer. With Duo-Matic fast-action couplings, the trailer vehicles can be coupled more quickly and securely than with standard couplings.

Operating principle



When hitching up the trailer, the handle (**b**) is pushed downwards, which opens the protective covers (**a** and **d**). The Duo-Matic trailer part is placed underneath the protective covers and the handle (**b**) is released. The torsion spring (**e**) acts on the protective covers (**a** and **d**) and pulls the trailer parts against the automatic closing valves (**c**), which open and the compressed air flows to the trailer.

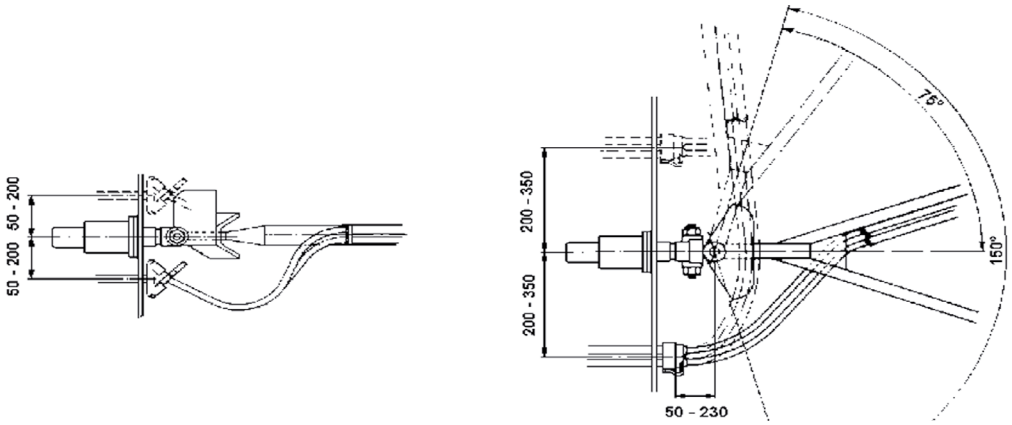
Technical data

PRODUCT NUMBER	452 802 009 0 TOWING VEHICLE PART	452 804 012 0 TRAILER PART
Max. operating pressure [bar]	10	
Nominal width [mm]	9	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	1.13	0.21

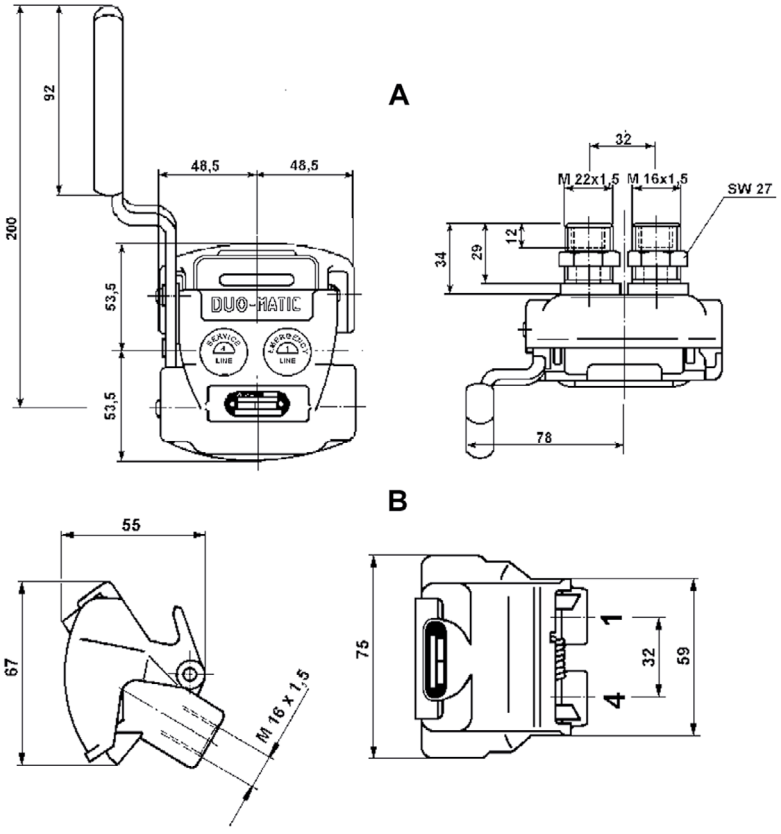
Installation recommendation

Install the Duo-Matic fast-action coupling in accordance with the standard ISO 1728 (see installation diagram below).

Installation diagram for drawbar trailers



Installation dimensions for drawbar trailers



LEGEND							
1	Energy supply	**4**	Control connection	**A**	Vehicle part	**B**	Trailer part

Maintenance

When connecting, make sure that the sealing surfaces which come into contact with each other are clean. Replace the valves or ring seals if there are any leaks.

Special maintenance that extends beyond the legally stipulated inspections is not required.

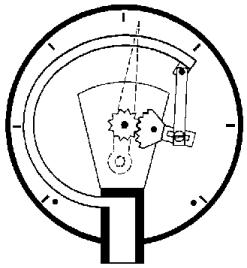
5.20 Single air pressure gauge with lighting 453 002

Design

Purpose

Air pressure gauges monitor the pressure in the air reservoirs.

Operating principle



The pressure from the air reservoir stretches the tube spring in the housing thus moving, via a lever and toothed rack, the pointer which is fastened to a rotatable shaft. The pressure can be read off the dial, which has divisions between 0 and 10 bar. If the pressure drops, the pointer is returned to the reading of the remaining pressure by means of a torsion spring.

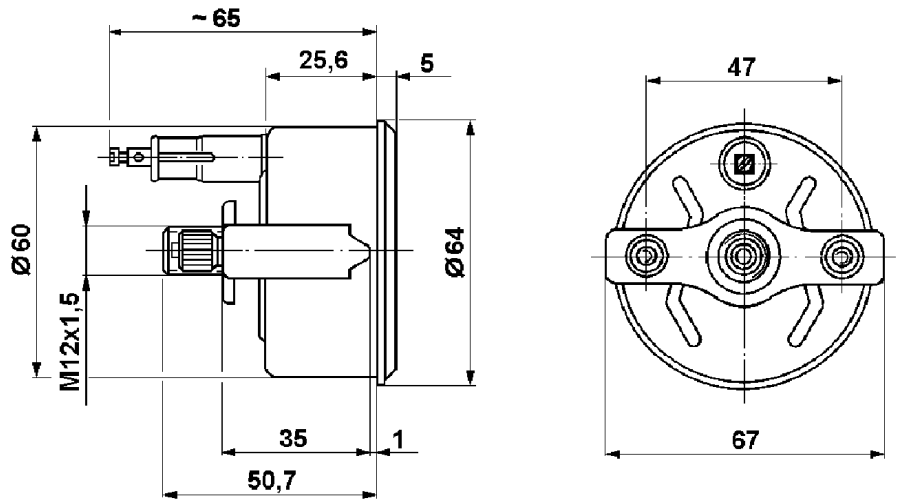
Technical data

PRODUCT NUMBER	453 002 000 0
Max. operating pressure [bar]	10
Measuring range [bar]	0 - 10
Display tolerance [bar]	± 0.2
Dial	Off-white with black lettering
Pointer	black
Cover	Glass
Edge ring	Chrome-plated
Light connection [V]	12
Thermal range of application [°C]	-25 to +65
Weight [kg]	0.21

Installation recommendation

- It should be placed in such a way that it is clearly visible by the driver.
- Use a 6x1 pipe from the reservoir to the pressure gauge.
- Insert the pressure gauge into a round opening in the dashboard and turn the holder in the catch. Then use a bracket to fasten the air pressure gauge from the rear.

Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required. When making comparisons with test devices, deviations must not exceed ± 0.2 bar.

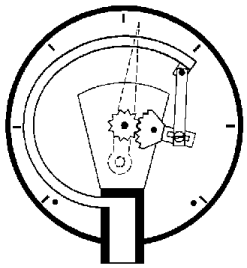
5.21 Single air pressure gauge with lighting 453 011

Design

Purpose

Air pressure gauges monitor the pressure in the air reservoirs.

Operating principle



The pressure from the air reservoir stretches the tube spring in the housing thus moving, via a lever and toothed rack, the pointer which is fastened to a rotatable shaft. The pressure can be read off the dial, which has divisions between 0 and 25 bar. If the pressure drops, the pointer returns to the residual pressure value.

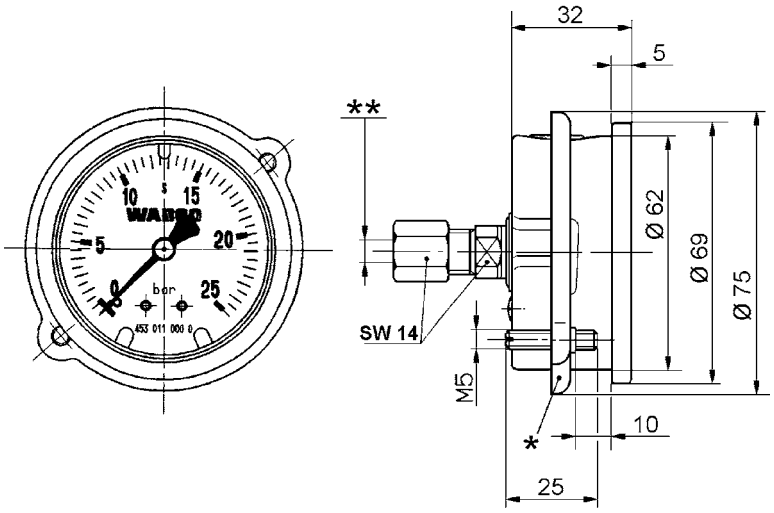
Technical data

PRODUCT NUMBER	453 011 000 0
Max. operating pressure [bar]	25
Display range [bar]	0 to 25
Gauge angle	270°
Excess pressure safety	complies with DIN 16007
Thermal range of application [°C]	-20 to +50
Dial	white with black lettering
Pointer	black
Device	with glycerine filling
Weight [kg]	0.24

Installation recommendation

- It should be placed in such a way that it is clearly visible by the driver.
- Use a 6x1 pipe as a supply line to the pressure gauge.
- Insert the pressure gauge into a corresponding opening in the dashboard.
- Turn the holder into the catch.

Installation dimensions



LEGEND			
*	Device fastening pieces enclosed	**	for pipe with ø 6 mm

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

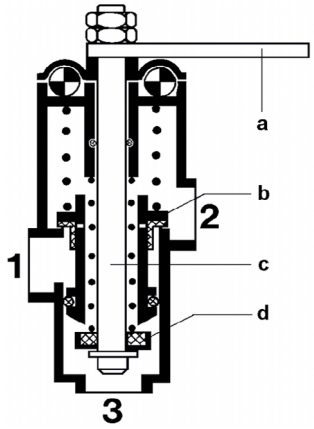
5.22 Hand brake valve 461 700

Design

Purpose

Hand brake valves aerate the brake control line for the trailer directly and without any graduations in conjunction with the mechanical towing vehicle hand brake. They are used in split braking systems.

Operating principle



The inlet valve (**b**) is closed in the release position. The port **3** linked to the brake cylinder line is linked to the port **2** via the open outlet valve (**d**). The line connected to that port leading to the relay valve is thus also depressurised.

When the hand brake is actuated, the lever (**a**) is pulled out of its ball catch and the valve rod (**c**) is raised. This action closes the outlet valve (**d**) and opens the inlet valve (**b**). The port **2** is charged without any graduation by the supply reservoir port **1** and the trailer is braked via the relay valve.

When the service brake is actuated, compressed air flows from the port **3** to the port **2** and also causes the trailer to be braked via the relay valve.

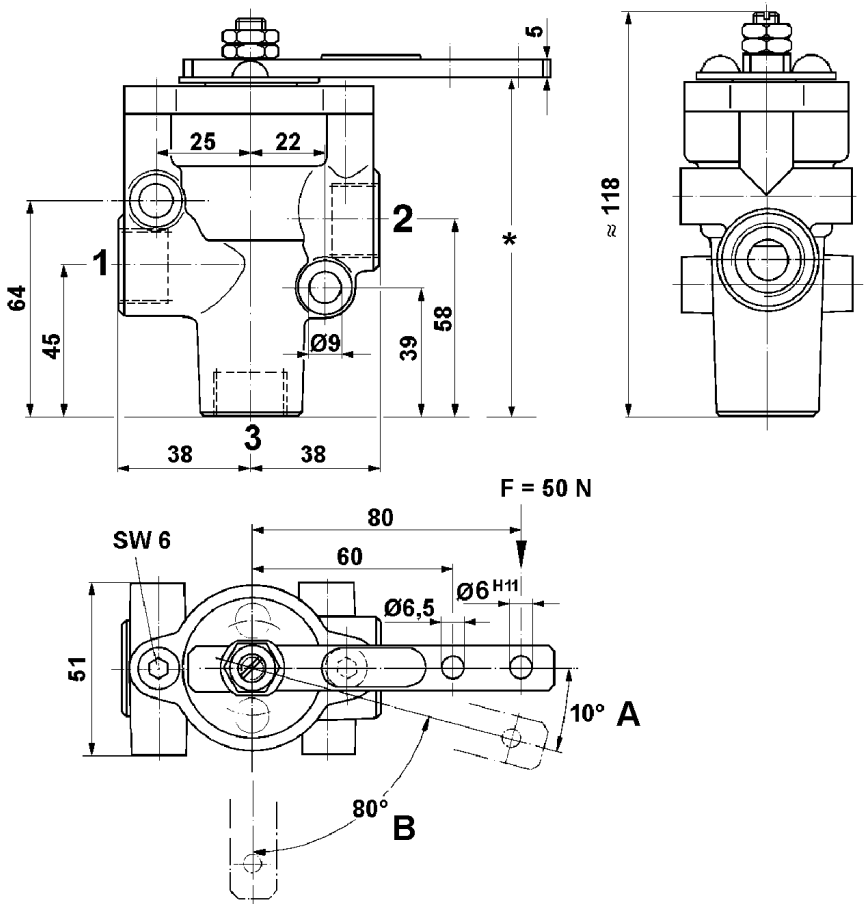
Technical data

PRODUCT NUMBER	461 700 000 0
Design	watertight
Max. operating pressure [bar]	8.0
Lever hole A [mm] (see illustration below)	6
Thermal range of application [°C]	-40 to +80
Nominal width [mm]	8
Weight [kg]	0.83

Installation recommendation

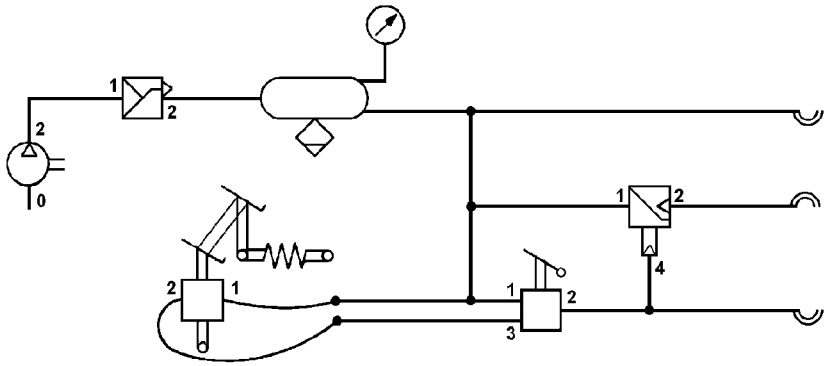
- Install the valve as a throughput valve into the brake line and connect it with the hand brake rod (see installation diagram at the end of the chapter).
- Fasten the valve optionally on the left or right side in any position with two M 8 screws. The valve can be actuated in both directions.
- After loosening the two screws (size 6), you can turn the lever to the desired zero setting. After adjustment, fasten the ball cage by re-tightening the screws.

Installation dimensions



LEGEND			
1	Energy supply M 22x1.5	A	Lever positions, closed to approx. 8° opening, lever positions opened as of 10° opening
2	Energy discharge (trailer control valve) M 22x1.5	B	Free path with open valve (no force increase)
3	Venting (foot brake valve)	*	with valve closed = 99.5 mm; with valve open = 104 mm

Installation diagram



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.23 Test connection 463 70X

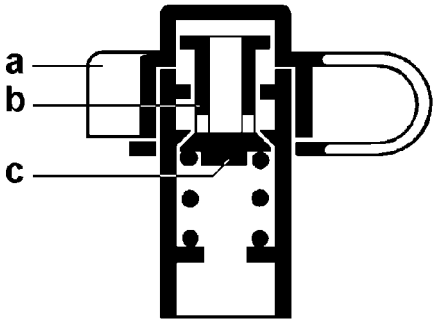
Design

463 705 105 0

Purpose

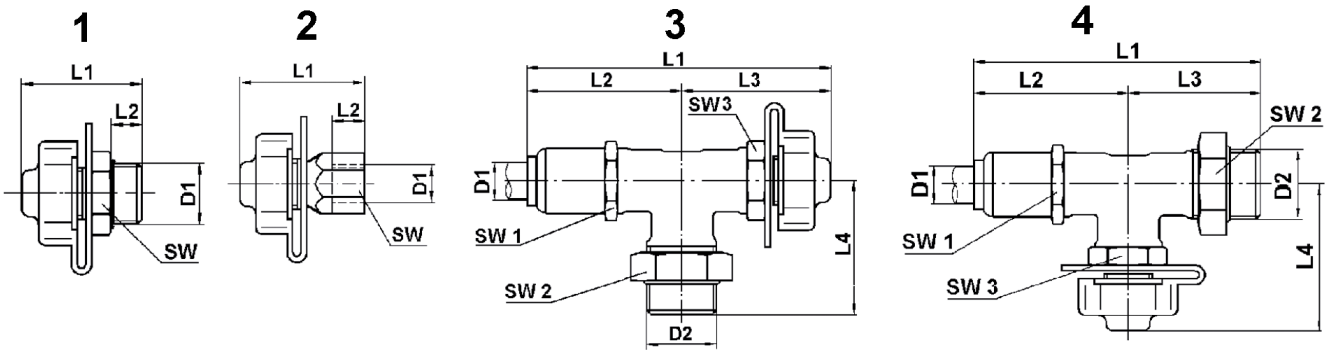
Test connections allow test hoses to be connected to the line system and the brake unit for test purposes. They also allow pressure measuring devices to be temporarily connected for testing systems or vehicle acceptance procedures.

Operating principle



When screwing on a test hose (or a pressure switch), the check valve (**c**) is pushed open by the tappet (**b**) and the connection to the pressure line is established. When the test hose is removed, the check valve (**c**) closes automatically. To prevent soiling of the connection when it is not in use, the cap (**a**) is pressed back onto the screw neck.

Installation dimensions



PRODUCT NUMBER	D_1	D_2	L_1	L_2	L_3	L_4	SW1	SW2	SW3	FIG.
463 700 002 0	M 18x1.5	–	46.3	22.5	–	–	22	–	–	1
463 703 005 0	10x1*	10x1	60	30	30	49	19	19	17	4
463 703 024 0	8x1*	M 12x1.5	65	28	33	52	17	17	–	4

PRODUCT NUMBER	D_1	D_2	L_1	L_2	L_3	L_4	SW1	SW2	SW3	FIG.
463 703 114 0	M 16x1.5	–	36	9	–	–	22	–	–	1
463 703 301 0	12x1.5*	M 22x1.5	96	45	51	42	27	27	17	3
463 703 303 0	M 22x1.5	M 22x1.5	96	42	54	42	27	27	17	3
463 703 306 0	12x1.5*	M 16x1.5	94.5	33	61.5	37	22	22	17	3
463 705 103 0	M 22x1.5	–	36	10	–	–	27	–	–	1
463 703 316 0	3/8"-18 NPTF	–	45	14	–	–	19	–	–	1
463 703 995 0	M 12x1.5	–	43	7	–	–	17	–	–	2
463 705 105 0	M 16x1.5	–	36	10	–	–	17	–	–	1

LEGEND	
*	Outer diameter x wall thickness

Maintenance

Check the valve (**c**) regularly to make sure it closes properly.

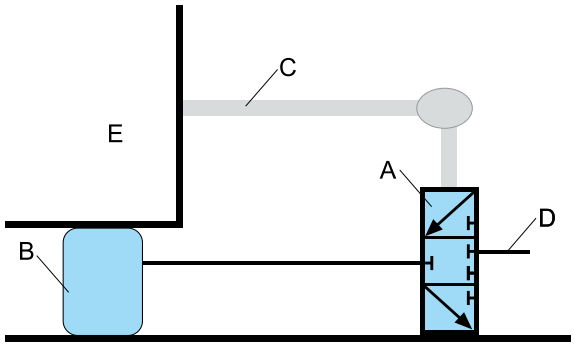
5.24 Levelling valve 464 007

Design

Purpose

The cab levelling valve controls the height of the cab and/or the driver's seat suspension. The valve is attached to the chassis, the levelling valve lever is connected to the driver's cab. 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 bellows
C	Levelling valve lever incl. connection to driver's cab
D	Pneumatic line
E	Driver's cab

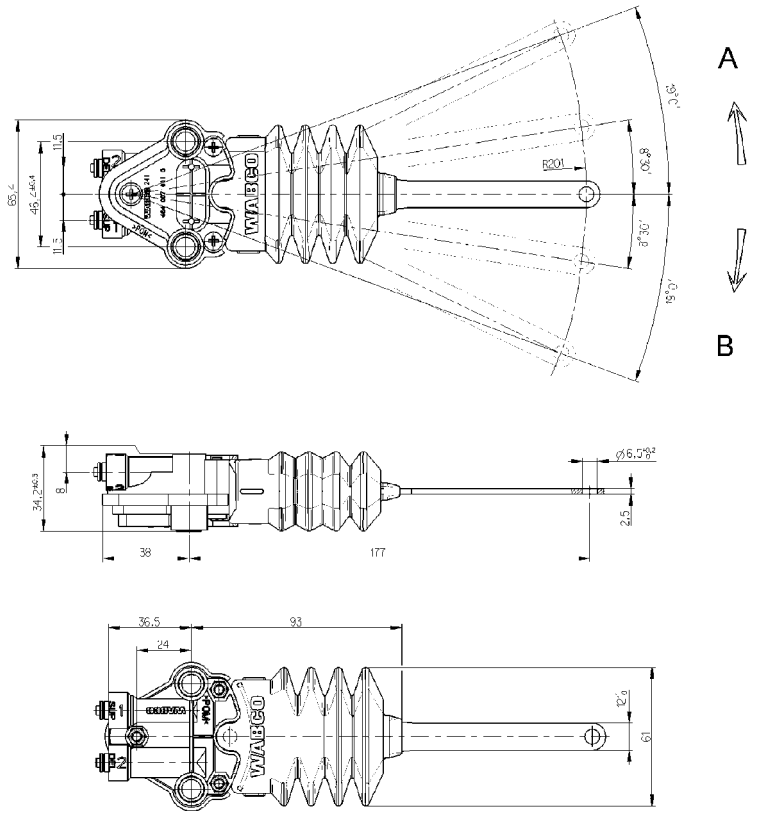
Technical data

PRODUCT NUMBER	464 007 001 0
Operating pressure (supply) [bar]	max. 11
Permissible medium	Air
Thermal range of application [°C]	-40 to +80
Check valve connection 2 [bar]	0.6
Weight [kg]	0.21

Installation recommendation

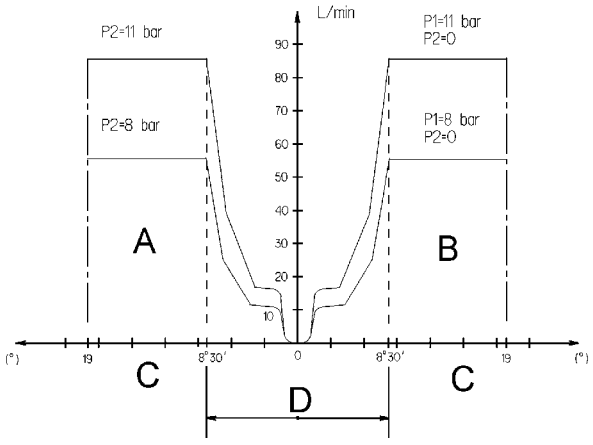
- Install the levelling valve to the chassis in the vicinity of the driver's cab using two M8 screws.
- To facilitate installation and adjustment of lever and connecting linkage the levelling valve shaft can be fixed in position by inserting a mandrel in the idle position.

Installation dimensions



LEGEND			
1	Energy supply	**2**	Energy discharge
A	Venting	**B**	Charging

Flow rate at P1 = 8 bar and at P1 = 11 bar



LEGEND			
A	Venting	**B**	Charging
C	Overstroke	**D**	Lever travel

5.25 Steering brake valve 467 399

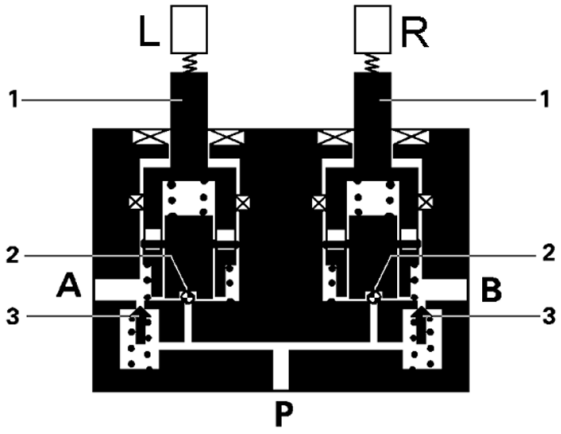
Design

Purpose

Steering brake valves provide steering assistance for tractors with hydraulic braking systems by optionally braking the right or left-hand rear wheel.

Operating principle

Brake pedal



L = left; **R** = right

In the idle position, both tractor brake pedals are attached to the valve tappets (**1**), closing the ball valves (**2**) by virtue of the pedal's retracting springs. The ball valves (**2**) close the passage from **P** to **A** and **B**. As both braking pedals are pushed down when driving on the road, the pressure on the valve tappets (**1**) is reduced, causing the ball valves (**2**) to be opened and release the passage from **P** to **A** and **B**.

When the steering brake is actuated, only one pedal is pushed down and only one ball valve is opened while the other ball valve remains closed. A connection is established either from **P** to **A**, or from **P** to **B**. The purpose of two cone check valves (**3**) is to relieve the pilot line between the steering brake valve and the wheel brake cylinders if the brake pedals – and ball valves (**2**) – are returned more rapidly than the brake shoes are released.

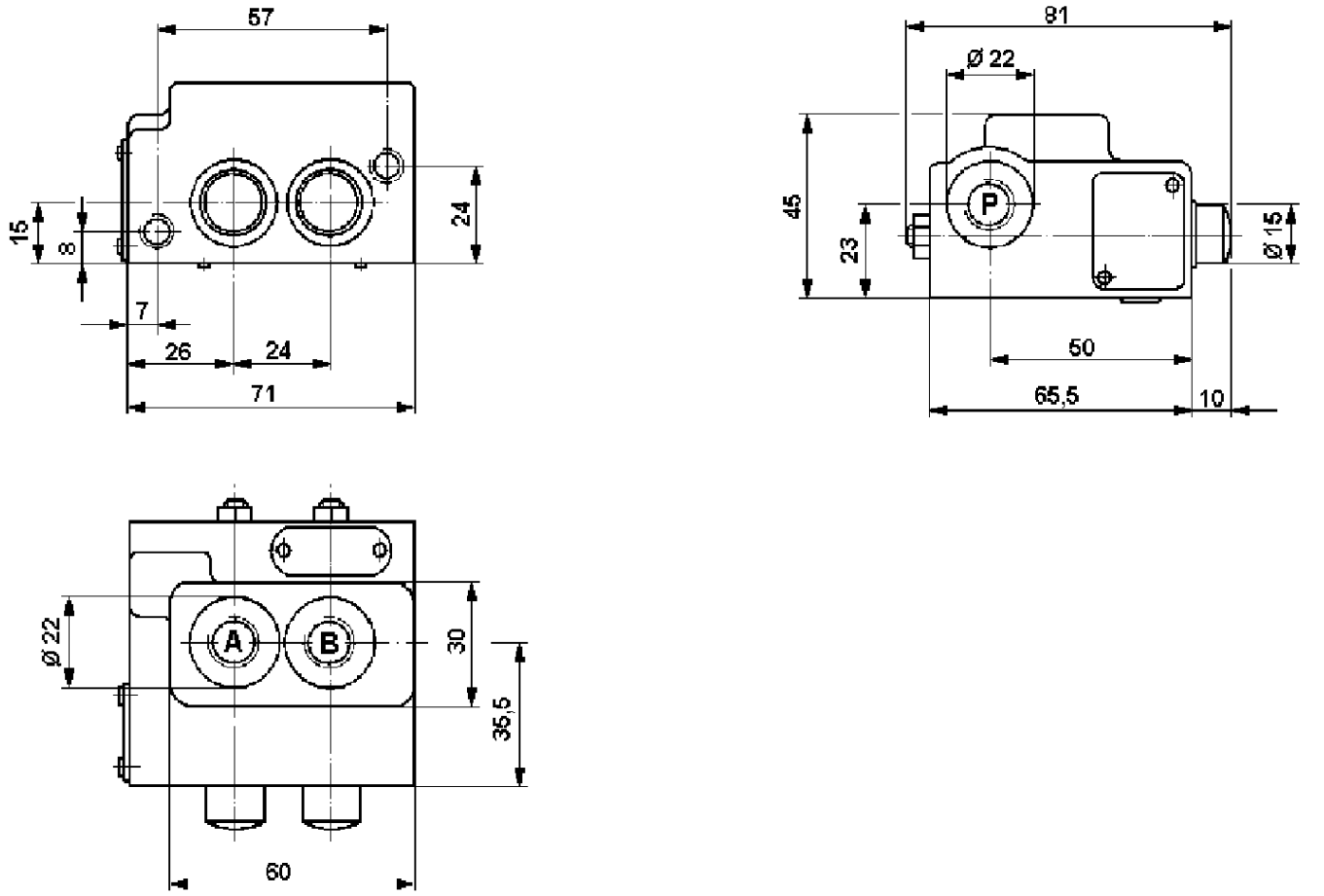
Technical data

PRODUCT NUMBER	467 399 015 0
Max. operating pressure [bar]	180
Residual pressure in ports A and B [bar]	0 to 0.1
Permissible medium	Mineral oil
Thermal range of application [°C]	-20 to +80
Actuation stroke [mm]	$0.8^{+0.5}$
Overstroke [mm]	$0.6^{+0.4}$
Flange fixation	2 threads
Weight [kg]	1.16

Installation recommendation

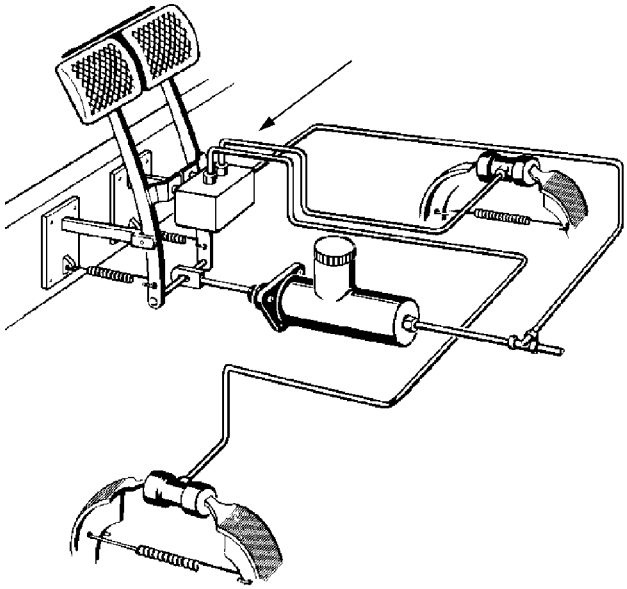
Attach the steering brake valve horizontally (with the vent pointing upwards) with the flange connection and 2 threaded bores holes 5/16" depending upon the position of the two brake pedals.

Installation dimensions for 467 399 015 0

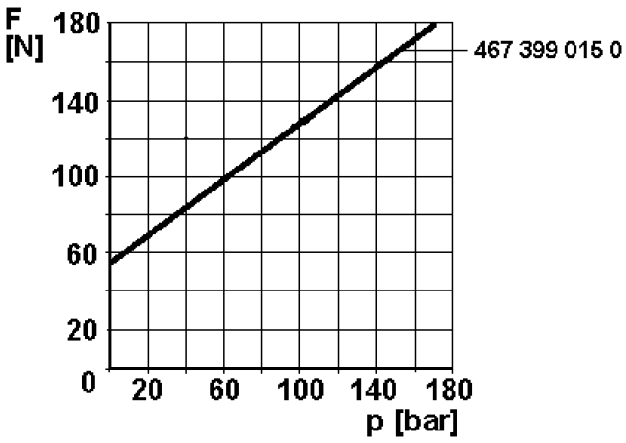


LEGEND					
A	Circuit 1 M 12x1	**B**	Circuit 2 M 12x1	**P**	From the main brake cylinder M 12x1

Installation diagram



Pressure curve



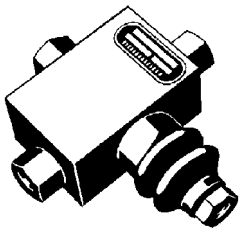
LEGEND			
p	Braking pressure	**F**	Actuating force

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.26 Compensating valve 468 397

Design

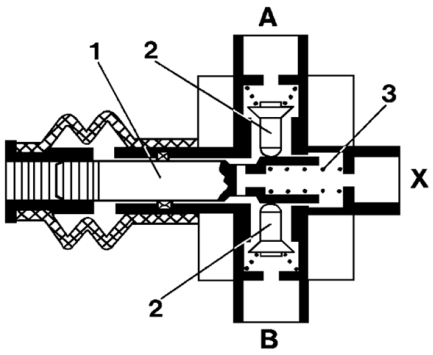


Purpose

Compensating valves balance the control pressures of the two master brake cylinders when the service brake is actuated, and to shut off the oil flow from the two master brake cylinders to the front axle and to the trailer control valve when the steering brake is actuated.

Operating principle

Service brake position



When not actuated, the two brake pedals are in contact with valve tappet (**1**), pushing it against the force of the compression spring (**3**) to the right. This closes the valves (**2**) and mutually blocks the ports **A**, **B** and **X** (see illustration below in the section "Installation dimensions"). When both brake pedals are pushed down, the valve tappet (**1**) is released and pushed towards the left by the force of the compression spring (**3**). The valves (**2**) open and a connection is established between the ports **A**, **B** and **X**. This balances out the braking pressures of the rear axles (ports **A** and **B**), and the brake cylinders of the front axle and the control piston of the trailer control valve get braking pressure from the port **X**. With steering braking, on the other hand, the valves (**2**) stay closed because the non-actuated brake pedal holds the valve tappet (**1**) in its right-hand end position.

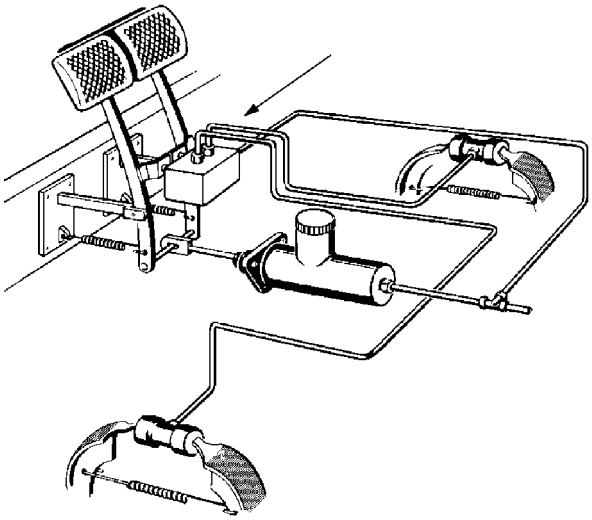
Technical data

PRODUCT NUMBER	468 397 003 0
Max. operating pressure [bar]	150
Ambient temperature [°C]	-30 to +80
Permissible medium	Brake fluid
Pressure medium temperature [°C]	-30 to +80
Stroke up to opening [mm]	0.5 $^{+1.2}$
Actuating force [N]	< 80
Retaining pressure at port X [bar]	< 2.8
Weight [kg]	1.10

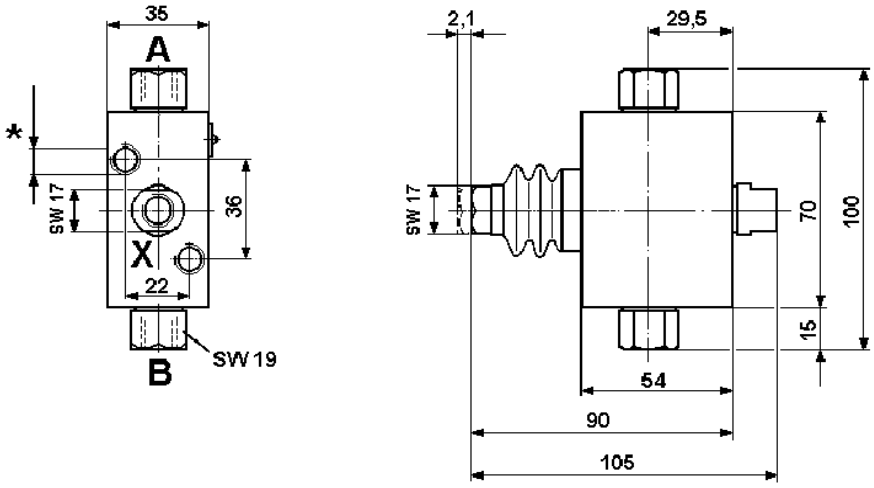
Installation recommendation

- Install the compensating valve in any installation position.
- The valve tappet must have passed a stroke of at least 1.7 mm before the braking pressure in the wheel brake cylinders begins to build up.
- The compensating reservoirs of the two master brake cylinders must be connected to each other.

Installation diagram



Installation dimensions



LEGEND			
A	Circuit 1 M 12x1 in compliance with EL DIN 74235	**B**	Circuit 2 M 12x1 in compliance with EL DIN 74235
X	Supply M 12x1 in compliance with EL DIN 74235	*	M 8 - 12 low

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.27 Electronic trailer control valve 480 204 041 0

MAIN REQUIREMENTS
eTCV controls the pneumatic trailer supply & brake lines acc. to these main requirements
Regulation EU 2015/68 compliance: ■ Trailer brake harmonization: trailer brake actuation according to compatibility band ■ Gradable secondary brake: tractor with speed > 40 km/h shall activate the trailer brake in a gradable way. ■ Breakaway function: automatic trailer brake activation in case of loss of yellow coupling head ■ Steering brake limitation: trailer braked at vehicle speed > 12 km/h even in case that only 1 pedal is pressed ■ Control position: testing ability of the tractor brakes to hold hanging trailer without enabled trailer brakes.
System offers a mechanic redundancy path for service brake activation.
System determines the brake demand from the hydraulic or pneumatic pressure in one pilot line.
The eTCV system drives two solenoid valves for park brake activation: ■ One main valve and ■ One redundant valve that is activated in case of a failure to keep the last set state
System will be frame mounted in exterior of tractors.
System voltage: 12 V
The functional safety level supported by the eTCV system is AgPL C (ISO 25119) / ASIL B (ISO 26262) . The responsibility for the functional safety level of the system in the vehicle falls to the vehicle manufacturer.
Environmental load specification (see separate document): ■ For ECU: acc. to special test sequence, max. temperature 105°C ■ For mechanic components: WABCO standard test sequence acc. to ISO 16750, max. temperature: 80°
In addition the eTCV ECU is electrically prepared to drive an Electronically Controlled Air Dryer (ECAD) that offers an optimal regeneration without the need for a regeneration reservoir for more packaging flexibility. This feature will be enabled by a software update at a later project phase.

Brake request handling

1. ELECTRONIC TRAILER BRAKE FROM BRAKE PEDAL	
Reference inputs	a) Hydraulic vehicle brake pressure monitored by pressure sensor in backup valve
	b) Pneumatic vehicle brake pressure monitored by standalone pressure sensor
	c) Brake demand via CAN
Further inputs	Power supply, supply pressure (physical and CAN), ignition switch, vehicle speed (CAN), brake switch (hard wired or CAN), several customer EOL parameters (e.g. brake map, anticipation, …)
Output	Gradable or non-gradable temporary pneumatic trailer brake pressure

2. ELECTRONIC TRAILER BRAKE FROM HAND BRAKE	
Reference inputs	a) Brake demand via CAN
	b) Brake demand via PWM sensor input (future option)
Further inputs	Power supply, supply pressure (physical and CAN), ignition switch, vehicle speed (CAN), several customer EOL parameters (e.g. brake map, anticipation, …)
Output	Gradable or non-gradable temporary pneumatic trailer brake pressure

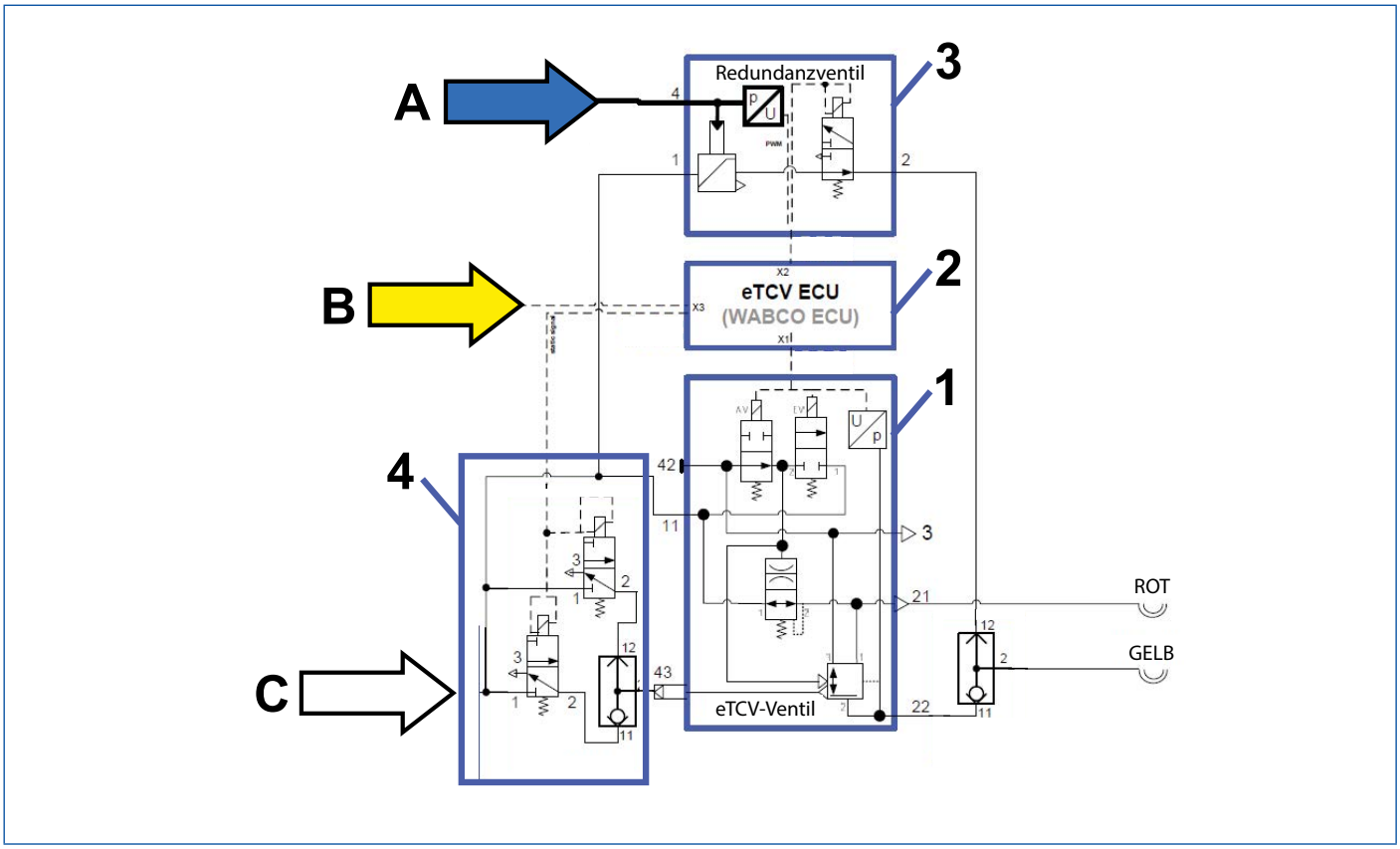
3. PERMANENT TRAILER BRAKE (PARK BRAKE)	
Reference inputs	a) Brake demand via CAN
	b) Brake demand via switch signal (hardwired, future option)
	c) eTCV internal handover from electronic trailer brake in case of standstill and e.g. elapsed timer
	d) Automatic activation via ignition off and standstill
Further inputs	Function given even without electrical power supply, several customer EOL parameters
Output	Permanent non-gradable pneumatic trailer brake pressure

4. MECHANIC REDUNDANT BRAKE	
Reference inputs	Detected eTCV system failure AND hydraulic or pneumatic vehicle brake pressure
Further inputs	Pneumatic supply pressure
Output	Gradable or non-gradable temporary trailer brake pressure

5. BRAKE DEMAND SUPPRESSION FOR STEERING BRAKE	
Reference inputs	Suppression demand (CAN or hard wired: only one pedal pressed) AND vehicle speed via CAN
Further inputs	Brake application acc. to 1), several customer EOL parameters
Output	Service brake suppression at vehicle velocity below a defined value (normally 12 kph)

6. TRAILER BRAKE TEST FUNCTION	
Reference inputs	a) Test function demand via CAN
	b) Test function via switch signal (hardwired, future option)
Further inputs	Power supply, supply pressure (physical and CAN), ignition switch, vehicle speed (CAN), several customer EOL parameters
Output	De-activate trailer brake for park brake test function in case of: ■ Trailer brake release switch “on” ■ Secondary Brake or Park Lock activated ■ Vehicle Speed below 1 kph ■ Timer “brake release timer” below threshold

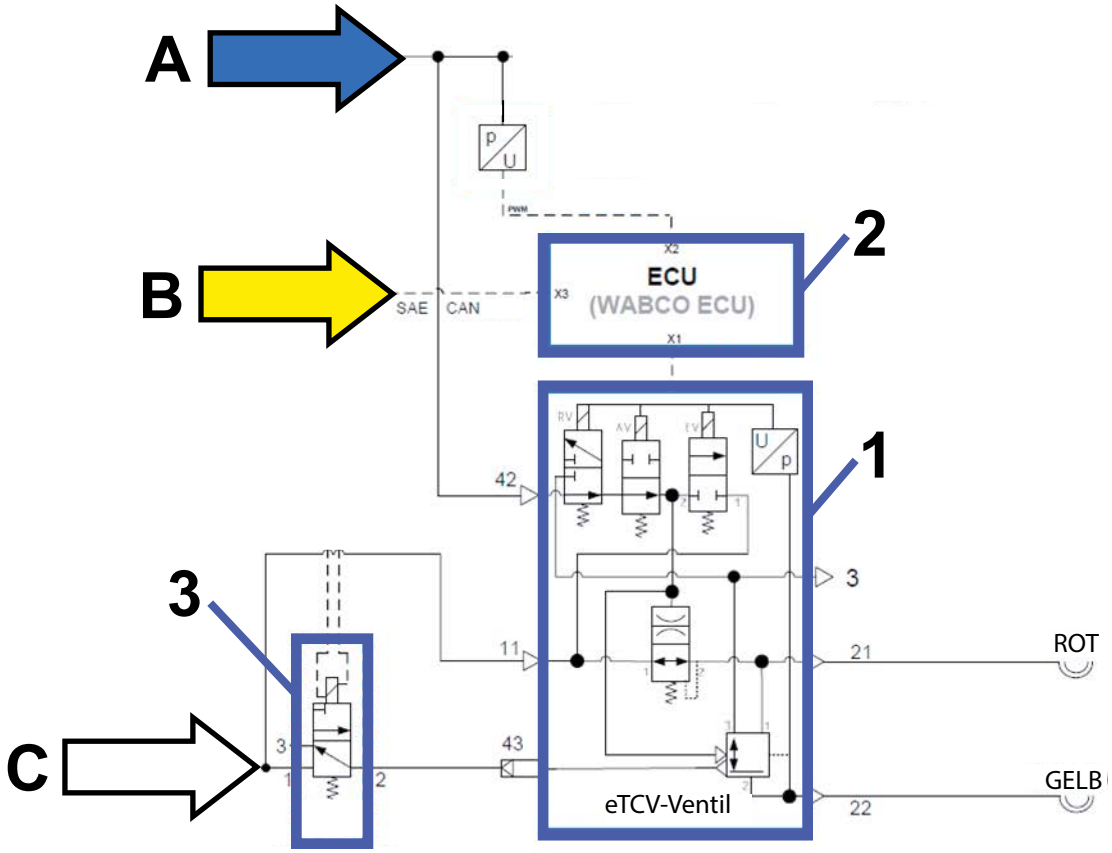
System components hydraulic system



INPUT SOURCES					
A	Hydraulic control	**B**	Electrical input (CAN)	**C**	Pneumatic supply

HYDRAULICALLY BRAKED TRACTORS					
1	Electronic Trailer Control Valve	**2**	System ECU (12 V)	**3**	Backup Valve
4	Parking Brake Valve				

System components pneumatic system



INPUT SOURCES					
A	Pneumatic control	**B**	Electrical input (CAN)	**C**	Pneumatic supply

PNEUMATICALLY BRAKED TRACTORS					
1	Electronic Trailer Control Valve	**2**	System ECU (12 V)	**3**	Parking Brake Valve

5.27.1 Main valve 480 204 041 0

Design

480 204 041 0

Purpose

The existing electronic Trailer Control Valve (eTCV) is used in commercial vehicle braking systems as a modulator controlling the coupling head pressures for the trailer

Main components

The main components of the TCV are:

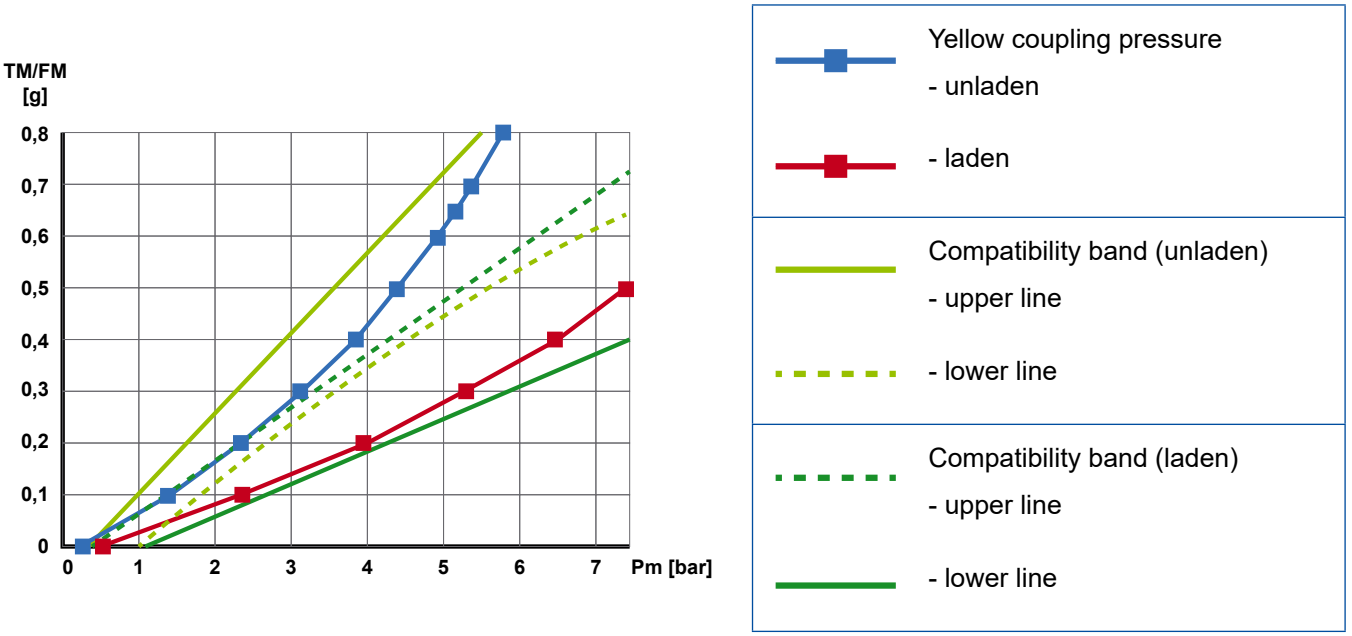
- Relay valve that is driven by a 2-2 inlet valve (EV) and 2-2 outlet valve (AV)
- 3-2 redundancy valve,
- Breakaway valve and
- Output pressure sensor.

Mounting

Directly to the frame with three integrated studs M8

PORT-NR.	SIZE	TUBE DIA	TUBE LENGTH
11	M22 x 1,5	12 x 1,5	max. 3 m
21	M22 x 1,5	12 x 1,5	max. 3 m
22	M22 x 1,5	12 x 1,5	max. 2 m
42	M16 x 1,5	8 x 1	max. 5 m
43	M16 x 1,5	8 x 1	max. 5 m

Operating principle



The blue curve shows the general possibility of the eTCV to generate a non-linear output pressure. It is to be seen just as an example that does not reflect regulation / customer needs in detail.

Non linear characteristics offer much more flexibility for the adaptation of the valve to the needs of the application compared to conventional TCVs.

The red line in this example results from a static example ratio of 1,7 between unladen and laden condition for the tractor brake pressure.

The real static curve parameters for a specific application need to be developed in close cooperation between WABCO and the customer. Normally these application dependant parameters are to be stored to the ECU at the EOL of the customer.

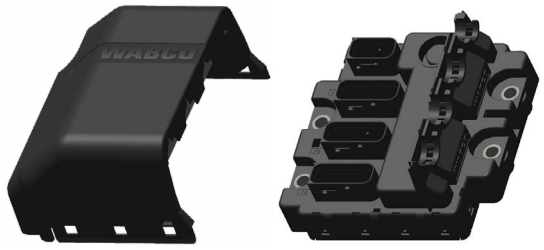
The number of points for curve definition are:

- One point defining the start of the curve
- One point defining the end of the curve
- Nine points between the start and the end of the curve

5.27.2 ECU for eTCV

Design

884 910 338 0



Main function

Regulate brake pressure to the trailer based on demand from the driver

- From service brake
- From handbrake (secondary brake)
- Electronic parking lock (optional)

Specific functions

- Calculate the brake demand from the pilot line pressure signal, brake pedal position, pedal switches and handbrake
- Implement brake map according to the compatibility bands
- Decision between brake demand from driver, external sources and stability function
- Enforce Steering Brake Limiter according to the legislations
- Analyze data related to trailer braking from CAN bus (SAE J1939)

Optional functions for future projects

1. Enable automatic brake intervention in situations such as:
   - Engine / transmission braking
   - Potential jack-knifing of tractor-trailer combination
   - Potential instability
2. Communication with tractor ABS system

5.27.3 Backup valve

Design

470 015 400 0

Purpose

The backup valve combines these individual components to one compact unit:

- Hydraulic pressure sensor
- Hydraulic- / pneumativ-converter
- 3-2 redundancy valve

The used components of the arrangement are WABCO devices or parts that consist of proven concepts that are used in other WABCO applications.

5.27.4 Main functions

MAIN SYSTEM FUNCTIONS	
Brake Demand	■ Input from driver food pedal and pedal switch(es) ■ Convert pedal position PWM signal to percentage value ■ Analyze and differentiate parameters of: • Hydraulic tractor • Pneumatic tractor
Service Brake Mapping	■ Interpolate pressure demand from eTCV internal calculation or external CAN message ■ The parameters scale and offset for the brake map are adjusted at customer EOL to comply with the requirements according EU 2015/68 ■ Output pressure = input * scale + offset ■ Default values: scale = 7.5 bar; offset = 0
Secondary Brake Mapping	■ Interpolate pressure demand (graduable) from external CAN message similar to “Service brake mapping” function
Steering Brake Limiter (SBL)	■ Pressure supplied to the trailer is 0 bar, when driver initiates a steering brake (= Differential braking) at a driving speed < 12 km/h with one brake pedal ■ Steering brake must not be enabled at a driving speed > 40 km/h
Trailer Brake Priorization	■ Pass the correct pressure demand to the “Pressure controller” function depending on a prioritization of the demand inputs
Pressure Controller	■ Controlled actuation of the valves in order to generate a brake pressure that corresponds to the brake demand
Diagnostics / Test mode	■ Offers diagnostics via UDS protocol

OPTIONAL FUNCTIONS FOR FUTURE PROJECTS	
Agricultural Tractor Brake Harmonization (ATBH)	■ Offers brake demand calculation based on drive train data ■ Advanced stability function in case of available tractor ABS ■ Regulations on automatic braking: • Automatic application of brakes permitted only for vehicle stabilization • Maximum time of 5s – for preventive action
External Pressure Demand	■ Considering further external brake demands from the tractor ECU

5.28 Trailer control valve 470 015 (for dual line trailer braking systems)

5.28.1 Trailer control valve (470 015 0XX 0 and 470 015 2XX 0)

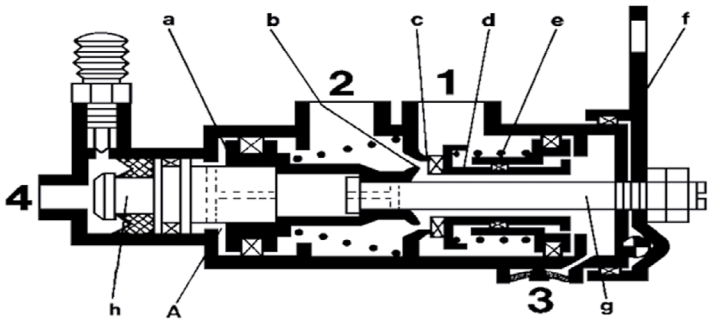
Design

470 015 203 0

Purpose

Trailer control valves control the dual line braking system of the trailer in conjunction 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 is already actuated before the tractor brake becomes effective.

Operating principle



In the release position, the compression spring (**e**) presses the valve sleeve (**d**) against the inlet (**c**) and keeps it closed. The port **2** is connected with the outlet (**b**) and the vent **3**. When the brake pedal is depressed, the hydraulic control pressure acts on the piston (**h**) via the port **4** and shifts the piston together with the differential piston (**a**) to the right. The outlet (**b**) is closed, the inlet (**c**) opens, and the compressed air at the port **1** flows to the trailer brake valve via the port **2**. The compressed air acting on the differential piston (**a**) moves it to the left against the hydraulic control pressure and the inlet (**c**) is closed. A final position has now been reached.

The 1-circuit hydraulically actuated and pneumatically pre-actuated trailer control valves (see * in the table below) are equipped with an additional pneumatic control connection. The port **42** and therefore the chamber **A** are pressurised with the supply pressure via an upstream 3/2 directional control valve when the brake pedal is actuated. The piston (**a**) closes the outlet (**b**) and opens the inlet (**c**). This means that a low control pressure reaches the trailer brake valve via the port **2** before control pressure builds up at the port **4**. Any increase in the hydraulic control pressure will also cause the pressure at the port **2** to increase. Releasing the brake pedal depressurises the ports **4** and **42**, causing the pressure in the port **2** to push the differential piston (**a**) back to its original position. The outlet (**b**) opens, and the port **2** is vented via the vent **3**.

The trailer control valve also has a hand brake lever (**f**) which, as the hand brake is actuated, pushes the piston (**a**) against the valve sleeve (**d**), and the opening inlet (**c**) causes a full braking of the trailer.

Technical data

PRODUCT NUMBER	475 015 0XX 0	475 015 2XX 0
Max. operating pressure "pneumatic part" [bar]	10	
Max. operating pressure "hydraulic part" [bar]	120	
Medium	Air (control medium, see table below)	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	approx. 1 to 1.4 (dependent on variant)	

PRODUCT NUMBER	CORRESPONDS TO FIG.	ACTUATION PRESSURE [bar]	HYDRAULIC PART LIMIT PRESSURE [bar]	DISPLACEMENT [cm³]	CONTROL MEDIUM
Single circuit					
470 015 002 0	1	7	30	1.5	Brake fluid
470 015 006 0	1	7	40	1.5	Brake fluid
470 015 010 0	1	7	70	1.5	Brake fluid
470 015 011 0	1	7	70	1.5	Mineral oil
470 015 051 0	1	5	15	2.2	Mineral oil
470 015 052 0	1	5	20	2.2	Brake fluid
470 015 054 0	1	5	30	2.2	Brake fluid
470 015 055 0	1	5	30	2.2	Mineral oil
470 015 090 0	1	7	45	1.5	Brake fluid
470 015 096 0	1	5	15	2.2	Brake fluid
470 015 098 0	1	4	25	2.2	Brake fluid
470 015 099 0	1	4	20	2.2	Brake fluid
470 015 201 0	2	3.5	8	2 x 2.2	Mineral oil
470 015 203 0	2	3.5	12	2 x 2.2	Mineral oil
470 015 214 0	3[1)]	8	73	2 x 0.6	Brake fluid
470 015 215 0	4	3	19	2 x 1.0	Mineral oil
470 015 217 0	2	3.5	14	2 x 2.2	Mineral oil
470 015 218 0	2	8	35	2 x 2.2	Brake fluid
470 015 221 0	4[2)]	3	19	2 x 1.0	Mineral oil
470 015 223 0	2	3	20	2 x 0.85	Mineral oil

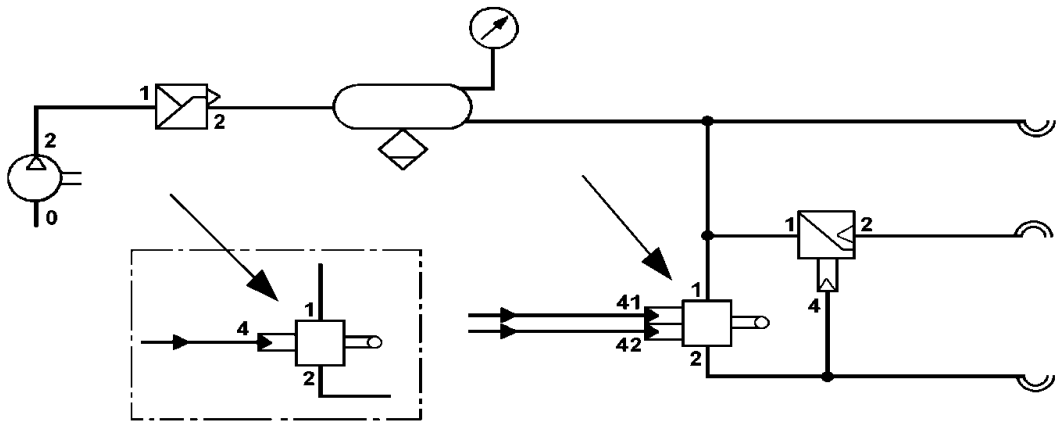
LEGEND			
1)	41 and 42 = M 10x1	2)	Control part rotated by 90° (in top view 41, 42 and 2)

PRODUCT NUMBER	CORRESPONDS TO FIG.	PRESSURE AT BRAKE COUPLING HEAD AT p_{42} = 7.4 bar	HYDRAULIC PART LIMIT PRESSURE [bar]	DISPLACEMENT [cm³]	CONTROL MEDIUM
1 circuit, hydraulically actuated and pneumatically pre-actuated					
470 015 252 0	3	0.0 - 1.0	20	2	Brake fluid
470 015 253 0	3	0.0 - 1.0	20	2	Mineral oil
470 015 254 0	3	0.0 - 1.0	11	2	Brake fluid
470 015 255 0	3	0.0 - 1.0	11	2	Mineral oil
470 015 256 0	3	0.0 - 1.0	19	2	Brake fluid
470 015 257 0	3	0.6 - 1.2	19	2	Mineral oil
470 015 258 0	3	0.0 - 1.0	14	2	Brake fluid
470 015 259 0	3	0.0 - 1.0	8	2	Mineral oil
470 015 261 0	3	0.0 - 1.0	14	2	Mineral oil
470 015 263 0	3	0.0 - 1.0	4	5.5	Mineral oil
470 015 265 0	3	0.6 - 1.6	11	2	Mineral oil
470 015 267 0	3	1.0 - 1.6	14	2	Mineral oil
470 015 269 0	3	0.0 - 1.0	14	2	Mineral oil
470 015 271 0	3	0.0 - 1.0	20	2	Mineral oil

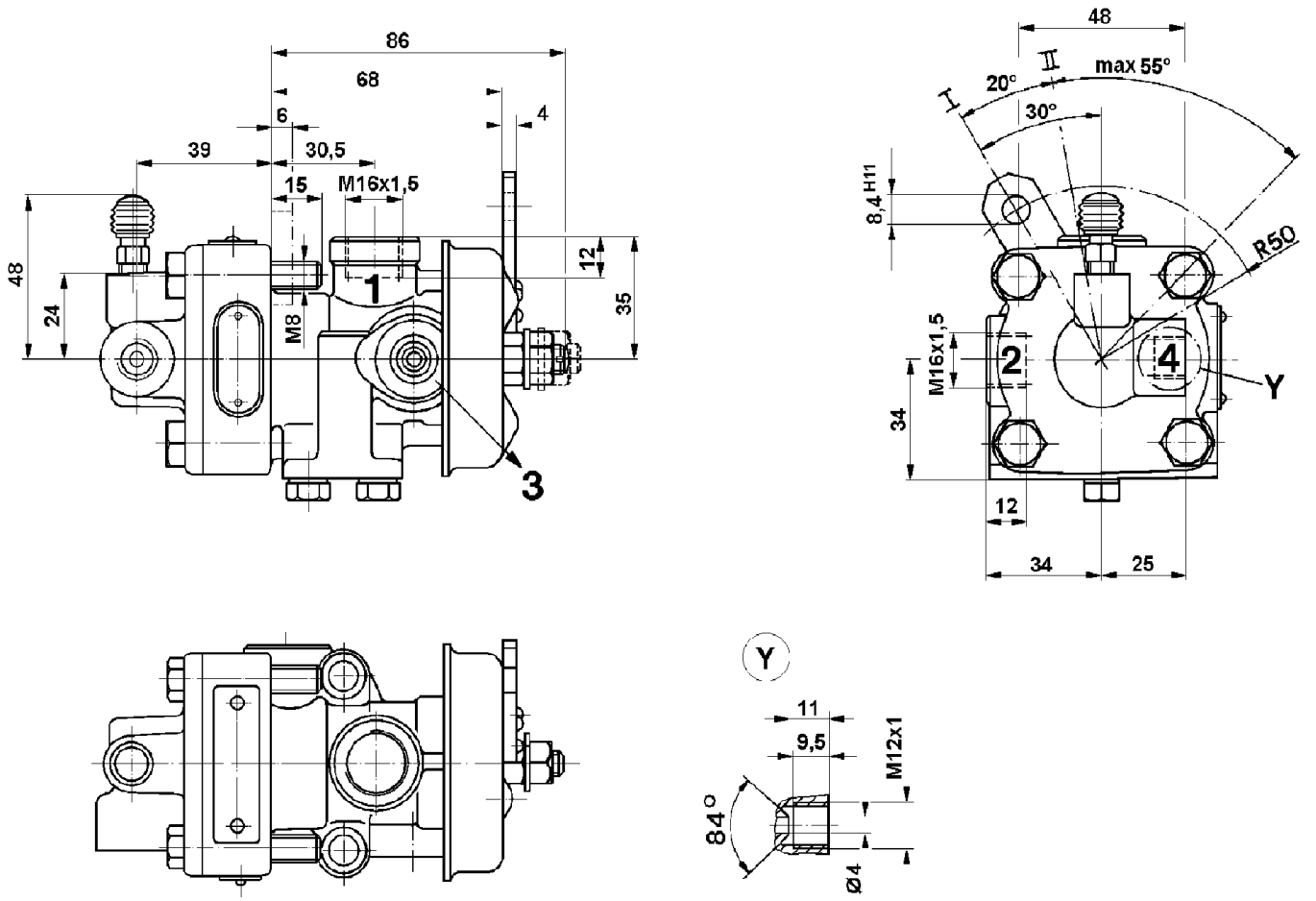
Installation recommendation

- Install the trailer control valve so that the vent valve for the hydraulic part points upward and is easily accessible.
- Fasten the trailer control valve with two of the four extended housing screws.
- Connect the hand brake lever with the existing hand brake linkage of the agricultural tractor.

Installation diagram



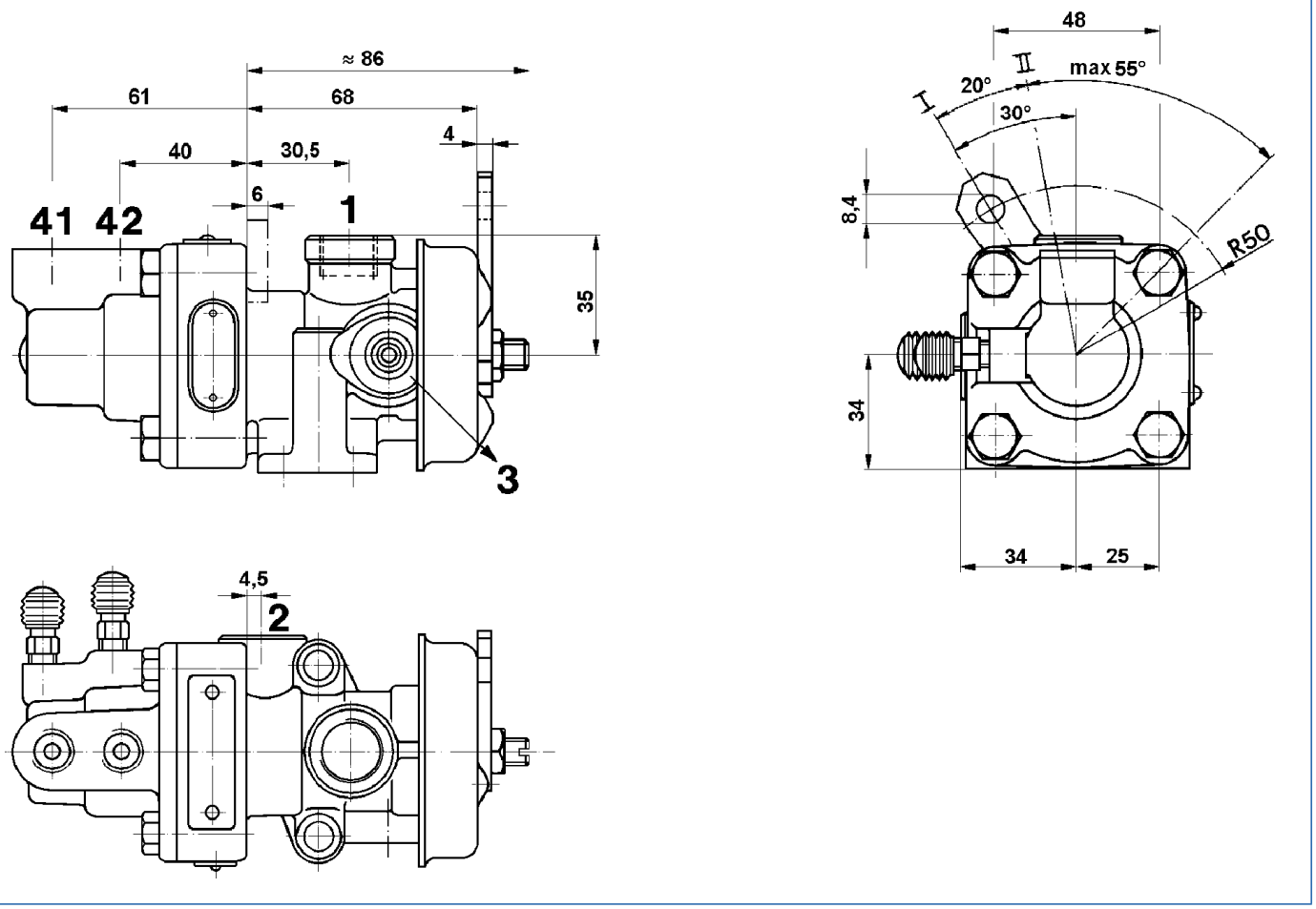
Installation dimensions for 470 015 008 0 (Fig. 1)



LEGEND					
1	Energy supply M 16x1.5	**2**	Energy discharge M 16x1.5	**3**	Venting

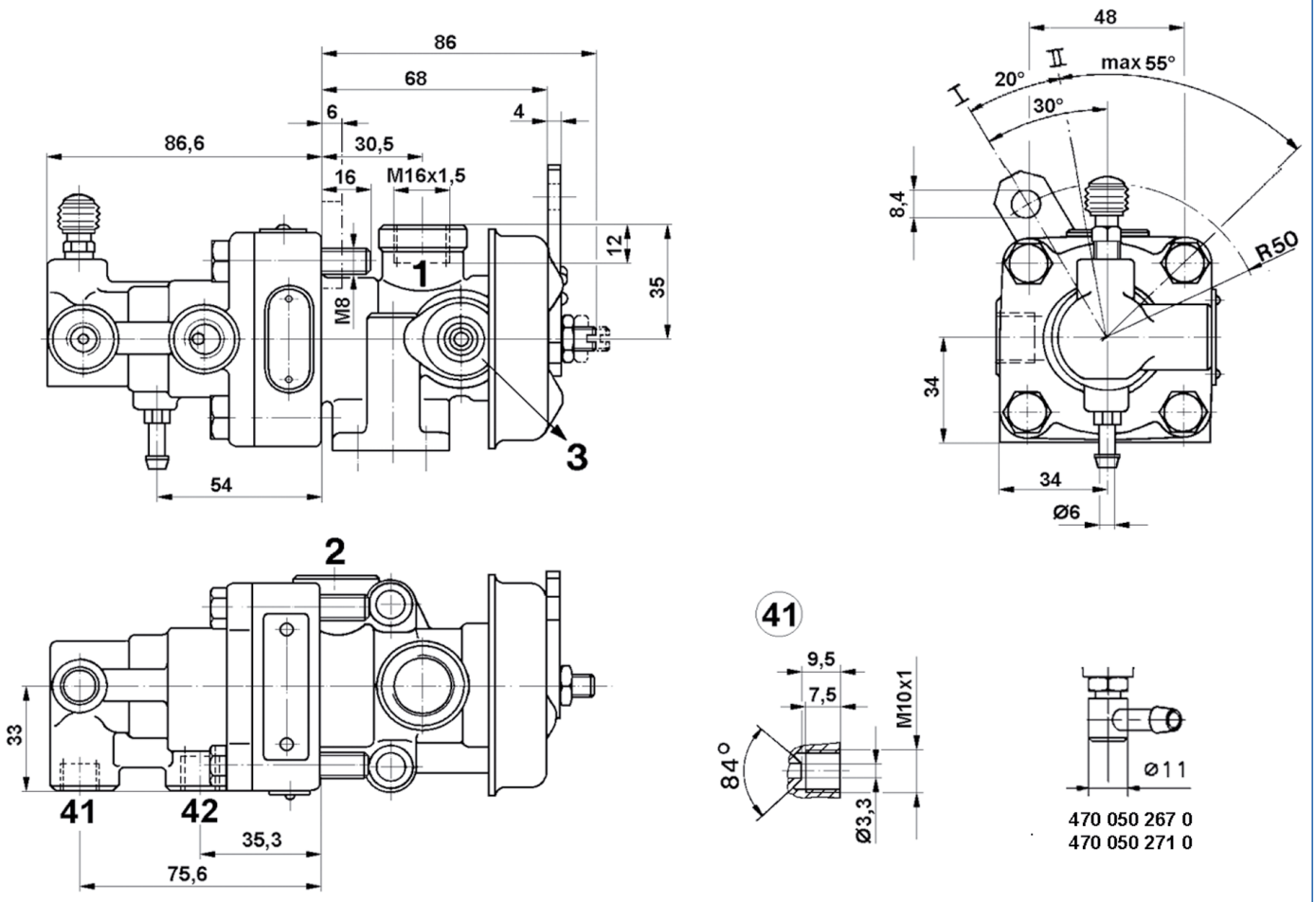
LEVER POSITION	I	II
p_1	7 bar	7 bar
p_2	0 bar	7 bar

Installation dimensions for 470 015 201 0 (Fig. 2)



LEGEND							
1	Energy supply M 16x1.5	**2**	Energy discharge M 16x1.5	**3**	Venting	**41, 42**	Hydraulic control port M 12x1

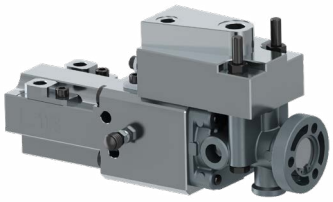
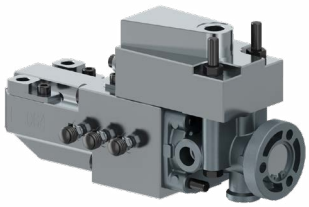
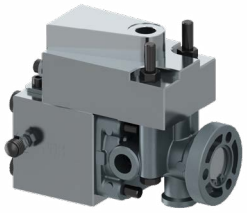
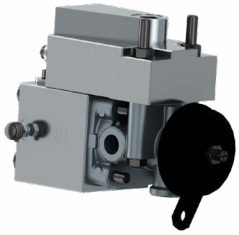
Installation dimensions for 470 015 252 0 (Fig. 3)



LEGEND					
1	Energy supply M 16x1.5	**2**	Energy discharge M 16x1.5	**3**	Venting
41	Hydraulic control port M 10x1	**42**	Hydraulic control port M 12x1.5		

5.29 Conventional trailer control valve 470 015 XXX 0 (for dual line trailer braking systems)

Design

470 015 037 0	470 015 122 0	470 015 047 0	470 015 111 0
			

Purpose

Trailer control valves control the dual line braking system of the trailer in conjunction with the tractor's hydraulic master brake cylinder or its hydraulic transmitter.

The cTCV device focuses on the requirements for trailer brake control devices in accordance with EU 2015/68 (state 10.2016).

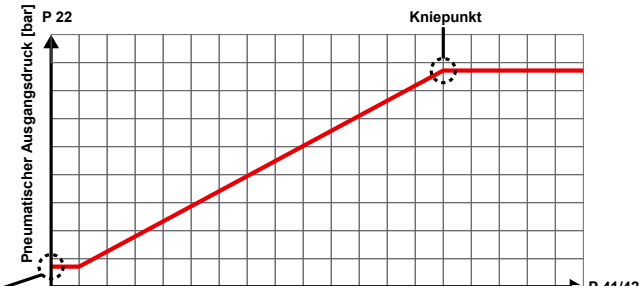
The listed main functions of the cTCV are in combination with the specific vehicle and the conditions mentioned below in accordance with EU 2015/68.

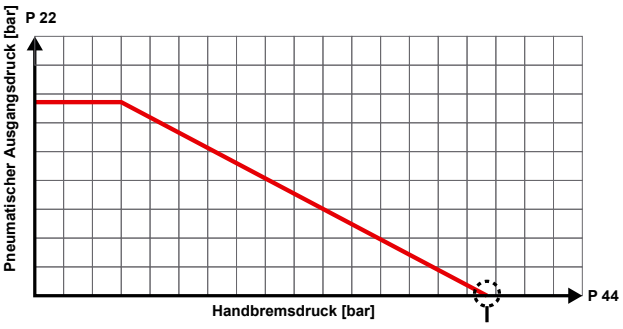
- Compliance with compatibility curves
- Automatic trailer braking in the event of a trailer control line failure
- Graduated hand brake
- Parking brake test function (additional hardware required)

Operating principle

The device is used for the control of dual-line trailer braking systems in combination with the hydraulic master cylinder or the hydraulic brake signal transmitter of the farm tractor, light truck, off-road vehicle or other towing vehicle equipped with hydraulic braking system. In addition, this device variant is equipped with a pneumatic control, thus enabling the supply of trailer braking pressure even before the hydraulic tractor brake becomes active. The pressure to be delivered is controlled by the different surface area ratios. By actuating the hydraulic/pneumatic hand brake in the towing vehicle, a pressure drop in the hydraulic/pneumatic spring accumulator will cause graduated braking of the vehicle combination.

If the supply pressure drops due to an interruption in the trailer brake line, the breakaway piston cuts off the open control line and releasing the pressure of the supply line of the trailer to cause an automatic braking action.





5.29.1 Single line actuation

Technical data

PRODUCT NUMBER	470 015 047 0	470 015 059 0	470 015 111 0
Max. operating pressure "pneumatic part" [bar]	10		
Max. operating pressure "hydraulic part" [bar]	120		
Medium	Air and mineral oil		
Thermal range of application [°C]	-40 to +80		
Weight [kg]	approx. 2,5 (dependent on variant)		

PRODUCT NUMBER	CORRESPONDS TO FIG.	STARTING POINT [bar]	KNEE POINT / RATIO [bar]	HANDBRAKE LEVER	INSTALLATION DIAGRAM
Single line service brake with 7.4 bar pre-control					
470 015 111 0	1	0.6 ± 0.4	7.4 / 26	Yes	a
470 015 047 0	2	0.6 ± 0.4	7.4 / 20	No	a
470 015 059 0	2	0.6 ± 0.4	7.4 / 26	No	a

PRODUCT NUMBER	470 015 037 0	470 015 040 0
Max. operating pressure "pneumatic part" [bar]	10	
Max. operating pressure "hydraulic part" [bar]	120	
Medium	Air and mineral oil	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	approx. 3.0 (dependent on variant)	

PRODUCT NUMBER	CORRESPONDS TO FIG.	STARTING POINT [bar]	KNEE POINT / RATIO [bar]	MAX. HANDBRAKE RELEASE PRESSURE [bar]	INSTALLATION DIAGRAM
Single line service brake with 3.5 bar pre-control and pneumatic handbrake					
470 015 037 0	3	0.3 ± 0.3	8.5 / 32.5	7.5	b
470 015 040 0	3	0.5 ± 0.4	8.5 / 37	7.5	b

5.29.2 Dual line actuation

PRODUCT NUMBER	470 015 038 0	470 015 039 0	470 015 122 0	470 015 074 0
Max. operating pressure "pneumatic part" [bar]	10			
Max. operating pressure "hydraulic part" [bar]	120 / 160			
Medium	Air and mineral oil			
Thermal range of application [°C]	-40 to +80			
Weight [kg]	approx. 3.0 (dependent on variant)			

PRODUCT NUMBER	CORRESPONDS TO FIG.	STARTING POINT [bar]	KNEE POINT / RATIO [bar]	MAX. HANDBRAKE RELEASE PRESSURE [bar]	INSTALLATION DIAGRAM
Dual line service brake with 6.5 bar pre-control and hydraulic high pressure hand brake					
470 015 038 0	4	0.5 ± 0.5	8.5 / 95	107	d
470 015 039 0	4	0.5 ± 0.5	8.5 / 60	107	d
470 015 122 0	5	0.6 ± 0.4	8.5 / 60	121	c
470 015 074 0	5	0.6 ± 0.4	8.5 / 46	121	c

PRODUCT NUMBER	470 015 123 0	470 015 072 0	470 015 073 0	470 015 075 0
	470 015 156 0	470 015 045 0	470 015 046 0	
Max. operating pressure "pneumatic part" [bar]	10			
Max. operating pressure "hydraulic part" [bar]	120			
Medium	Air and mineral oil			
Thermal range of application [°C]	-40 to +80			
Weight [kg]	approx. 3.0 (dependent on variant)			

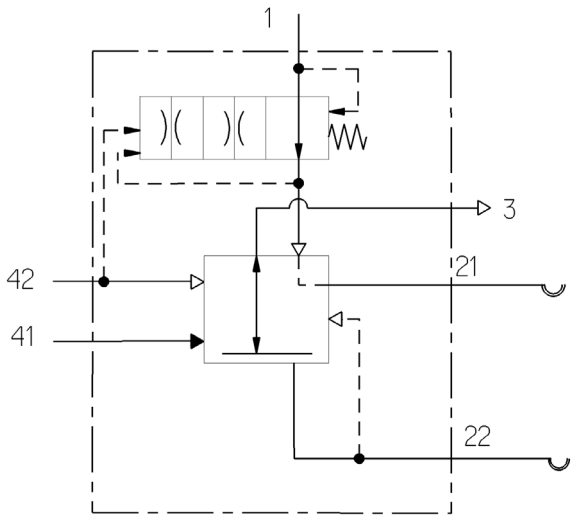
PRODUCT NUMBER	CORRESPONDS TO FIG.	STARTING POINT [bar]	KNEE POINT / RATIO [bar]	MAX. HANDBRAKE RELEASE PRESSURE [bar]	INSTALLATION DIAGRAM
Dual line service brake with 6.5 bar pre-control and hydraulic low pressure hand brake					
470 015 123 0	6	0.6 ± 0.4	8.5 / 25	17	c
470 015 072 0	6	0.6 ± 0.4	8.5 / 20	17	c
470 015 073 0	6	0.6 ± 0.4	8.5 / 60	17	c
470 015 075 0	6	0.6 ± 0.4	8.5 / 68	17	c
470 015 156 0	6	0.6 ± 0.4	8.5 / 45.5	17	c
470 015 045 0	6	0.6 ± 0.4	8.5 / 53	17	c
470 015 046 0	6	0.6 ± 0.4	8.5 / 41	17	c

Installation recommendation

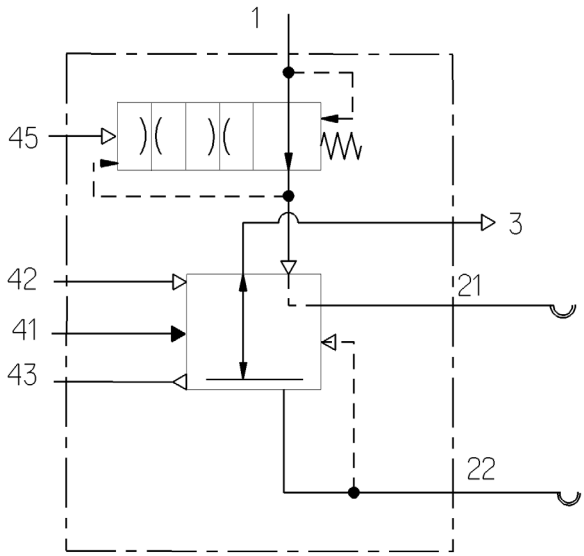
- The device has to be mounted on the vehicle frame with the pneumatic exhaust facing downwards and the venting screw for hydraulic circuit must be at the top of the valve.
- The device's centre line may deviate by a maximum of + 10°.
- Fasten the device so that it is rigid.
- Exposure to direct water jets is not permitted in the vicinity of the exhaust.

Installation diagram

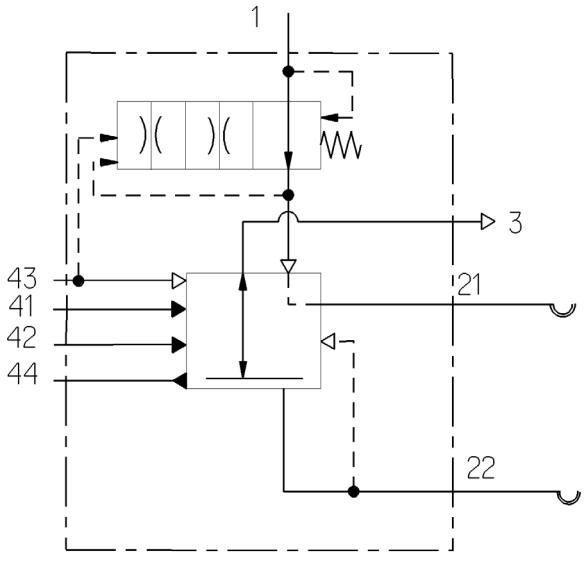
a



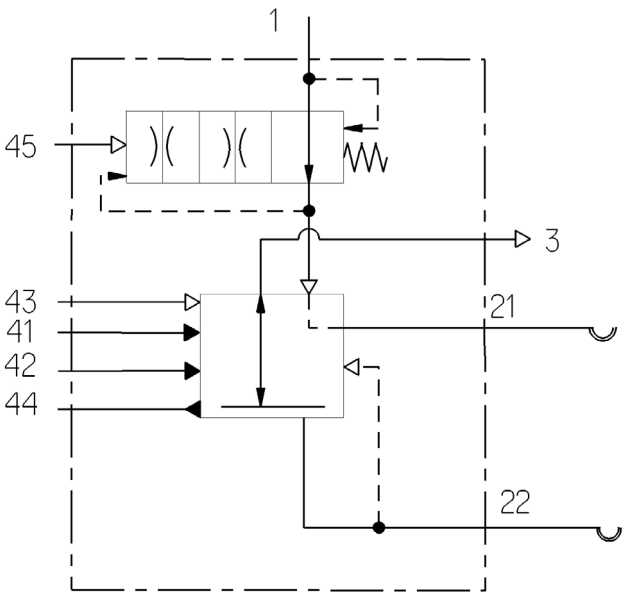
b



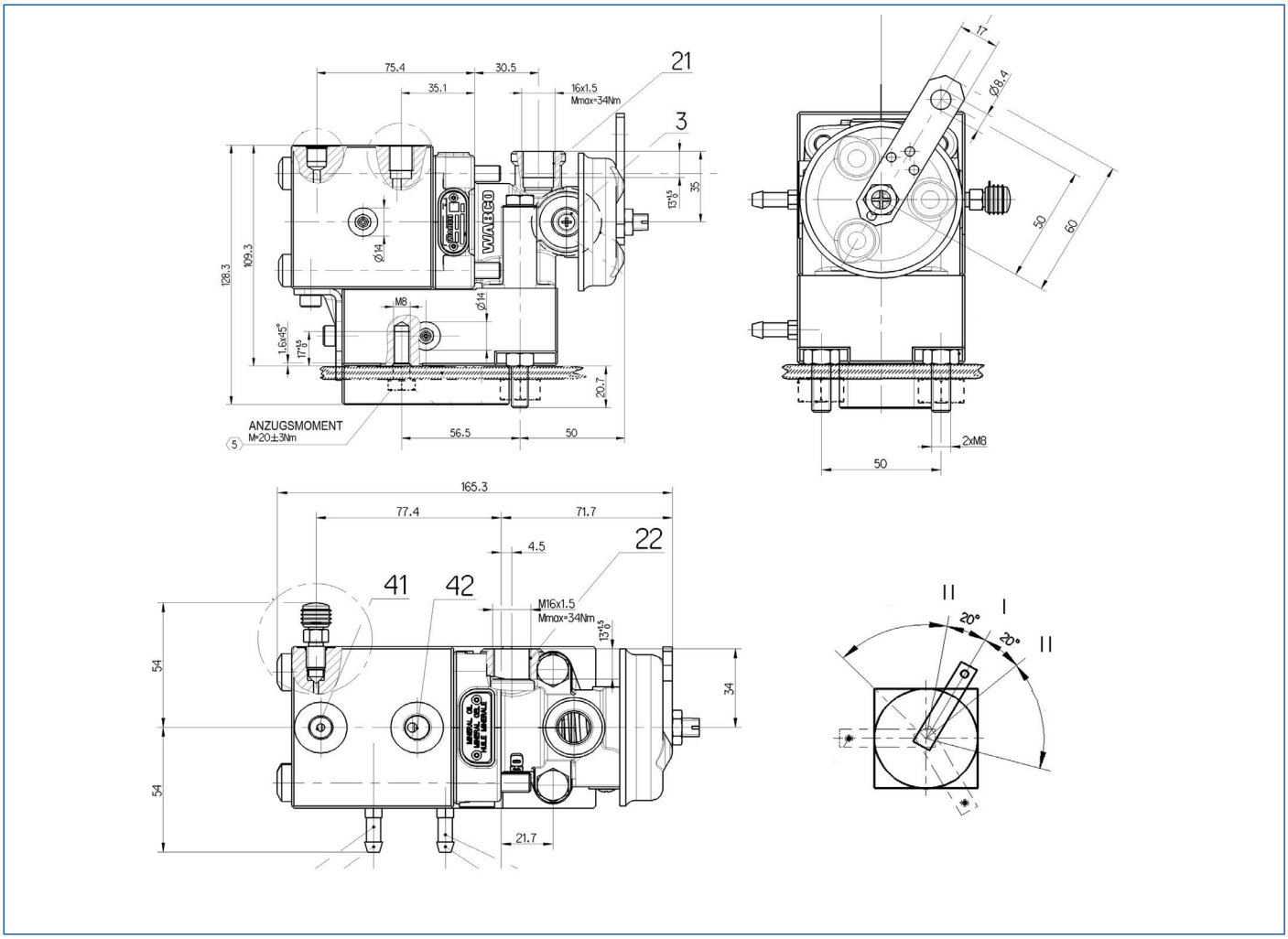
c



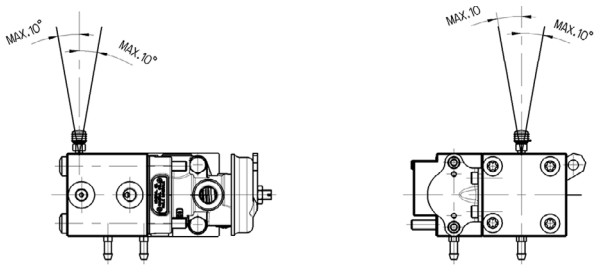
d



Installation dimensions for 470 015 111 0 (Fig. 1)



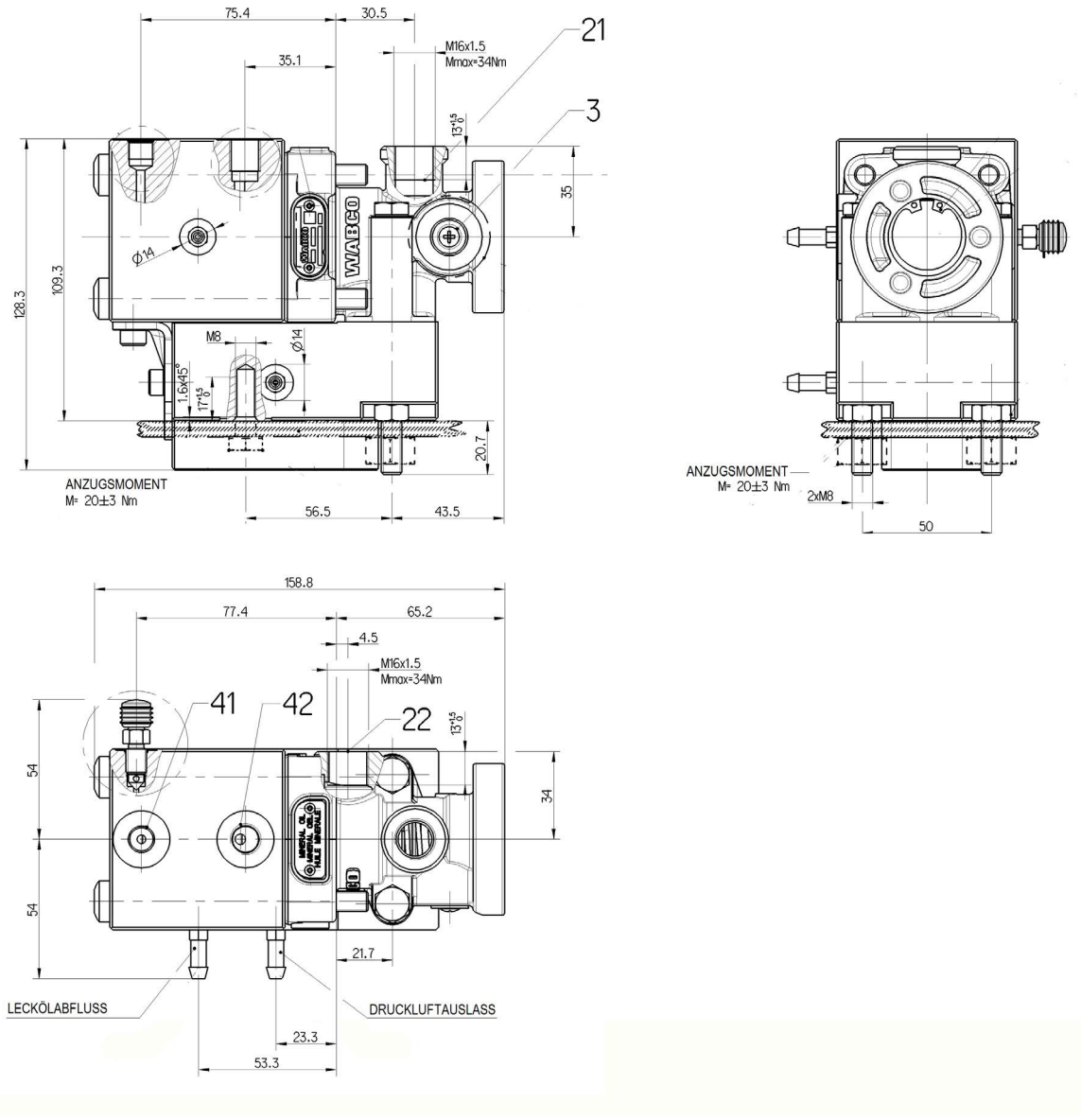
Mounting position



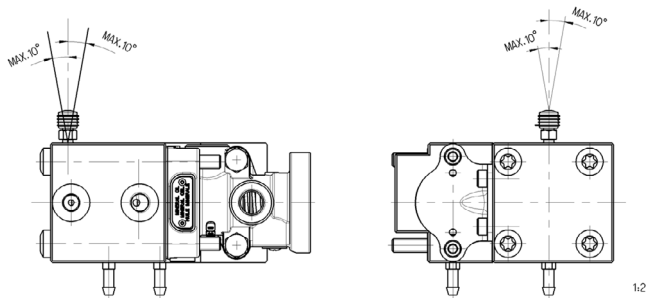
LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41**	Hydraulic control port M 10x1	**42**	Pneumatic control port M 12x1.5

LEVER POSITION	I	II
p_1	7.4 bar	7.4 bar
p_2	0 bar	7.4 bar

Installation dimensions for 470 015 047 0 (Fig. 2)

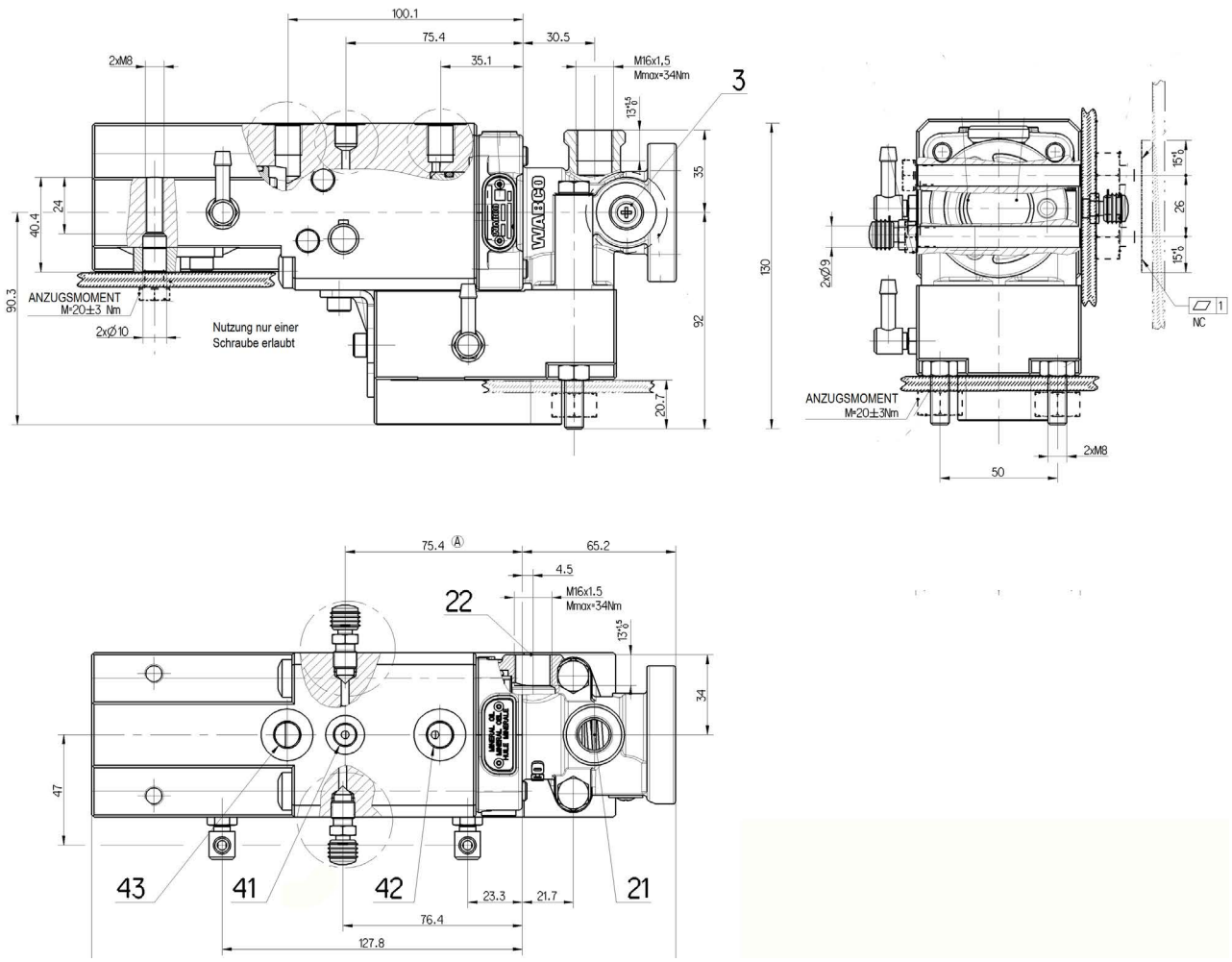


Mounting position

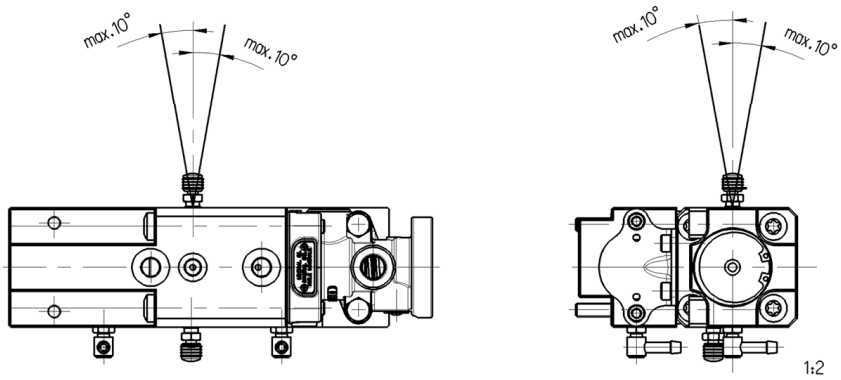


LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41**	Hydraulic control port M 10x1	**42**	Pneumatic control port M 12x1.5

Installation dimensions for 470 015 037 0 (Fig. 3)

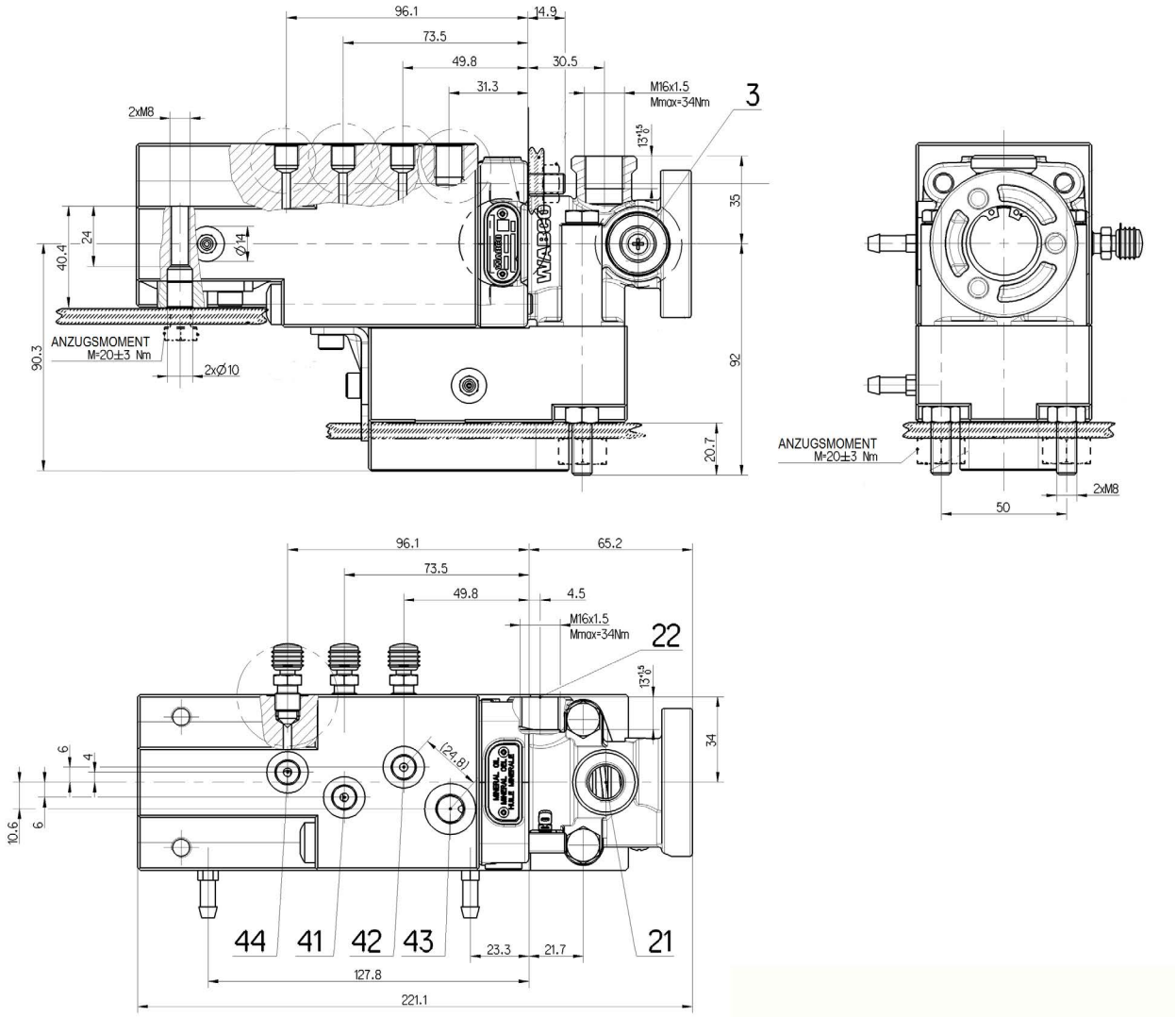


Mounting position

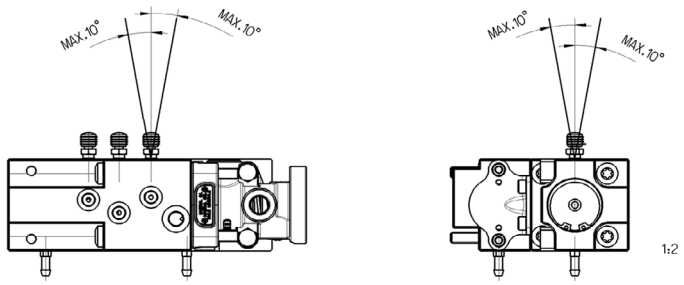


LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41**	Hydraulic control port M 10x1	**42, 43, 45**	Pneumatic control port M 12x1.5

Installation dimensions for 470 015 122 0 (Fig. 5)

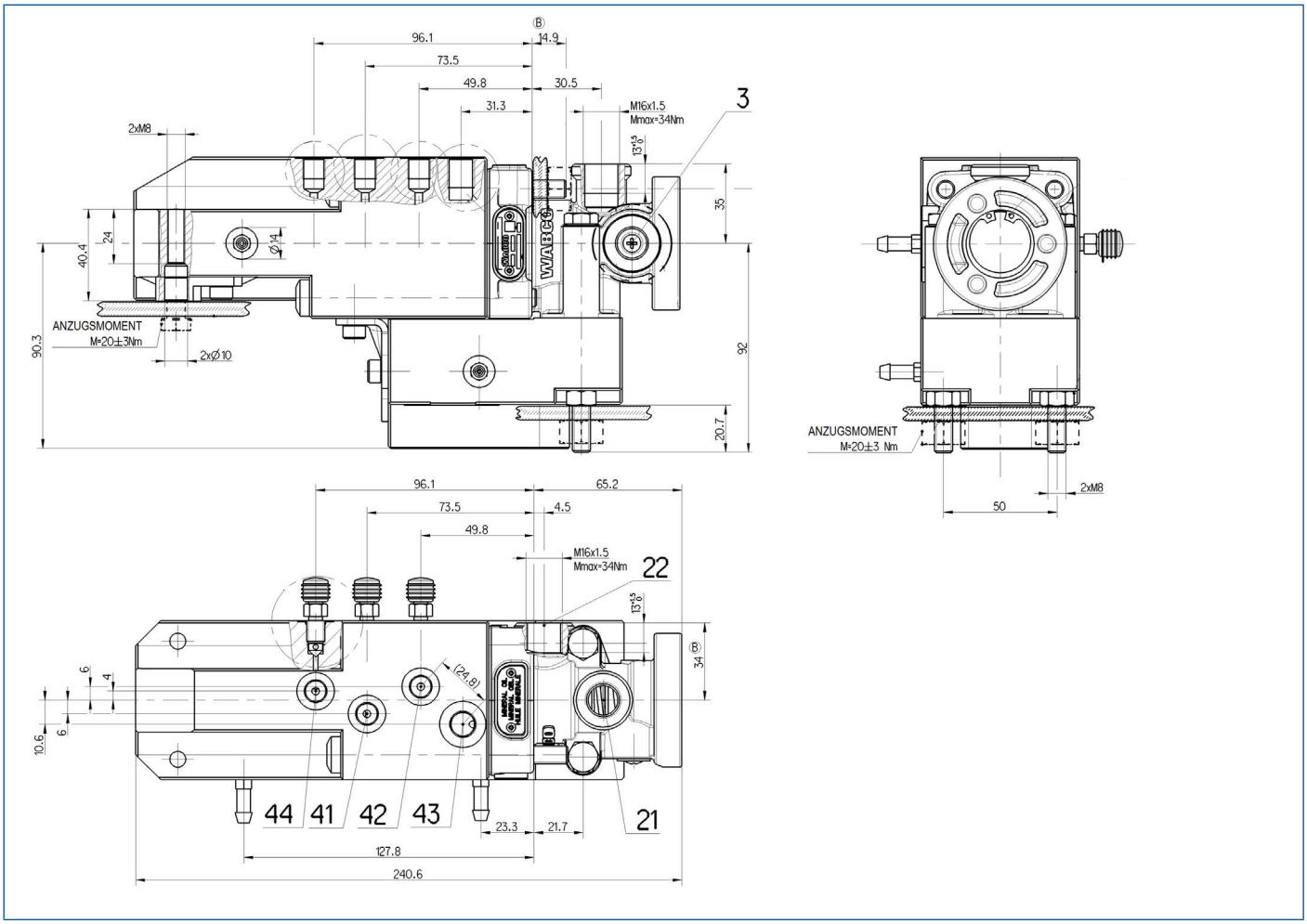


Mounting position

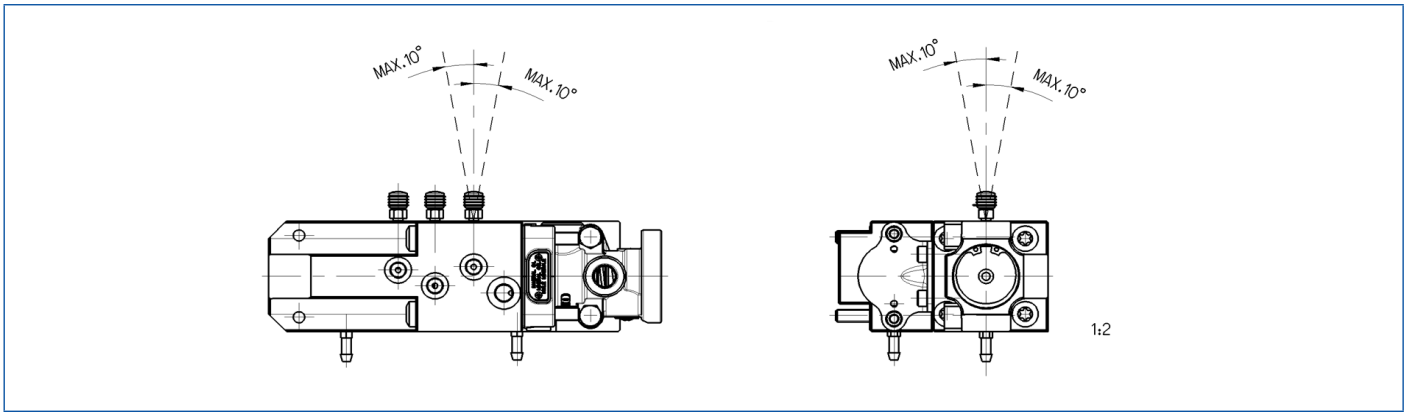


LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41, 42, 44**	Hydraulic control port M 10x1	**43, 45**	Pneumatic control port M 12x1.5

Installation dimensions for 470 015 122 0 (Fig. 5)

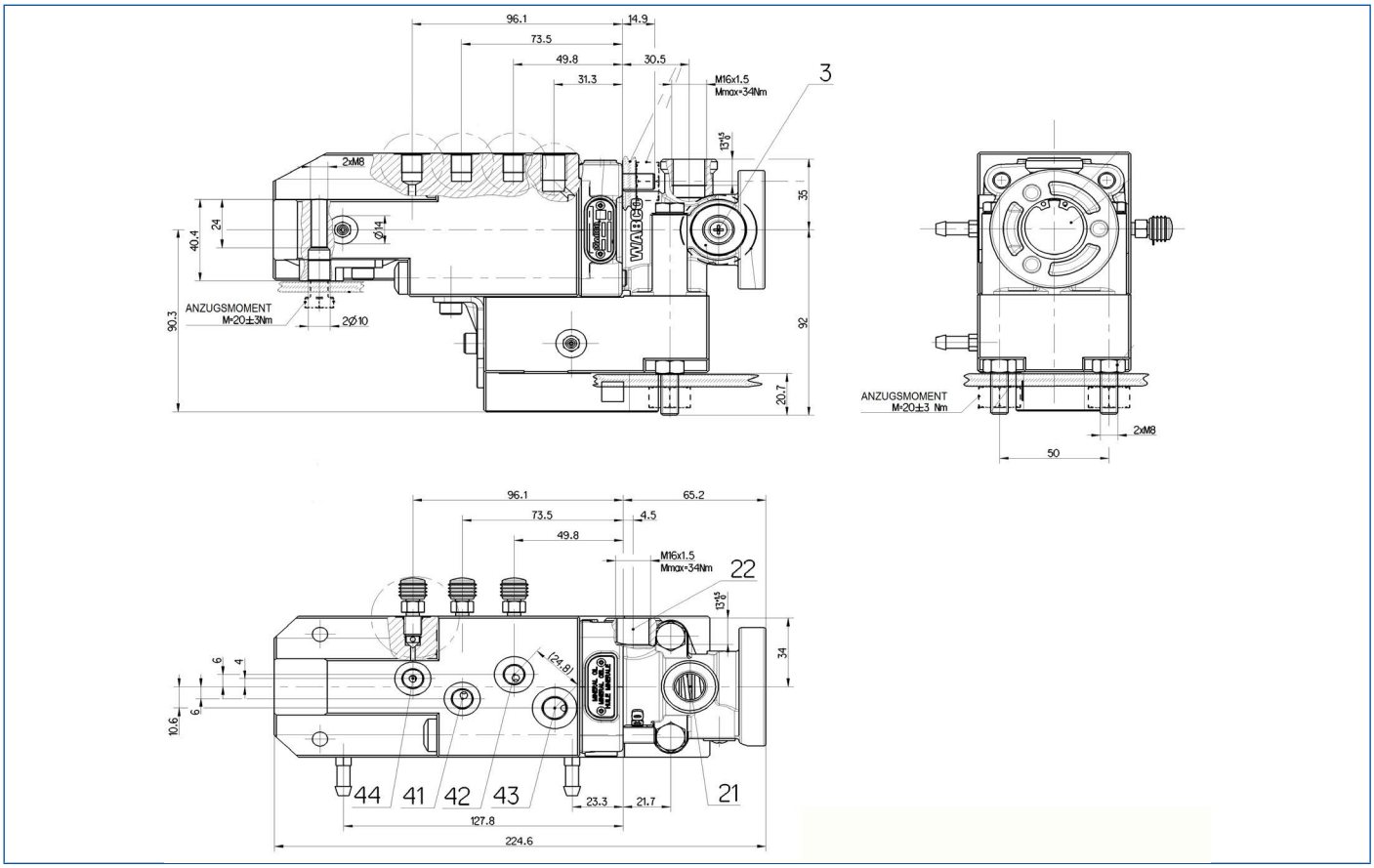


Mounting position

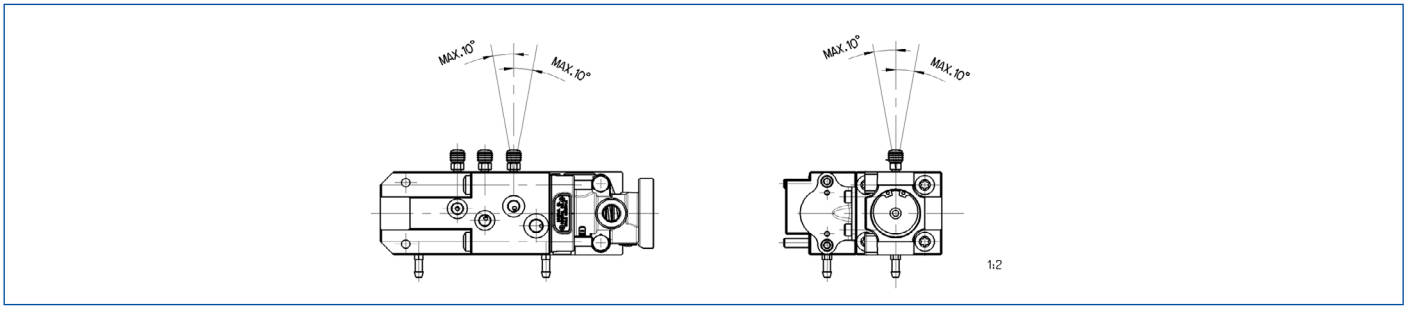


LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41, 42, 44**	Hydraulic control port M 10x1	**43**	Pneumatic control port M 12x1.5

Installation dimensions for 470 015 123 0 (Fig. 6)



Mounting position



LEGEND									
1	Energy supply M 16x1.5	**21, 22**	Energy discharge M 16x1.5	**3**	Venting	**41, 42, 44**	Hydraulic control port M 10x1	**43**	Pneumatic control port M 12x1.5

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.29.3 Trailer control valve 470 015 30X 0

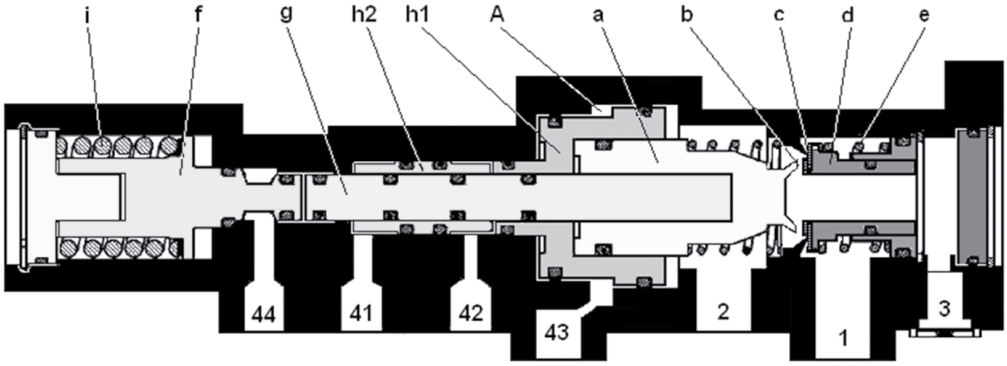
Design

470 015 300 0

Purpose

Trailer control valves control the dual line braking system of the towing vehicle in conjunction with the trailer's hydraulic master brake cylinder or its 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.

Operating principle



In the release position, the compression spring (**e**) pushes the valve (**d**) against the inlet (**c**) and keeps it closed. The port **2** is connected with the outlet (**b**) and the vent **3**.

When the brake pedal is depressed, an upstream 3/2 directional control solenoid valve is actuated – via the stop light switch, for example – and the supply pressure is applied to the port **43** and therefore the chamber **A**. The piston (**a**) closes the outlet (**b**) and opens the inlet (**c**). This means that a low control pressure reaches the brake coupling head and then the trailer brake valve via the port **2** before hydraulic control pressure builds up at the ports **41** and **42**. The compressed air acting on the differential piston (**a**) moves it to the left against the pilot control pressure in the chamber **A**, and the inlet (**c**) is closed. A final position has now been reached.

The hydraulic control pressure then starts to act on the pistons (**h1** and (**h2**)) via the ports **41** and **42**, and the differential piston (**a**) is shifted to the right. The outlet (**b**) is closed, the inlet (**c**) opens, and the compressed air at the port **1** flows to the brake coupling head and then on to the trailer brake valve via the port **2**. The compressed air acting on the differential piston (**a**) moves it to the left against the hydraulic control pressure and the inlet (**c**) is closed. A final position has now been reached.

The increase in the hydraulic control pressure causes the proportional output of pneumatic pressure at the port **2**. Releasing the brake pedal depressurises the ports **41**, **42** and **43**, causing the pressure in the port **2** to push the differential piston (**a**) back to its original position. The outlet (**b**) opens, and the port **2** is vented via the vent **3**.

A hydraulic, graduated hand brake function is integrated in the trailer control valves. In the driving position, hydraulic pressure is applied to the port **44**, and the piston (**f**) is pressed against a spring (**i**), which contracts. When the hand brake is applied, the hydraulic pressure at the port **44** is reduced, the spring (**i**) presses the piston (**f**) against the pistons (**g**), and shifts it to the right together with the differential piston (**a**). The outlet (**b**) is closed, the inlet (**c**) opens, and the compressed air at the port **1** flows to the trailer brake valve via the port **2**. The compressed air acting on the differential piston (**a**) moves it to the left against the hydraulic control pressure and the inlet (**c**) is closed. A final position has now been reached.

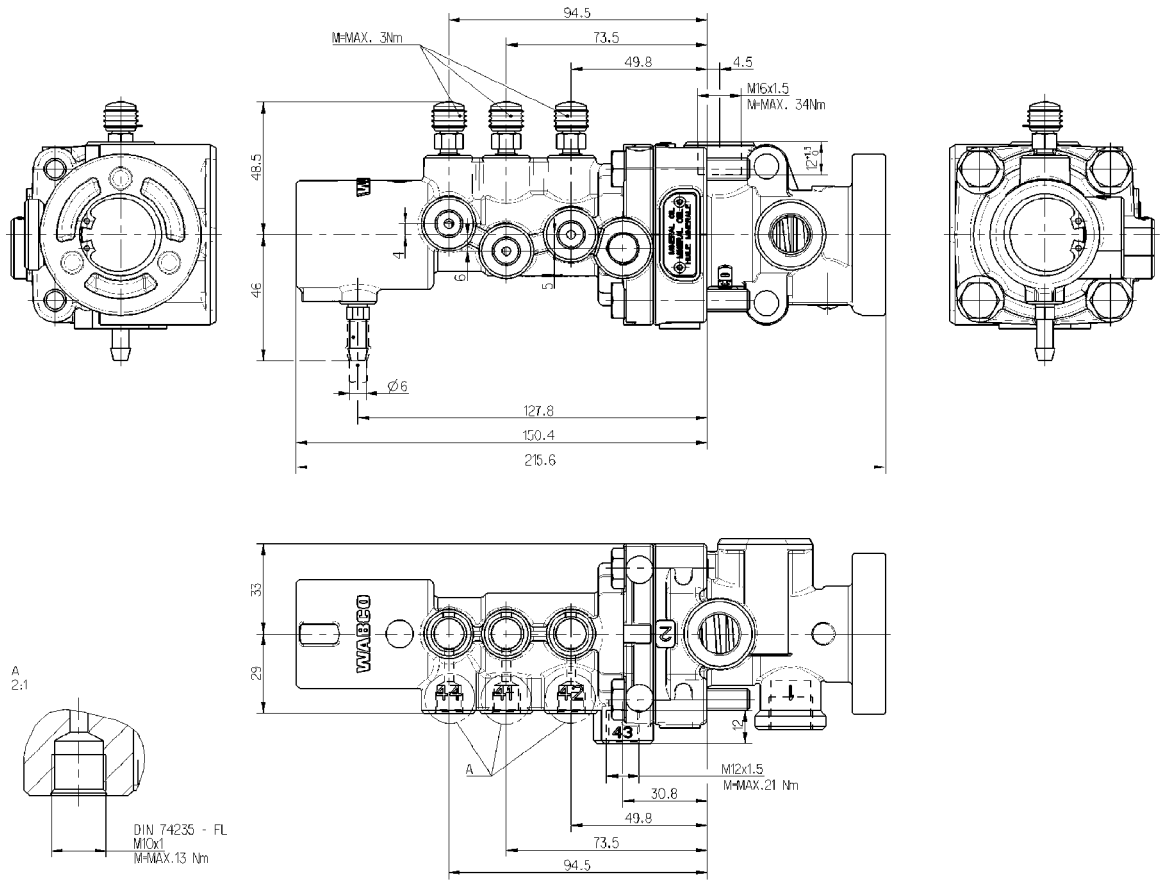
Technical data

PRODUCT NUMBER	470 015 300 0	470 015 301 0
Actuation pressure [bar]	0.0 to 0.5	
Hydraulic part limit pressure [bar]	60	95
Displacement [cm³]	1.0	
Control medium	Mineral oil	
Max. operating pressure "pneumatic part" [bar]	8.5	
Max. operating pressure "hydraulic part" [bar]	120	
Thermal range of application [°C]	-40 + 80	
Weight [kg]	1.01	

Installation recommendation

- Install the trailer control valve so that the vent valve for the hydraulic part points upward and is easily accessible.
- Fasten the trailer control valve to a bracket with two of the four extended housing screws.

Installation dimensions for 470 015 300 0 and 470 015 301 0



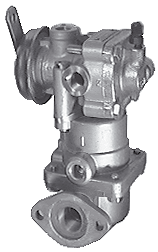
LEGEND							
1	Supply M 16x1.5	**2**	Brake M 16x2.5	**3**	Venting	**41**	Control connection braking circuit 1 M 10x1
42	Control connection Braking circuit 2 M 10x1	**43**	Control connection Pilot pressure M 12x1.5	**44**	Control connection Hand brake circuit M 10x1		

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.29.4 Trailer control valve 470 015 5XX0

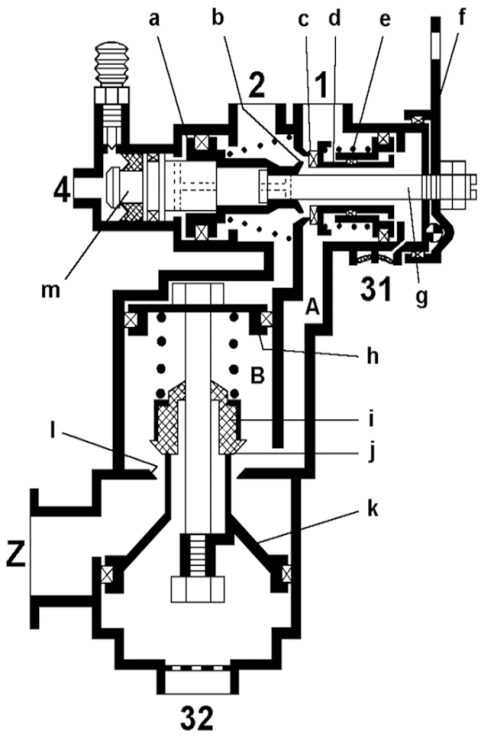
Design



Purpose

Trailer control valves control the dual line braking system of the towing vehicle in conjunction with the trailer's hydraulic master brake cylinder or its hydraulic transmitter.

Operating principle



In the release position, the compression spring (**e**) presses the valve sleeve (**d**) onto the inlet (**c**). The supply air from the port **1** flows through the bore **A** into the chamber **B** and lifts the piston (**h**), which takes the piston (**k**) and valve (**i**) with it. The inlet (**l**) is opened, causing the supply air to flow via the port **Z** into the trailer control line (single line). When the forces are balanced between the pistons (**h** and **k**), the inlet (**l**) is closed and the pressure at the port **Z** is limited to 5.2 bar. The port **2** is vented via the outlet (**b**) and the vent **31**.

When the brake pedal is depressed, the hydraulic control pressure acts on the piston (**m**) via the port **4** and shifts the piston together with the differential piston (**a**) to the right. The outlet (**b**) is closed and the inlet (**c**) opens. The compressed air can now flow via the port **2** to the trailer brake line of the dual line braking system. The compressed air acting on the differential piston (**a**) shifts it against the hydraulic control pressure, and the inlet (**c**) is closed. A final braking position has now been reached. At the same time, the pressurised piston (**h**) is pushed downwards. The outlet (**j**) opens and the pressure at the port **Z** is partially vented via the vent **32**. A final braking position has been reached when the force in the chamber **B** acting on the underside of the piston (**h**) is greater than the force acting on the top of the pistons (**h** and **k**). The piston (**h**) is lifted until the outlet (**j**) and inlet (**l**) are closed.

An increase in the hydraulic control pressure also causes the pressure to rise at the port **2** respectively to drop at the port **Z**. When the brake pedal is released, the port **4** is depressurised, causing the pressure in the port **2** to push the differential piston (**a**) back to its original position, and the outlet (**b**) opens. The port **2** is vented via the vent **31**. At the same time, the pressure acting on the top of piston (**h**) is reduced and the supply pressure in the chamber **B** pushes it to its top end position. The port **Z** is pressurised again up to 5.2 bar via the open inlet (**l**). The trailer control valve also has a hand brake lever (**f**) which, as the hand brake is actuated, pushes the piston (**a**) against the valve sleeve (**d**), and the opening inlet (**c**) causes a full braking of the trailer.

Technical data

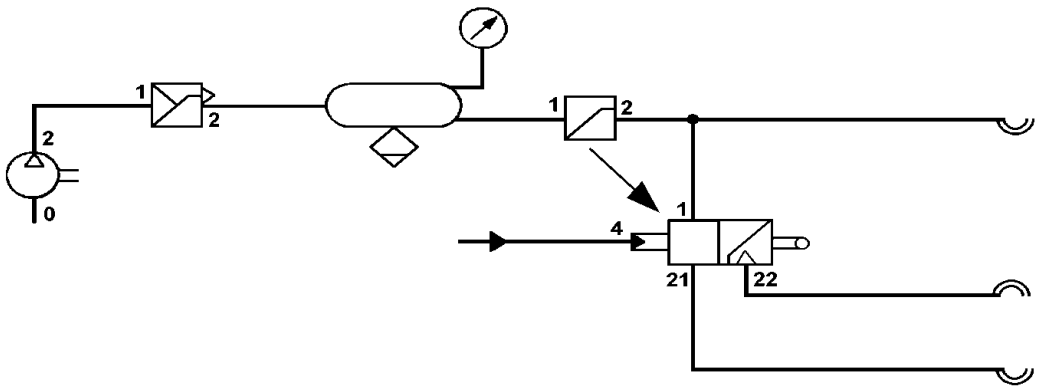
ORDER NUMBER	470 015 5XX 0
Max. operating pressure "pneumatic part" [bar]	10
Max. operating pressure "hydraulic part" [bar]	120
Medium	Air (control medium, see table below)
Thermal range of application [°C]	-40 to +80
Weight [kg]	approx. 1.9

PRODUCTNUMBER	ACTUATION PRESSURE [bar]	HYDRAULIC PART LIMIT PRESSURE [bar]	DISPLACEMENT [cm³]	CONTROLMEDIUM
470 015 506 0	7	40	1.5	Brake fluid
470 015 510 0	7	70	1.5	Brake fluid
470 015 522 0	7	30	1.5	Brake fluid
470 015 551 0	5	15	1.5	Mineral oil
470 015 588 0	7	45	1.5	Brake fluid
470 015 590 0	7	45	1.5	Brake fluid
470 015 595 0	4	20	2.2	Mineral oil
470 015 599 0	4	20	2.2	Brake fluid

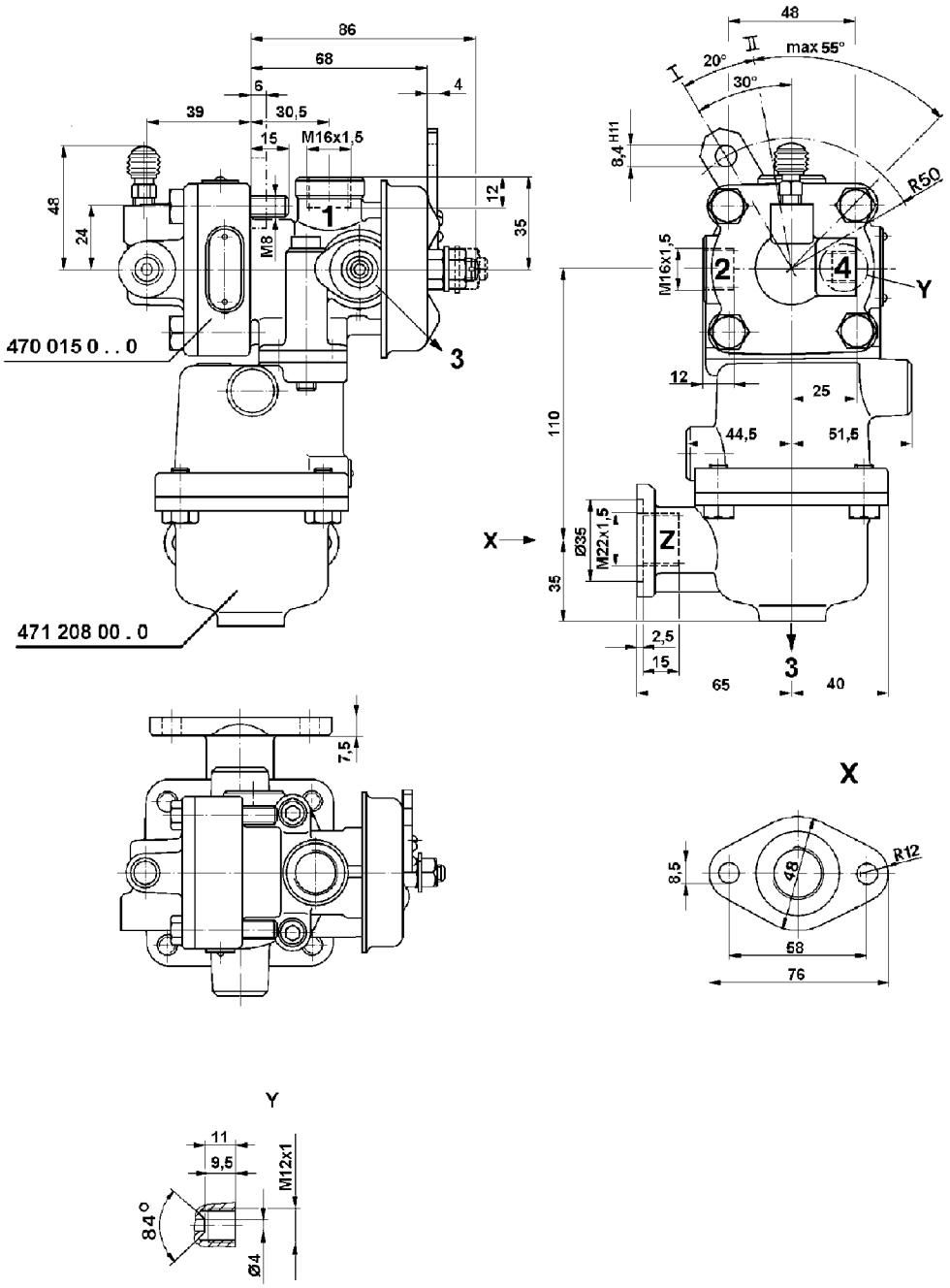
Installation recommendation

- Install the trailer control valve so that the vent valve for the hydraulic part points upward and is easily accessible.
- Fasten the trailer control valve with two of the four extended housing screws.
- Connect the hand brake lever with the existing hand brake linkage of the agricultural tractor.

Installation diagram



Installation dimensions



LEGEND					
1	Supply M 16x1.5	**2**	Output pressure (dual line) M 16x1.5	**3**	Venting
4	Hydraulic control pressure	**Z**	Output pressure (inlet)		

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

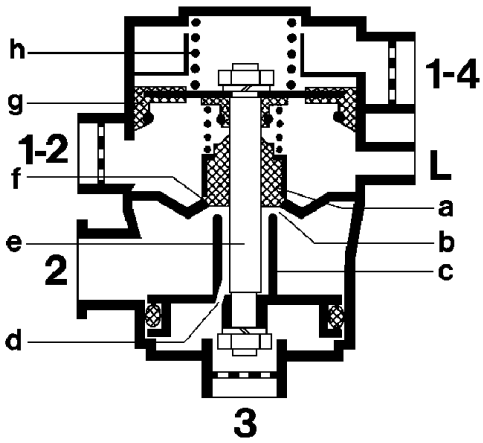
5.30 Trailer control valve 471 003 (for single line trailer braking systems)

Design

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 purpose of trailer brake valves is to gradually brake the trailer regardless of the pressure in the trailer brake line.

Operating principle of the trailer brake valve



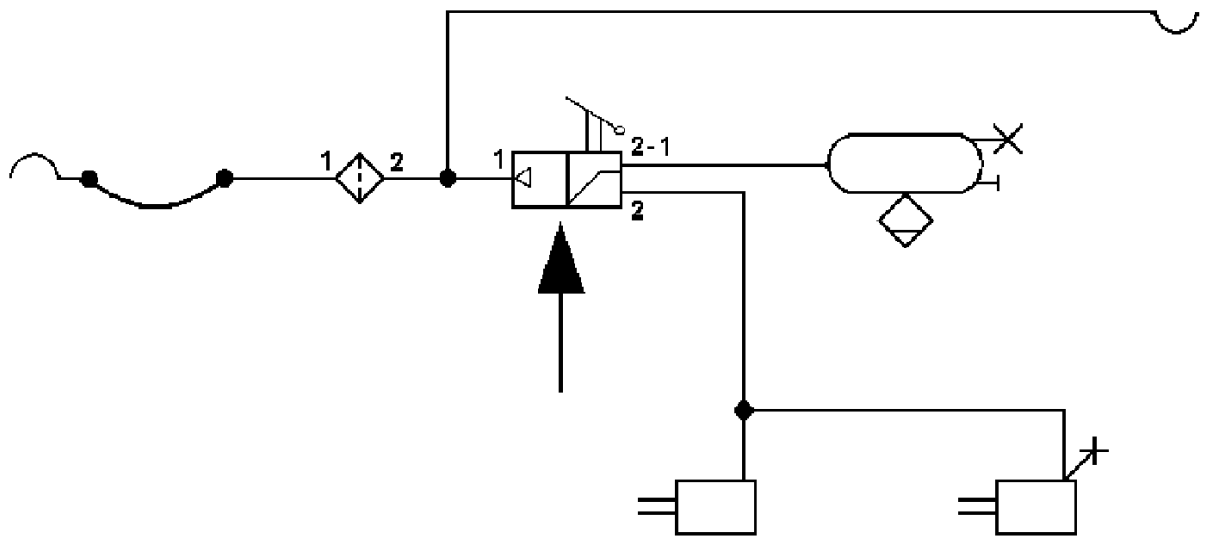
When the towing vehicle's brake is released, pressure from the supply reservoir is conveyed to the port **1-4** of the trailer brake valve via the coupling hose, past the cup seal (**g**) and the port **1-2**, and on to the trailer's supply reservoir. When the brakes are actuated, the pressure in the trailer control line and therefore at the port **1-4** is reduced, causing the cup seal (**g**) to be pushed upwards by the reservoir pressure acting on its underside. It pulls the piston (**c**) against the valve (**a**) via the piston rod (**e**) so that the outlet (**b**) is closed and the inlet (**f**) is opened. Compressed air from the trailer's supply reservoir now flows via the port **2** to the load-sensing valve and from there to the brake cylinders. After a pressure has built up which corresponds to the fall in pressure at the port **1-4** above the piston (**c**), this piston together with the piston rod (**e**) and cup seal (**g**) move downwards, closing the inlet (**f**). A final braking position has now been reached.

When the trailer control line is pressurised again, the inflowing pressure from the port **1-4**, supported by the spring (**h**), pushes the cup seal (**g**) with the piston rod (**e**) and piston (**c**) into the bottom end position. The outlet valve seat of the piston (**c**) is lifted off the valve (**a**), and the compressed air from the brake cylinders flows through the bore (**d**) and vent **3** out into the open air. If the line leading to the port **1-4** is abruptly vented due to the coupling hose being ripped off, this triggers an automatic full braking of the trailer.

Technical data of the trailer brake valve

PRODUCT NUMBER	471 003 530 0
Max. operating pressure [bar]	5.3
Max. brake cylinder pressure in lever position (delivery state) "Release" [bar]	0
Max. brake cylinder pressure in lever position (delivery state) "Unladen" [bar]	1.4 to 1.6
Max. brake cylinder pressure in lever position (delivery state) "Half laden" [bar]	3.2 to 3.4
Max. brake cylinder pressure in lever position (supplied) "Fully laden"	Air reservoir pressure
Setting range "Unladen" in lever position "Half laden" [bar]	0.8 to 1.7 2.8 to 3.7
Thermal range of application [°C]	-40 to +80
Weight [kg]	1.6

Installation diagram

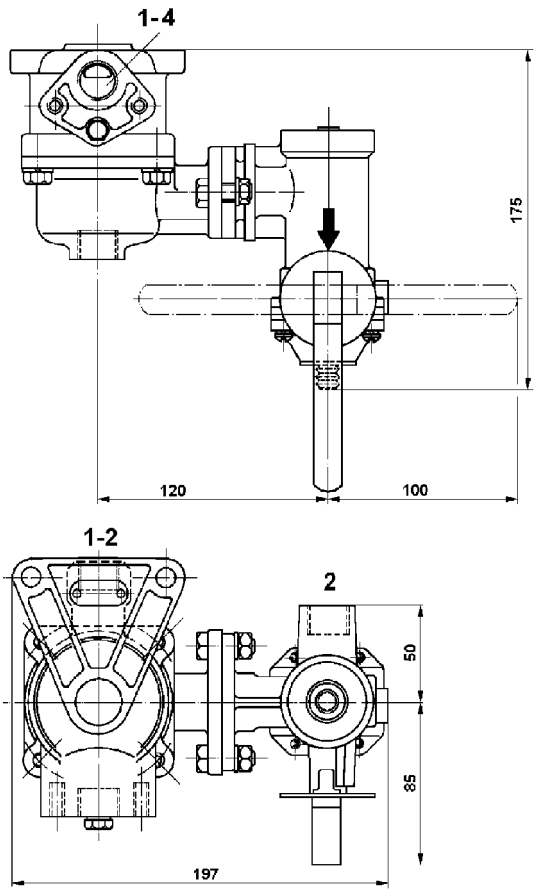


Note: In Austria and the Czech Republic, only manual control devices without a release position are permitted.

Installation recommendation

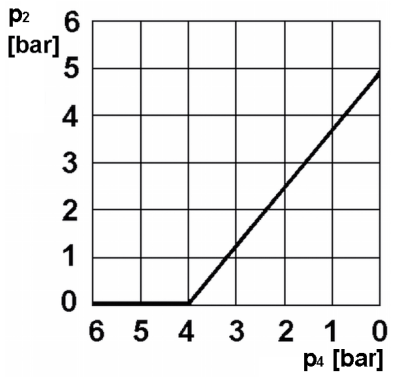
The brake valve must be mounted vertically with the vent pointing downwards using two M 10 screws.

Installation dimensions for the trailer brake valve



LEGEND			
1-2	Energy supply or discharge (supply reservoir) M 22x1.5	**1-4**	Energy supply or control connection (towing vehicle) M 22x1.5
2	Energy discharge M 22x1.5		

Pressure curve

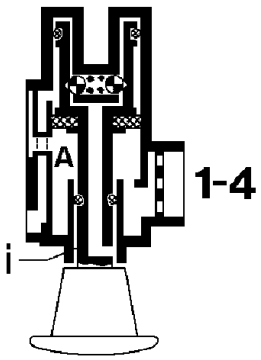


LEGEND			
p_2	Output pressure	p_4	Input pressure

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

Operating principle of the trailer release valve



When using the trailer brake valve in combination with an automatic load-sensing brake force controller or with mechanically adjustable load-sensing valves that have no release position, the trailer release valve 963 001 XXX X allows the trailer to be moved even when it is not hitched up to a towing vehicle. The piston rod (**i**) has to be pulled out up to the end stop to do this. This blocks the passage from the port **1-4** is thus blocked and a connection established between the port **L** and the port **1-4** of the trailer brake valve. The pressure from the trailer supply reservoir present at the port **L** flows through the chamber **A** to the port **1-4** of the flange-mounted trailer brake valve, causing it to reverse to its release position and the brake cylinders to be depressurised.

If the piston rod (**i**) has not been manually pushed into the release valve when hitching up the trailer to its towing vehicle, it is pushed in by the filling pressure flowing from the towing vehicle via the port **1-4**. The release valve is then back in its normal position in which the ports **1-4** are connected with one another. The piston rod (**i**) has a full-width vent hole which prevents the build-up inside the valve of either an air cushion when the piston is pushed in, or a vacuum when it is retracted.

Technical data of the trailer release valve

PRODUCT NUMBER	471 003 020 0
Max. operating pressure [bar]	5.3
Thermal range of application [°C]	-40 to +80
Weight [kg]	0.9

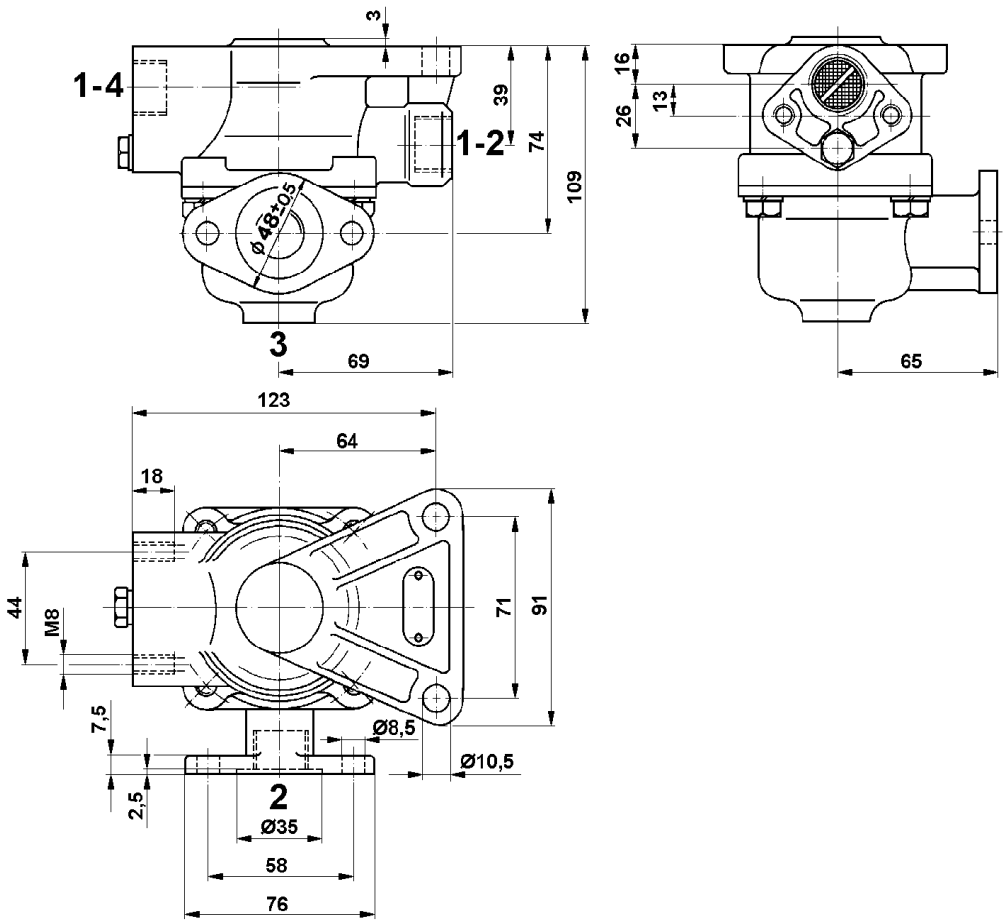
Installation recommendation

- Fasten the brake valve vertically so that the vent opening faces downward.
- Fasten the brake valve with two M10 screws.
- The parts listed in the table below are required to flange-mount a trailer release valve 963 001 XXX X to the trailer brake valve, whereby the O-rings are supplied with the release valve.

Flange accessories – trailer release valve

PRODUCT NUMBER	CONTENTS
897 086 680 4 (included in the scope of delivery)	1 O-ring 24x2
897 086 670 4 (included in the scope of delivery)	1 O-ring 8.9x1.9
810 128 037 4	2 cylinder screws M 8x25 DIN 6912-8.8-Zn
810 420 006 4	2 spring washers 8 WN 7

Installation dimensions for the trailer release valve



LEGEND			
1-2	Energy supply or discharge M 22x1.5	**1-4**	Energy supply or control connection M 22x1.5
2	Energy discharge M 22x1.5	**3**	Venting M 22x1.5

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

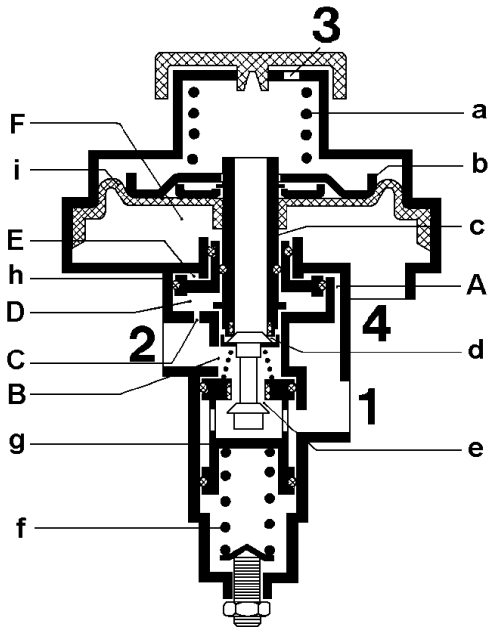
5.31 Trailer control valve with pressure limitation 471 200

Design

Purpose

Trailer control valves control the initiating trailer braking system in conjunction with the trailer control valve attached to the brake pedal for the dual line trailer braking system on the tractor. They also restrict the output pressure to 5.2 bar.

Operating principle



In the release position, the compression spring (**a**) holds the diaphragm piston (**b**) with the valve sleeve (**c**) in its bottom end position. The outlet (**d**) is closed and the inlet (**e**) open. The compressed air from the tractor's supply reservoir flows via the port **1** to the port **2** and reaches the trailer brake valve via the coupling heads. At the same time, the compressed air flows through the bore **C** into the chamber **D** underneath the piston (**h**), and through the bore **A** into the chamber **E** above the piston (**h**). As soon as the pressure in the chamber **B** and in the line to the trailer has reached 5.2 bar, the valve (**g**) is moved downwards against the force of the compression spring (**f**) until the inlet (**e**) closes.

When the tractor foot brake lever is actuated, the output pressure from the trailer control valve attached to the foot brake lever for the dual line trailer braking system flows via the port **4** into the chamber **F**. Here, pressure now builds up below the cup seal which moves the diaphragm piston (**b**) with the valve sleeve (**c**) upwards against the force of the compression spring (**a**). The outlet (**d**) opens. Sufficient compressed air now escapes into the open air through the valve sleeve (**c**) and vent bore **3** so that the abrupt reduction in pressure in the trailer line required for advanced retardation of the trailer is attained.

At the same time, the pressure in the chamber **D** also falls, and the piston (**h**) is forced downwards by the supply pressure in the chamber **E** acting on its top part. It takes with it the valve sleeve (**c**), which in turn closes the outlet (**d**) as it settles on the double cone valve.

As described above, the increased braking effect of the tractor causes the pressure of the trailer control line to be further reduced whilst the advanced retardation of the trailer is maintained. When the tractor brake is released, the chamber **F** is vented again, causing the diaphragm piston (**b**) and valve sleeve (**c**) to be forced downwards by the force of the compression spring (**a**). The inlet (**e**) opens and the supply air present at the port **1** flows into the trailer control line via the port **2**.

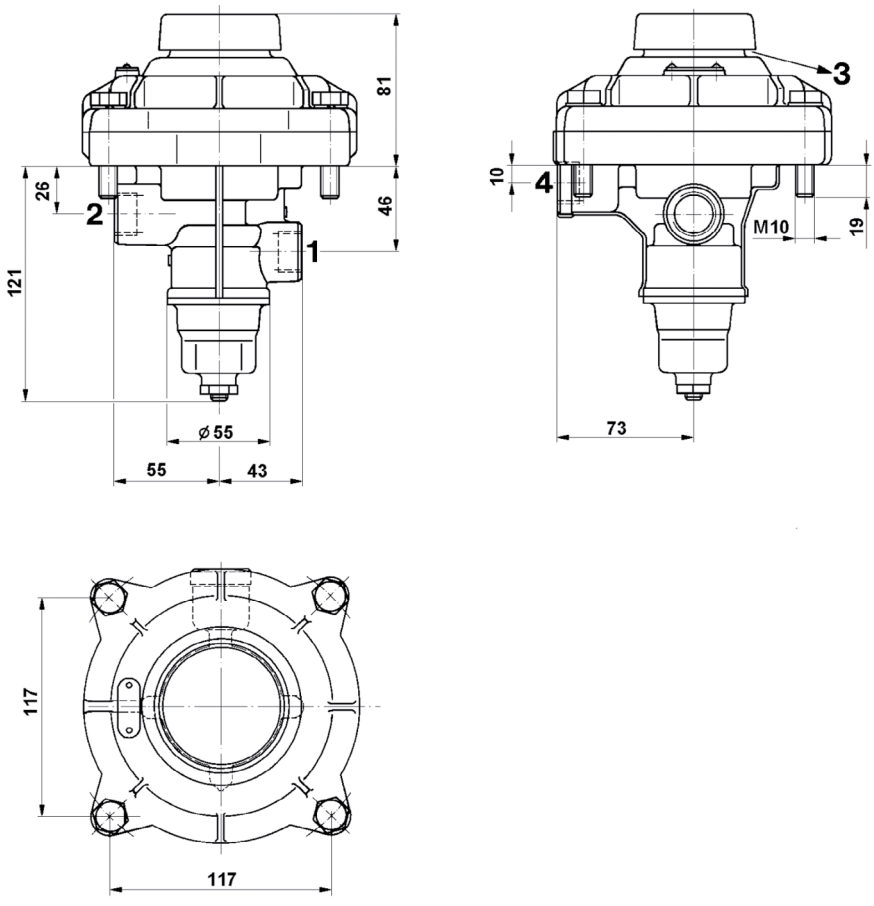
Technical data

PRODUCT NUMBER	471 200 008 0	471 200 110 0
Max. operating pressure [bar]	8.0	
Nominal diameter	10 mm corresponds to 78.5 mm²	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	2.02	2.01

Installation recommendation

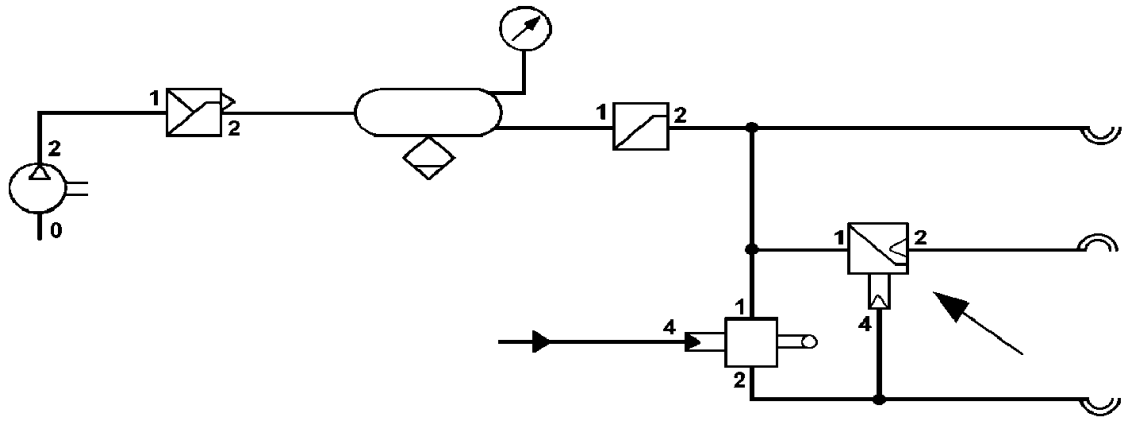
- Install the valve at the rear end of the tractor in order to keep the line leading to the trailer as short as possible. It can be mounted either vertically – with the rubber cap for the vent pointing upwards – or with the valve axle in a horizontal position.
- Fasten the trailer control valve with extended M10 housing screws.

Installation dimensions

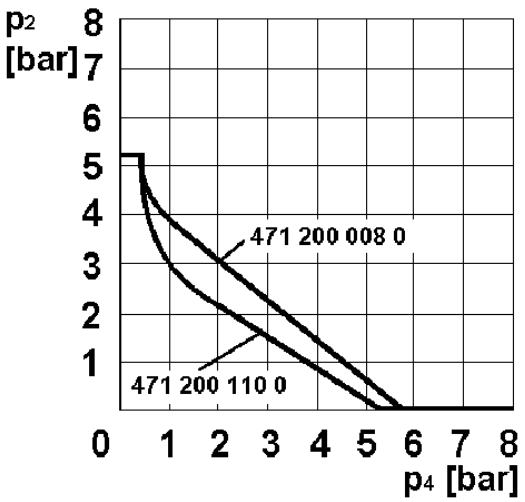


LEGEND			
1	Energy supply M 22x1.5	**2**	Trailer control line M 22x1.5
3	Venting	**4**	Control connection M 22x1.5

Installation diagram



Pressure curve

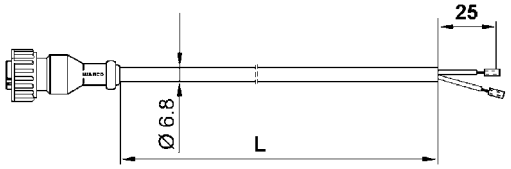
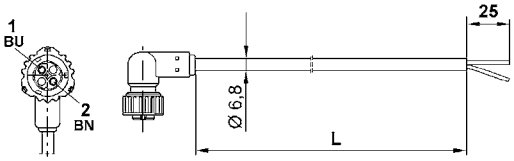
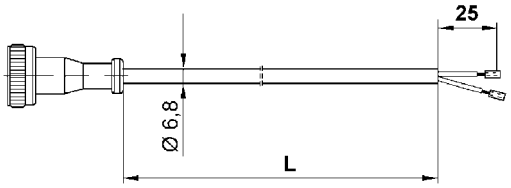
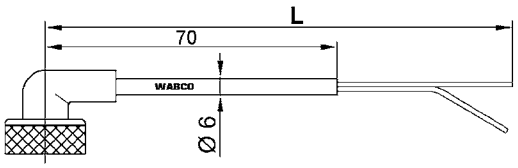
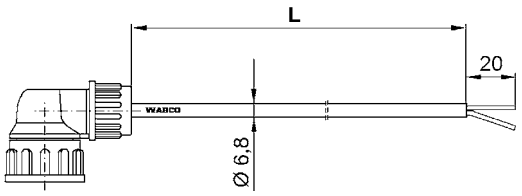


LEGEND			
p_2	Output pressure	p_4	Input pressure

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.32 Overview of cables for solenoid valves 449 XXX / 894 XXX

FIGURE	PRODUCT NUMBER	L [m]	"CABLE ENDS" TYPE	
DIN bayonet, straight connector				
	449 415 060 0 449 415 080 0 449 415 100 0	6 8 10	Socket DIN 72585 B1-2.1-Sn/K1	2 conductors (2x 1.5 mm²) with cable sleeves
DIN bayonet, elbow connector				
	449 515 004 0 449 515 020 0 449 515 050 0 449 515 100 0 449 515 120 0 449 515 150 0	0.4 2 5 10 12 15	Elbow socket DIN 72585 B1-2.1-Sn/K1	2 conductors (2x 1.5 mm²)
Kostal socket				
	449 521 050 0 449 521 100 0 449 521 150 0	5 10 15	Socket M 27x1 (2-pin)	2 conductors (2x 1.5 mm²) ends stripped 5 mm
Kostal elbow socket				
	894 600 451 2	0.30	Elbow socket M 27x1 (2-pin)	2 conductors (2x 1.5 mm²)
Kostal elbow socket				
	894 600 454 2	5	Elbow socket M 27x1 (2-pin)	2 conductors (2x1 mm²)

5.33 3/2 directional control solenoid valve (venting) 472 102 / 472 173

Design types

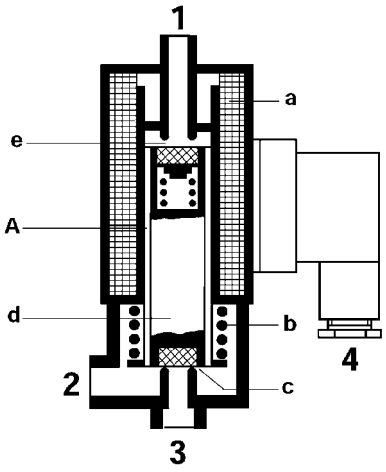
472 102 040 0

472 173 701 0

Purpose

3/2 directional control solenoid valves vent the working lines when the current flows to the magnet.

Operating principle



The supply line leading from the air reservoir is connected to the port **1** so that the supply air flows through the chamber **A** and the port **2** into the working line. The solenoid armature (**d**), which is designed as a valve body, holds the outlet (**c**) closed by the force of the compression spring (**b**). When current is fed to the solenoid coil (**a**), the armature (**d**) moves upwards, the inlet (**e**) closes and the outlet (**c**) opens. The compressed air from the working line now escapes into the open air via the port **3** and the downstream operating cylinder is vented.

If the flow of current to the solenoid coil (**a**) is interrupted, the compression spring (**b**) moves the armature (**d**) back to its initial position. The outlet (**c**) closes, the inlet (**e**) opens, and the supply air flows back into the working line via the chamber **A** and the port **2**.

Technical data

PRODUCT NUMBER	472 102 040 0	472 173 701 0
Operating voltage (DC) [V]	10.8 to 28.8	9 to 16
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
Duty cycle	100 %	
Max. operating pressure [bar]	8	< 13
Thermal range of application [°C]	-40 to +70	-40 to +80
Weight [kg]	0.6	0.5

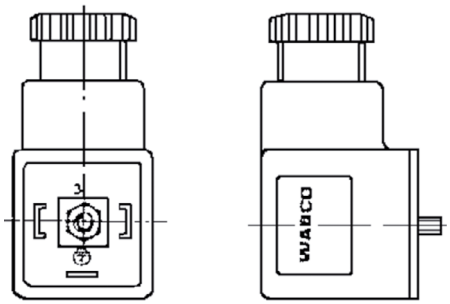
Installation recommendation

Install the 3/2 directional control valve in any position. Fasten the 3/2 directional control solenoid valve with two M8 screws.

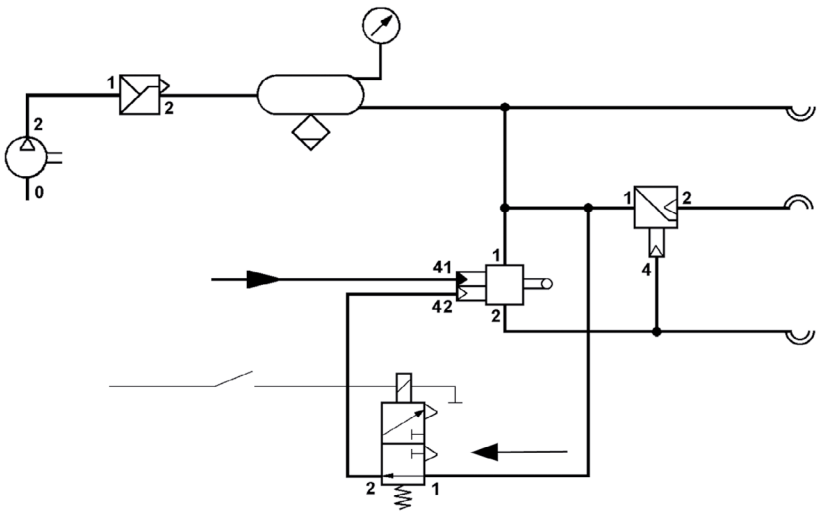
Note: On trailers which have electronic systems (e. g. ABS, ECAS) fitted, no solenoid valves may be installed without protective wiring if they have the same source of power as the electronics.

Note: If solenoid valves are being used without protective wiring, use diode plug 894 101 620 2.

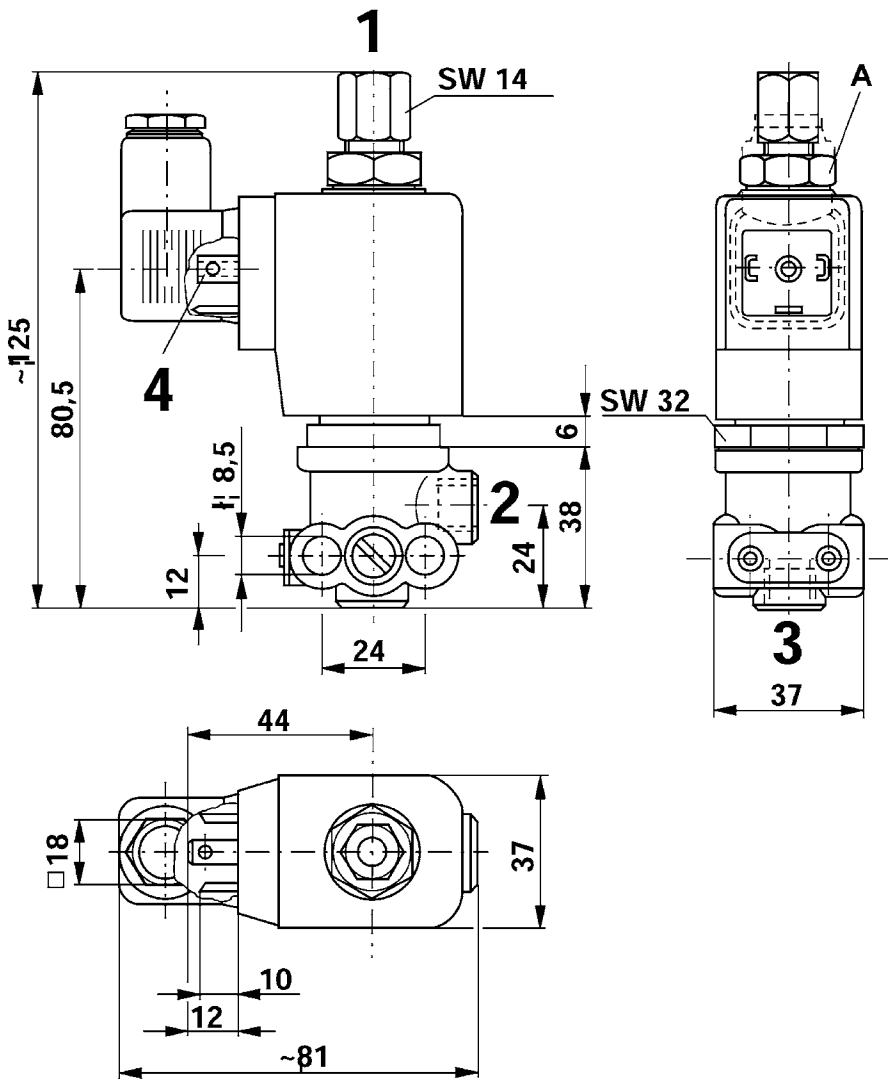
Diode plug 894 101 620 2



Installation diagram

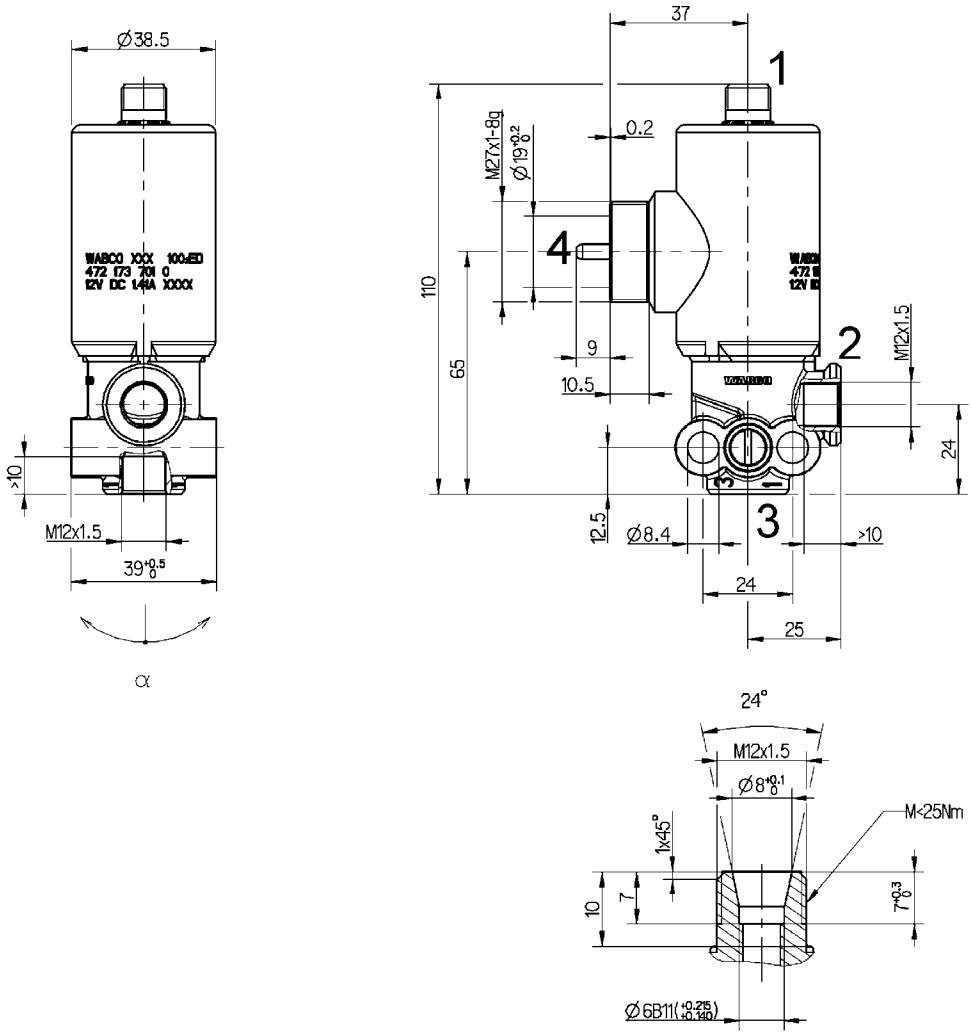


Installation dimensions for 472 102 040 0



LEGEND			
1	Energy supply M 12x1.5	**2**	Energy discharge M 12x1.5
3	Venting	**4**	Electrical control connection M 12x1.5
A	Loosen hexagon nut size 19 to turn the magnet		

Installation dimensions for 472 173 701 0



LEGEND			
1	Energy supply M 12x1.5	**2**	Energy discharge M 12x1.5
3	Venting	**4**	Electrical control connection M 12x1.5

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.34 3/2 directional control solenoid valve (charging) 472 127 / 472 170

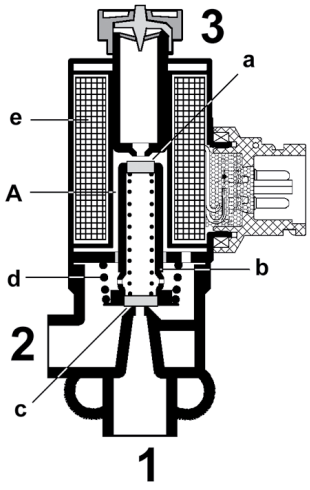
Design types

472 127 140 0	472 170 601 0	472 170 637 0
		

Purpose

3/2 directional control solenoid valves of this type pressurise the working lines when current flows to the magnet.

Operating principle



The supply line leading from the air reservoir is connected to the port **1**. The solenoid armature (**b**), which is designed as a valve body, holds the inlet (**c**) closed by the force of the compression spring (**d**).

When current is fed to the solenoid coil (**e**), the armature (**b**) moves upwards, the outlet (**a**) closes and the inlet (**c**) opens. The compressed air from the supply line now flows from the port **1** to the port **2** and pressurises the working line.

If the flow of current to the solenoid coil (**e**) is interrupted, the compression spring (**d**) moves the armature (**b**) back to its initial position. The inlet (**c**) closes, the outlet (**e**) opens, and the working line is vented via the chamber **A** and the vent **3**.

Technical data

PRODUCT NUMBER	472 127 140 0	472 170 601 0	472 170 637 0
Operating voltage (DC) [V]	10.8 to 28.8	12 +0.4/-1.2	
Nominal width [mm]	Ø 2.2	Ø 4	
Nominal current [A]	at 12 V = 0.33 at 24 V = 0.65	1.41	
Duty cycle	100 %		
Max. operating pressure [bar]	8	10.2	
Thermal range of application [°C]	-40 to +70	-40 to +80	
Connector	–	Kostal M 27x1	DIN bayonet
Weight [kg]	0.7	0.5	

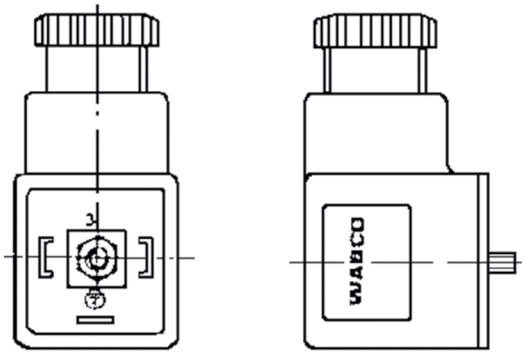
Installation recommendation

Install the 3/2 directional control valve in any position. Fasten the 3/2 directional control solenoid valve with two M8 screws.

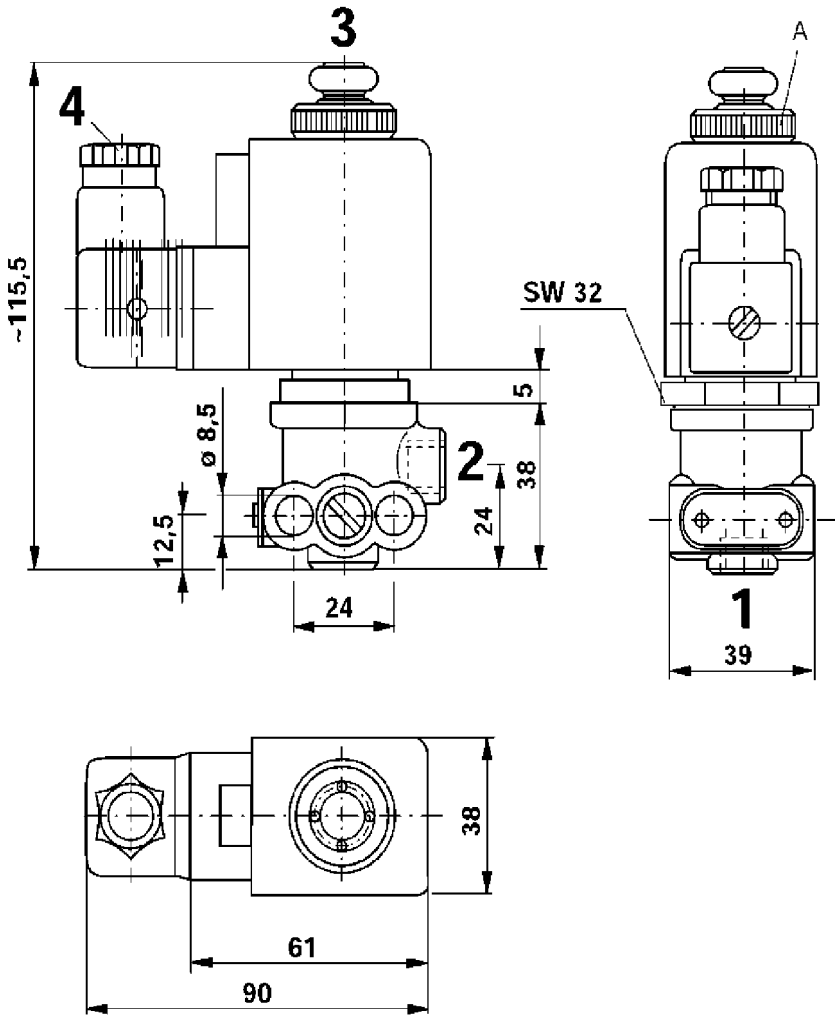
Note: On trailers which have electronic systems (e. g. ABS, ECAS) fitted, no solenoid valves may be installed without protective wiring if they have the same source of power as the electronics.

Note: If solenoid valves without any protective circuitry are being used, use diode plug 894 101 620 2.

Diode plug 894 101 620 2

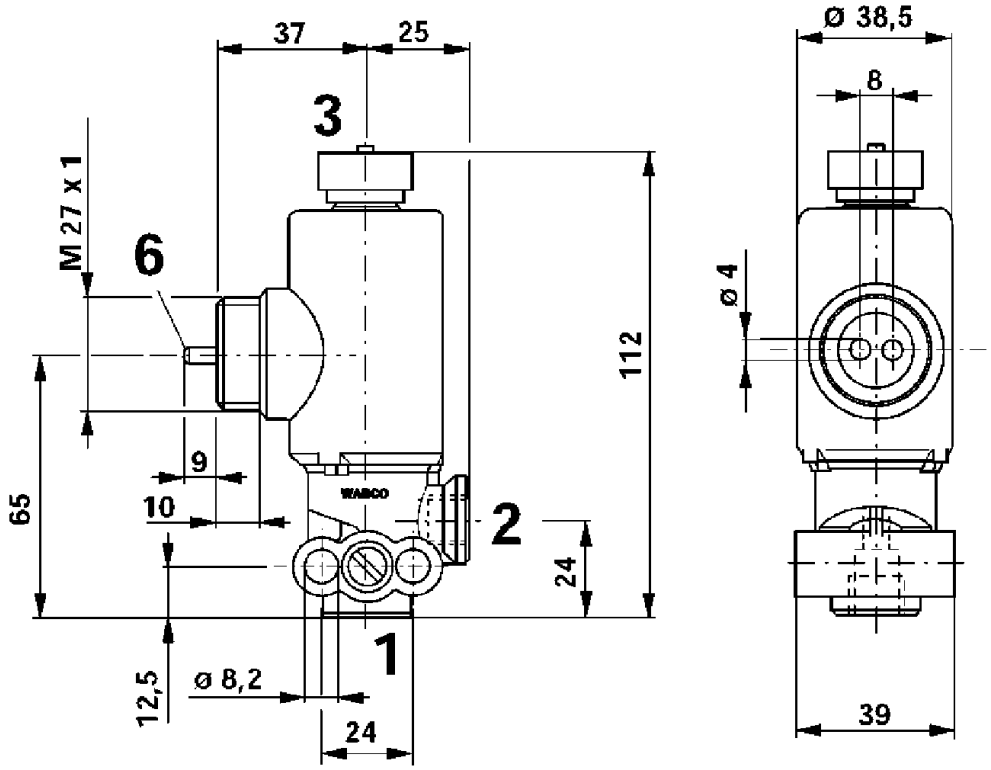


Installation dimensions for 472 127 140 0



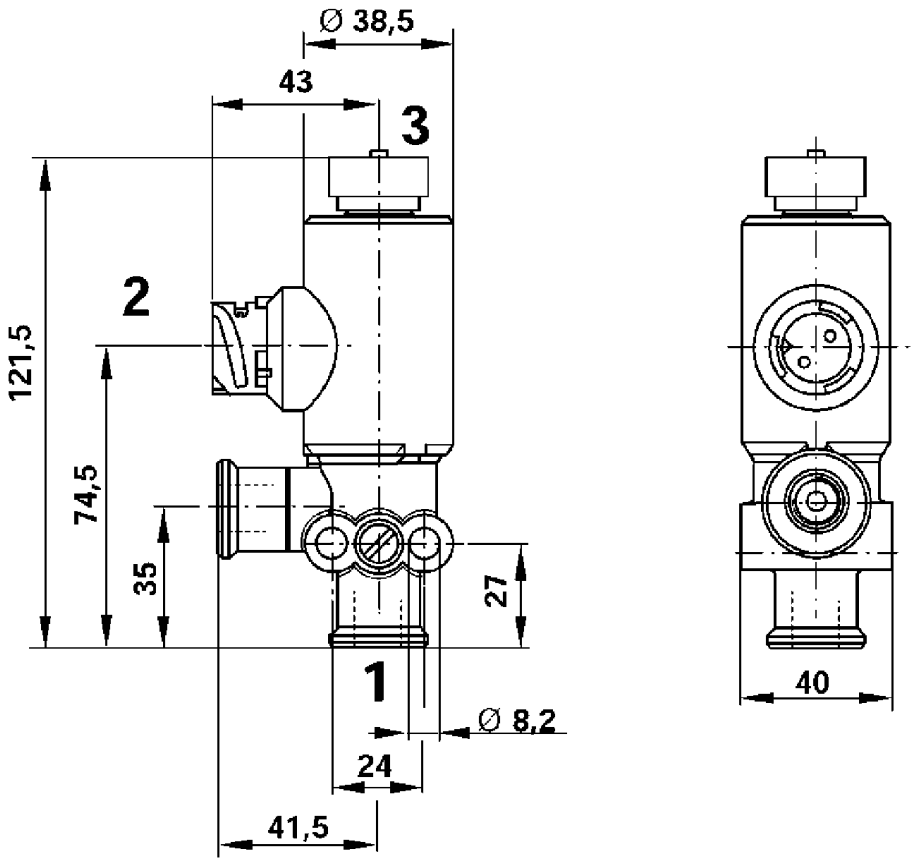
LEGEND			
1	Energy supply M 12x1.5	**2**	Energy discharge M 12x1.5
3	Venting	**4**	Electrical control connection M 12x1.5
A	Loosen the wheel nut to turn the magnets		

Installation dimensions for 472 170 601 0



LEGEND			
1	Energy supply M 12x1.5	**2**	Energy discharge M 12x1.5
3	Venting	**6**	Electrical control connection M 27x1

Installation dimensions for 472 170 637 0



LEGEND					
1	Energy supply M 16x1.5	**2**	Energy discharge M 16x1.5	**3**	Venting

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

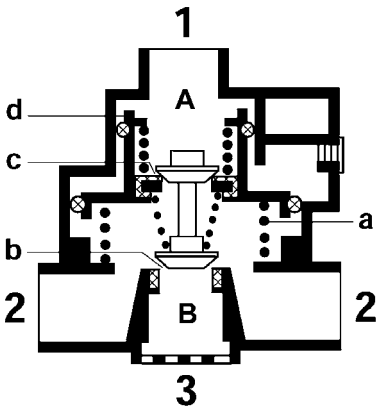
5.35 Pressure reduction valve 473 301

Design

Purpose

Pressure reduction valves reduce the inlet pressure in a certain ratio. They also quickly vent the downstream braking units.

Operating principle



Compressed air flows into the chamber **A** through the port **1** and moves the differential piston (**d**) downwards against the force of the compression spring (**a**). The outlet valve (**b**) closes and the inlet valve (**c**) opens. The compressed flows through the port **2** to the downstream brake devices. At the same time, pressure builds up in the chamber **B** which acts on the underside of the piston (**d**). As soon as equal force is being applied to the underside and the smaller top end of the differential piston (**d**), the piston is lifted and the inlet valve (**c**) closes. The ratio of the pressures then corresponds with the ratio of the two surfaces of the differential piston.

If the pressure drops at the port **1**, the now higher pressure in the chamber **B** moves the differential piston (**d**) upwards. The outlet valve (**b**) opens, and the downstream braking devices are vented either partially or completely vented (corresponding to the control pressure) via the vent **3**. The compression spring (**a**) always keeps the differential piston at the top end position even in an unpressurised state.

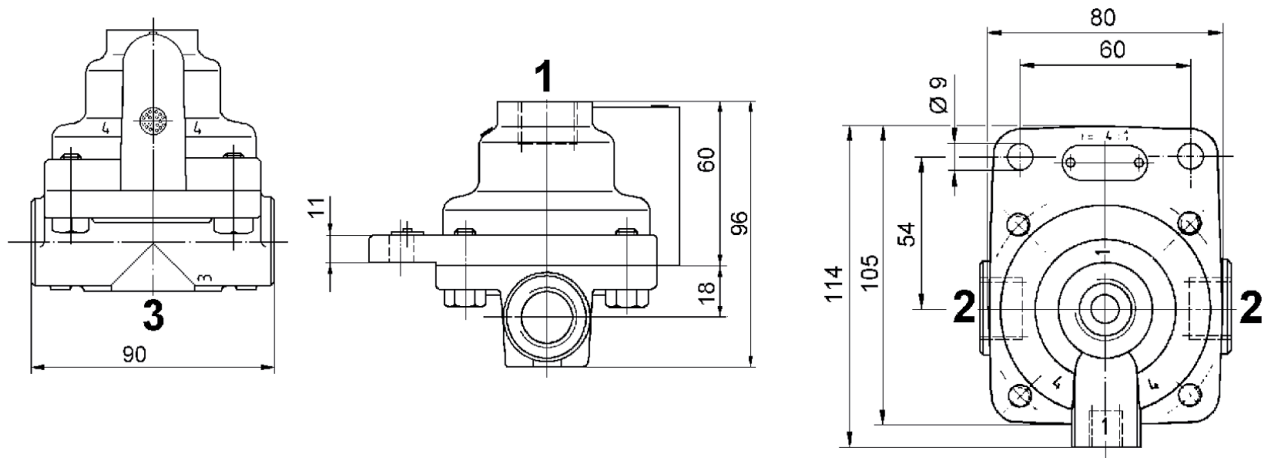
Technical data

PRODUCT NUMBER	473 301 000 0	473 301 001 0	473 301 002 0	473 301 003 0
Pressure reduction ratio	2:1	1.5:1	1.35:1	1.15:1
Max. operating pressure [bar]	10			
Thermal range of application [°C]	-40 to +80			
Weight [kg]	0.8			

Installation recommendation

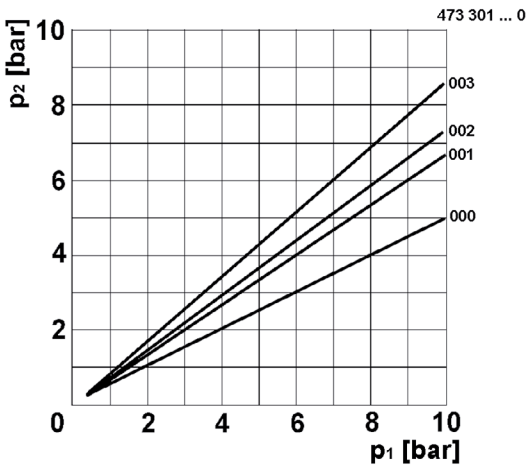
- Install the pressure reduction valve vertically so that the vent **3** faces downwards.
- Fasten the pressure reduction valve with two M8 screws.

Installation dimensions



LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting Reed valve

Pressure curve



LEGEND			
p_1	Output pressure	p_2	Input pressure

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

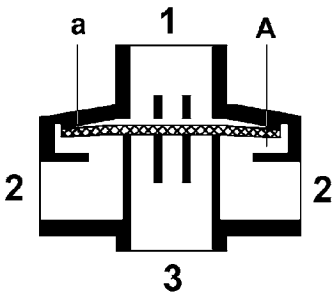
5.36 Quick-release valve 473 501

Design

Purpose

Quick-release valves vent longer control cables or brake lines and brake cylinders very quickly. The brake is therefore released without a delay.

Operating principle



In an unpressurised state, the slightly prestressed diaphragm (**a**) lies on the vent **3** and closes with its outer edge the passage from the port **1** to the chamber **A**. Compressed air flowing through the port **1** pushes back the outer edge and flows to the downstream brake cylinders via the ports **2**.

If the pressure at the port **1** falls, the higher pressure in the chamber **A** forces the diaphragm (**a**) to arch upwards. The downstream brake cylinders are now partially or completely vented via the vent **3** corresponding to the reduction in pressure at the port **1**.

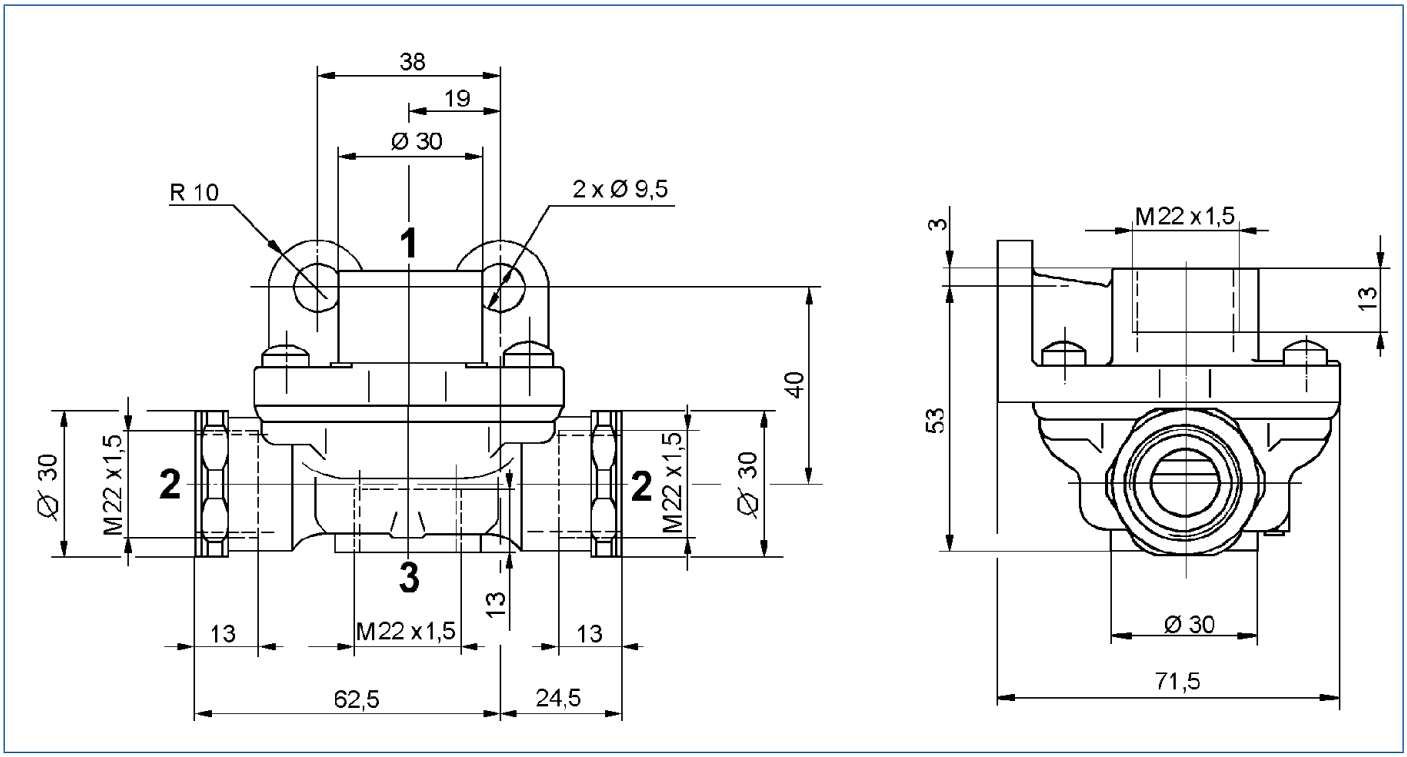
Technical data

PRODUCT NUMBER	473 501 000 0	473 501 001 0	473 501 004 0
Max. operating pressure [bar]	10		
Port 1, 2 with filter	–		X
Nominal width [mm]	Ø 14		
Thermal range of application [°C]	-40 to +80		
Weight [kg]	0.25		

Installation recommendation

- Install the quick-release valve vertically so that the vent **3** faces downwards.
- Fasten the quick-release valve with two M8 screws.

Installation dimensions



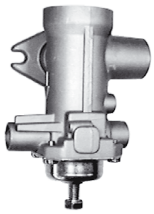
LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting M 22x1.5

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.37 Pressure limiting valve 475 010

Design types

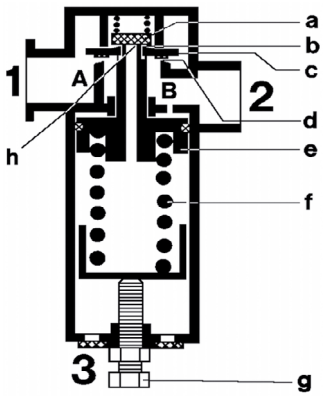
475 010 0XX 0	475 010 3XX 0
	

Purpose

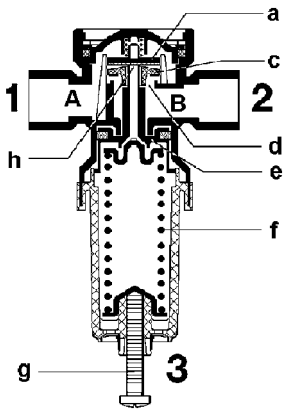
Pressure limiting valves are used to limit the initial pressure for the downstream components to the value set with the adjusting screw. Pressure limiting valves are used in both motor vehicles and trailers.

Operating principle

475 010 0XX 0



475 010 3XX 0



The compressed air fed into the chamber **A** via the port **1** (high pressure) flows through the inlet (**d**) into the chamber (B) and on to the port **2** (low pressure). At the same time, pressure is applied to the piston (**e**), which is initially held in its top end position by the compression spring (**f**).

When the pressure in the chamber **B** reaches the level set for the low-pressure side, the piston (**e**) is forced downwards against the force of the compression spring (**f**). The downstream valves (**a** and **c**) close the inlet (**b** and **d**). If the pressure in the chamber **B** has risen above the preset value, the piston (e) continues moving downwards, and in doing so opens the outlet (**h**). The excess compressed air now escapes into the open air via the centre bore in the piston (**e**) and the vent **3**. When the preset pressure has been reached, the outlet (**h**) is closed again.

If a loss in pressure is caused by a leakage in the low-pressure line, the piston (**e**) lifts the valve (**a**) due to the relieved pressure. The inlet (**b**) opens and a corresponding volume of compressed air is fed into the system. With the 475 010 3 XXX 0 series, the piston (**e**) lifts the valve (**c**), and in doing so opens the inlet (**d**).

When the port **1** is vented, the higher pressure in the chamber **B** lifts the valve (**c**) together with the valve (**a**) resting on it. The inlet (**d**) opens and the low-pressure line is vented via the chamber **A** and the port **1**. The piston (**e**) is moved back to its top end position by the force of the compression spring (**f**).

The preset pressure limitation can be adjusted within a certain range by changing the initial tension of the compression spring (**f**) using the adjusting screw (**g**).

Technical data

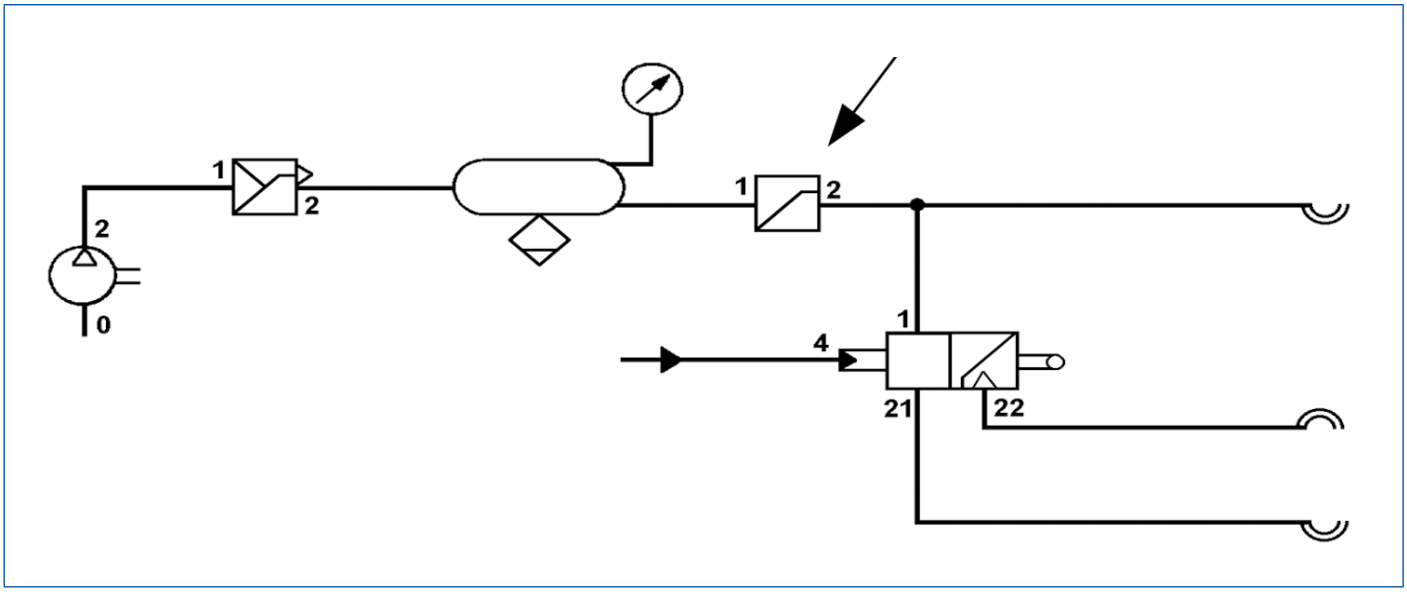
PRODUCT NUMBER		475 010 000 0	475 010 015 0	475 010 302 0	475 010 305 0	475 010 307 0
Max. operating pressure [bar]		20				
Thermal range of application [°C]		-40 to +80				
Setting range [bar]		6.0 to 9.0		1.5 to 6.0	6.0 to 7.5	1.5 to 6.0
Weight [kg]		0.5		0.4		
Output pressure	p_2 [bar]	$7.0^{+0.3}$	$7.0^{+0.2}$	$5.3^{+0.3}$	$6.0^{+0.3}$	$1.8^{+0.3}$
	At inlet pressure p_1 = ... bar	10.0		7.5		8.0

Other variations available on request.

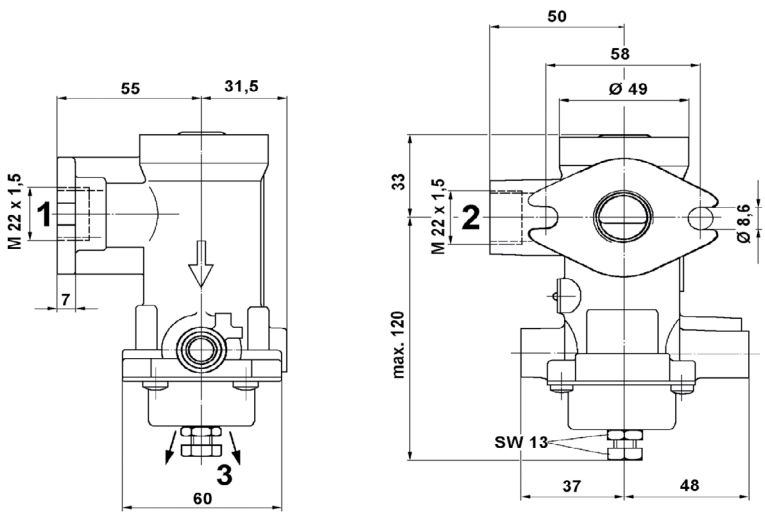
Installation recommendation

- Install the pressure limiting valve vertically so that the vent **3** is pointing downwards.
- Fasten the pressure limiting valve with two M8 screws.

Installation diagram

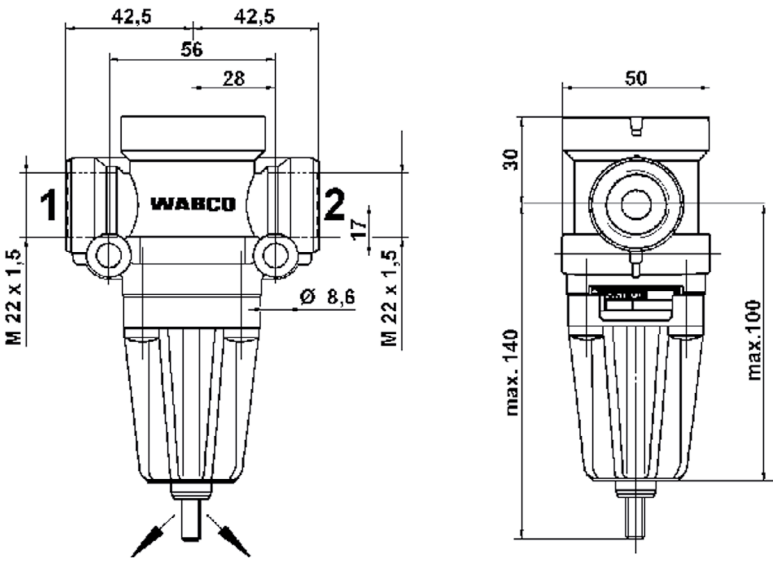


Installation dimensions for 475 010 000 0



LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting

Installation dimensions for 475 010 302 0



LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

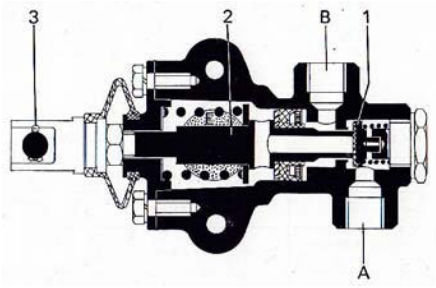
5.38 Inverted hand brake valve 100 300 380 (replaces 961 103 XXX 0

Design

Purpose

The hand brake valve is used for direct charging of the trailer brake line in conjunction with the mechanical foot brake of the tractor for an inverse single line trailer braking system.

Operating principle



Air from the reservoir enters the inlet port (A) and flows out through the delivery port (B) to the actuator, releasing the brakes. When the pressure at the delivery port (B) reaches the balancing pressure of the unit, the valve (1) closes on the seat, preventing a further build up of pressure in the delivery line.

When the fork (3) is pulled, the valve stem (2) is lifted clear of the valve (1), and air from the actuator is rapidly vented through the central bore of the valve stem and vent (S), applying the brakes.

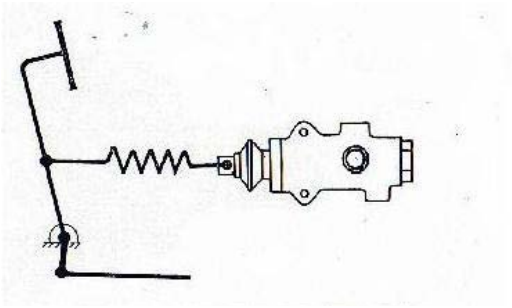
Technical data

PRODUCT NUMBER	100 300 380
Max. operating pressure [bar]	8.4
Permissible medium	Air
Thermal range of application [°C]	-40 to +80
Weight [kg]	1

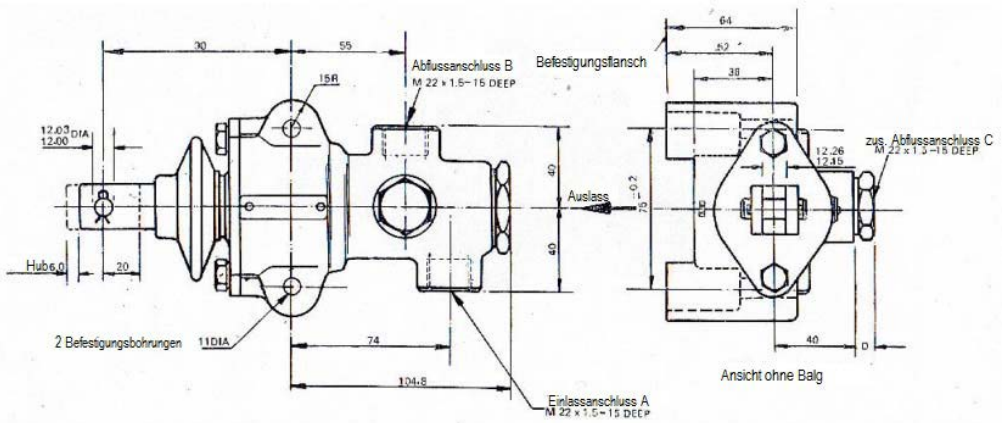
Installation recommendation

- The valve must be mounted onto the chassis or frame of the vehicle using M10 mounting screws fitted through the mounting flange of the unit.
- The fork must be connected to the foot brake lever by means of suitable mechanical linkages.

Installation diagram



Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

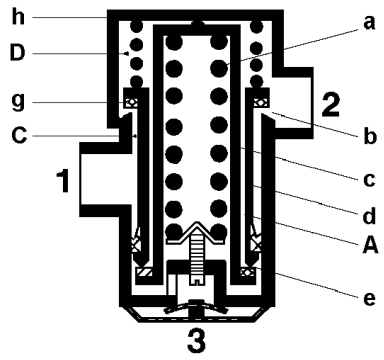
5.39 Pressure limiting valve 475 015

Design

Purpose

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

Operating principle



The pressure limiting valve is set that only a certain pressure is outputted at the low-pressure side (port **2**). The spring (**a**) constantly acts on the pistons (**c** and **d**), whereby it holds the piston (**c**) in its top end position, where it makes contact with the housing (**h**). The inlet (**b**) is open. The supply pressure entering at the port (**1**) flows from the chamber (**C**) into the chamber (**D**), and then on to the downstream components via the port **2**.

If the pressure building up in the chamber **D** exceeds the force of the compression spring (**a**), the pistons (**c** and **d**) move downwards. The valve (**g**) closes the inlet (**b**), and a final position has been reached.

Due to the air consumption on the low-pressure side, the pressure balance at piston (**c**) is neutralised. The spring (**a**) forces the pistons (**c** and **d**) upwards again. The inlet (**b**) opens, and more air is fed in until the preset pressure has been reached and the balance has been established again.

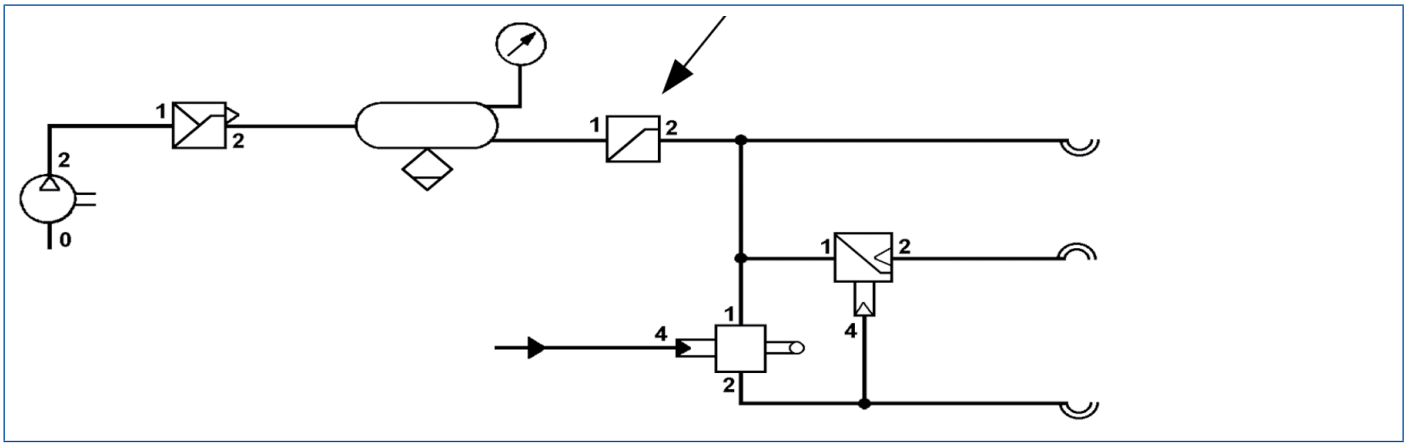
Technical data

PRODUCT NUMBER	475 015 001 0	475 015 005 0
Operating pressure (high pressure, port 1) [bar]	$p_{1\,max}$ = 20 / 10 $p_{1\,max}$ = 10, if p_1 = variable $p_{1\,max}$ = 20, if p_1 = non-variable	
Output pressure p_2 at p_1 (low-pressure side, port 2) [bar]	7.4 +0.3/-0.1 (at p_1 = 16)	8.0 +0.3/-0.1 (at p_1 = 12)
Nominal diameter	10 mm corresponds to 78.5 mm²	
Max. opening pressure of safety valve [bar]	p_2 = +2.5	
Thermal range of application [°C]	-40 to +80	
Weight [kg]	0.36	

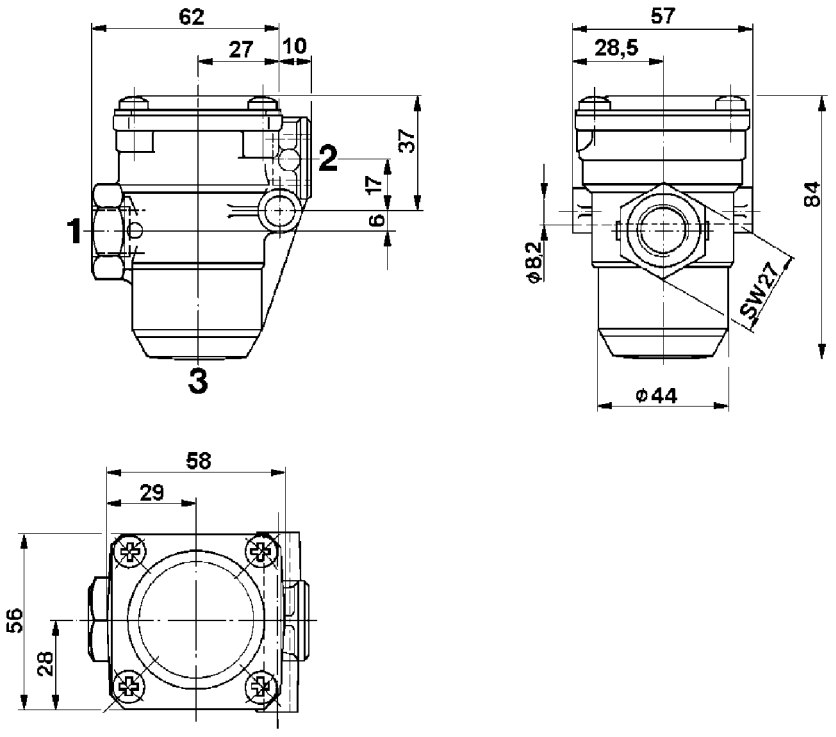
Installation recommendation

- Install the pressure limiting valve vertically so that the vent **3** is pointing downwards.
- Fasten the pressure limiting valve with one M8 screw.

Installation diagram



Installation dimensions



LEGEND					
1	Energy supply (high pressure) M 16x1.5	**2**	Energy discharge (low pressure) M 16x1.5	**3**	Venting

Maintenance

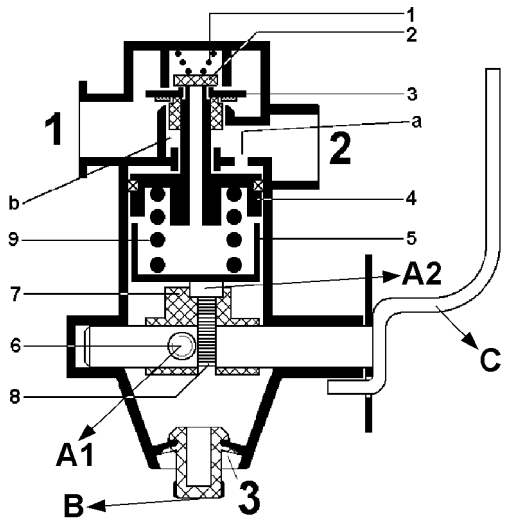
Special maintenance that extends beyond the legally stipulated inspections is not required.

5.40 Manually operated load-sensing valve 475 604

Purpose

Manually operated load-sensing valves limit the output pressure according to the load status of the trailer vehicle.

Operating principle



Unladen position

In the "unladen" position, the compression spring (**9**) is preloaded by the cam (**7**) via the spring housing (**5**). This causes the pressure limiting piston (**4**) to move to its top position. The relieved outlet valve (**2**) is closed, and the inlet valve (**3**) that is lifted by the piston (**4**) is open.

Pressure limiting position

When the brakes are applied, the pressure output from the trailer brake valve flows through the port **1** of the load-sensing valve and via the opened inlet valve (**3**) into the chamber (**b**). At the same time, the pressure is exerted via the bore (**a**) on the entire surface of the piston (**4**). If the force of the piston (**4**) is greater than the spring force (**9**), the pressure limiting piston (**4**) moves downwards, and the inlet valve (**3**) is closed by the force of spring (**1**). The compressed air in the chamber (**b**) now flows via the port (**2**) to the trailer brake cylinder.

Half laden

As the load status of the trailer increases, the lever moves from the "unladen" position to the "half laden" position. The current position of the cam (**7**) allows the spring (**9**) to be preloaded even more. For this reason, a higher pressure is required in the chamber (**b**) when braking. Pressure is then limited accordingly as described in the section "Pressure limiting position".

Fully laden

If the load-sensing valve is at the "fully laden" position, the spring (**9**) has been preloaded even further. The pressure being created in the chamber (**b**) is now no longer capable of forcing the piston (**4**) downwards. The inlet valve (**3**) stays open here, allowing the full input pressure to reach the brake cylinders.

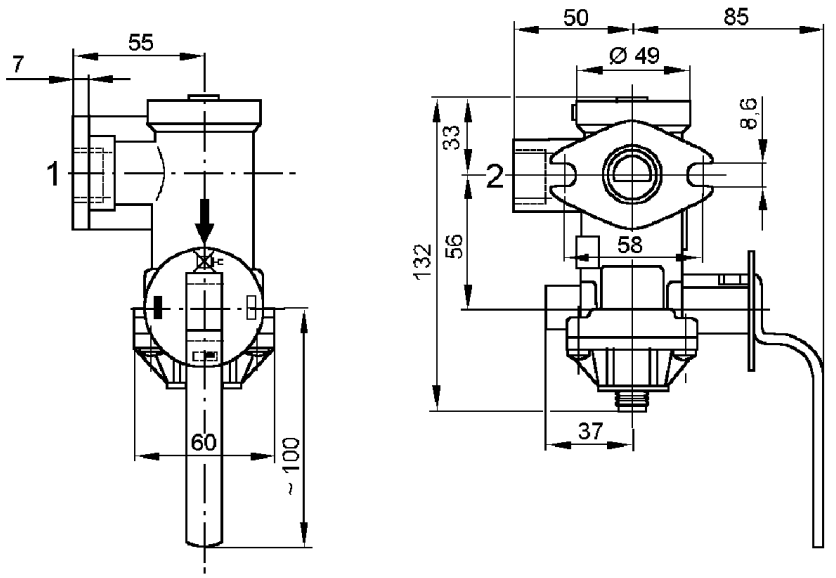
Releasing

When the trailer control line is disconnected, the trailer brake valve outputs the full pressure. When the load-sensing valve is moved from one of its three positions to the "release" position, the force of the spring (**9**) is relieved. The pressure in the chamber (**b**) forces the piston (**4**) downwards, and the rod of the piston (**4**) lifts off the outlet valve (**2**), releasing the vent. This action vents the pressure from the chamber (**b**) and the brake cylinders.

Technical data

PRODUCT NUMBER		475 604 010 0	475 604 011 0
Max. operating pressure [bar]		10	
Thermal range of application [C°]		-40 to +80	
Setting range [bar]	Releasing	0	
	Unladen	0.8 to 2.2	1.4 to 2.8
	1/2 load	2.8 to 3.7	3.4 to 4.3
	Laden	p_1	
Set to [bar]	Unladen	$1.6_{-0.2}$	$2.1_{-0.2}$
	1/2 load	$3.4_{-0.2}$	$4.0_{-0.2}$
Order separately for mounting on the trailer brake valve			
Flange seal		897 010 300 4	
Nut (2x)		810 304 017 4	

Installation dimensions



LEGEND			
1	Inlet M 22x1.5	**2**	Outlet M 22x1.5

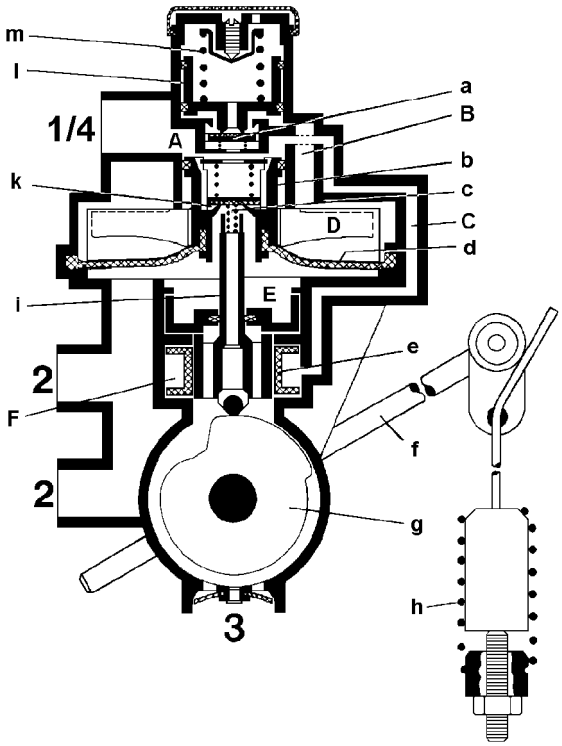
5.41 Automatic load-sensing valve 475 713

Design

Purpose

Automatic load-sensing valves automatically control the braking force of pneumatic brake cylinders depending on the vehicle's load status.

Operating principle



The load-sensing valve is mounted on the vehicle chassis and is actuated via a connecting cable attached to the axle by means of a tension spring. When the vehicle is empty, the distance between the axle and the valve is greatest and the lever (**f**) is in its unladen braking pressure position. If the vehicle is loaded, this distance is reduced and the lever (**f**) moves from its unladen position towards the fully laden position. The movement of the lever (**f**) causes the cam plate (**g**) to move the valve tappet (**i**) to the position corresponding to the vehicle's load. The output compressed air from the trailer brake valve flows via the port **1** into the chamber **A** and exerts pressure on the piston (**b**).

The piston is forced downwards, closing the outlet (**c**) and opening the inlet (**k**). The compressed air now flows into the chamber E below the diaphragm (**d**) and via the ports **2** to the downstream pneumatic brake cylinders. At the same time, compressed air flows into the chamber **D** via the opened valve (**a**) and the duct **B**, and exerts pressure on the top of diaphragm (**d**). This pressure predominance causes the reduction in the partially-laden range to be neutralised at low control pressures. If the control pressure rises further, the piston (**l**) is forced upwards against the force of the compression spring (**m**) and the valve (**a**) closes. During the downward motion of the piston (**b**), the diaphragm (**d**) detaches itself from a support in the controller and rests against the fan-shaped part of the piston (**b**).

The effective surface area of the diaphragm is thus increased continuously until it exceeds the area of the top side of the piston. This causes the piston (**b**) to be lifted again and the inlet (**k**) is closed. A final end position is reached (the inlet (**k**) only remains open in the fully laden position "1:1").

The pressure delivered to the actuators of the fully laden vehicle corresponds to the pressure in the load-sensing valve delivered from the trailer brake valve; with a partially laden or unladen vehicle, however, this pressure is reduced accordingly. When the braking pressure has been reduced, the piston (**b**) is forced upwards by the pressure in the chamber E. The outlet (**c**) opens, and the compressed air escapes into the open air via the valve tappet (**i**) and the vent **3**.

Each time the brakes are applied, compressed air flows into the chamber **F** via the duct **C** and exerts pressure on the ring seal (**e**). This is pressed against the valve tappet (**i**), and at a braking pressure > 0.8 bar a frictional connection is established between the valve tappet (**i**) and the housing. This blocks the reduction ratio of the load-sensing valve, which is maintained even when the distance between the axle and the chassis continues to change. The tension spring (**h**) sitting on the axle absorbs this displacement. An integral torsion spring in the load-sensing valve ensures that the valve tappet (**i**) moves into the "fully laden" position if the linkage breaks.

Technical data

PRODUCT NUMBER	475 713 500 0	475 713 501 0
Max. operating pressure [bar]	10	
Max. control ratio	8 : 1	
Nominal width [mm]	Ø 10	
Required adjusting torque M_1 [Nm]	2 (p_1 = 0 bar)	
Max. permissible adjusting torque M_2 [Nm]	20	
Control stroke	α = 20°	α = 33°
Thermal range of application [C°]	-40 to +80	
Weight [kg]	2.0	

Installation recommendation

– Use the following nomograph to determine the required lever length for the load-sensing valve and set it on the device.
Using an adjustment tool and a ø 3 mm pin, you can set the unladen braking pressure at a certain input pressure (e.g. 6 bar) and clamp it with the screw size 10.

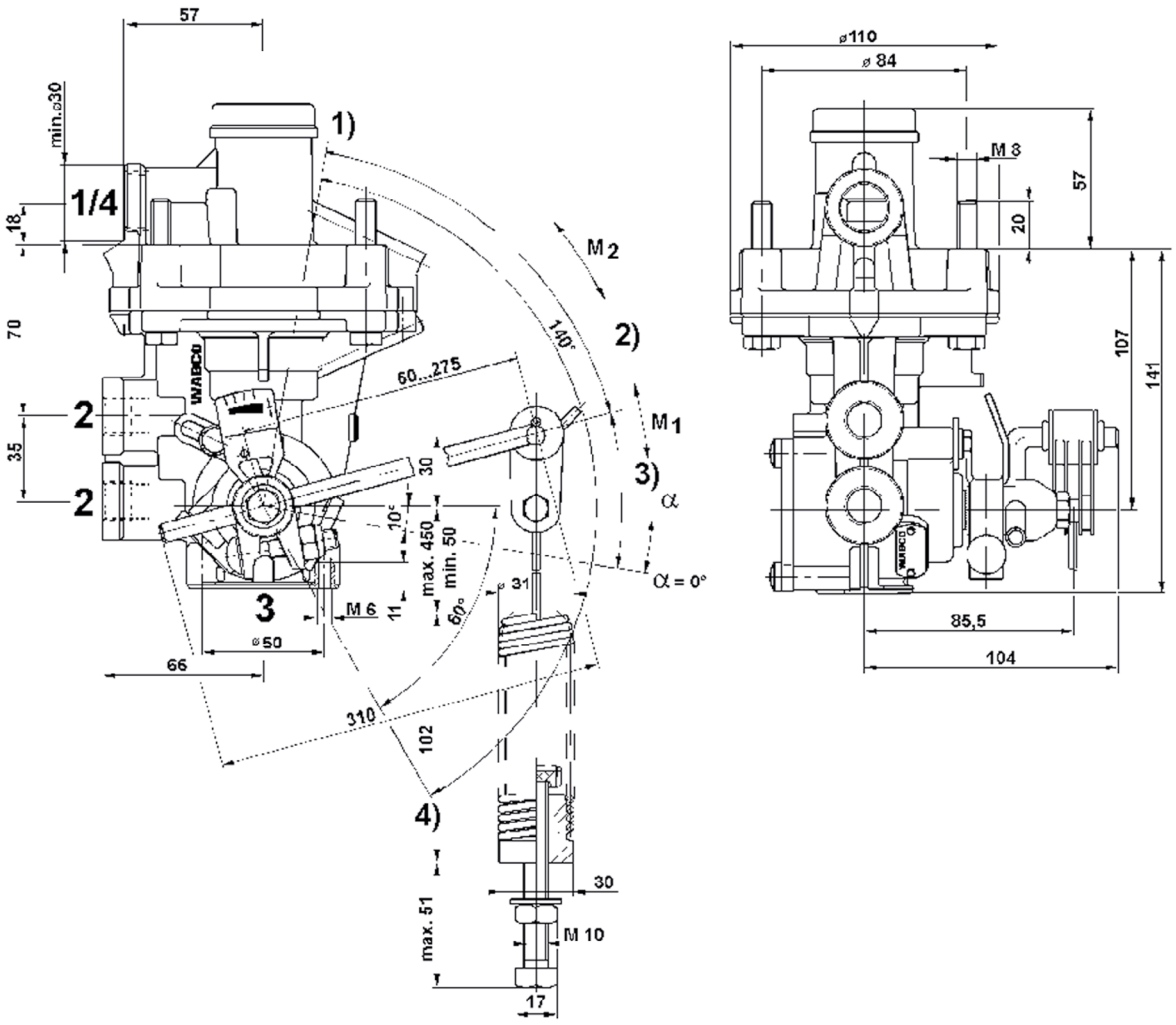
– The LSV controller must be depressurised before making any adjustment to it (cable length, lever position, etc.).

⇨ After fitting the load-sensing valve in the vehicle (unladen) and the knuckle joint on the axle shaft (in the process, the spring of the knuckle joint has to be prestressed by 15 mm using the fastening screw), and after tightening and fixing the connecting cable (cable length at least 50 mm but no more than 450 mm), the connecting cable must hang vertically below its fastening on the lever.
If the pin is now removed from the adjustment tool, and the input pressure is exerted on the load-sensing valve again, it must output the unladen braking pressure.

– Make small corrections to the unladen braking pressure by screwing the fastening bolt in or out (max. 5 mm).

⇨ If the unladen braking pressure is correct, the knuckle joint is prestressed or increased by the total suspension travel of the trailer (path differential loaded – unloaded). When the LSV controller is charged again, it must output the input pressure.
If the output pressure is less than the input pressure, either the lever is too long or the suspension travel is too short.
If the output pressure is the same as the input pressure, the lever is lowered by approx. 10 % of the suspension travel towards "unladen".
The resulting output pressure must be less than the input pressure. If this is not the case, the LSV controller is either too short or the suspension travel is too long.

Installation dimensions 475 713 500 0



LEGEND					
1/4	Energy supply M 22x1	**1)**	End stop at linkage break	**3)**	Control stroke
2	Energy discharge M 16x1	**2)**	Overstroke	**4)**	End stop
3	Venting				

Setting instructions for load-sensing valve programme (LSV)

The required lever length can be also determined with our calculation program instead of using nomographs.

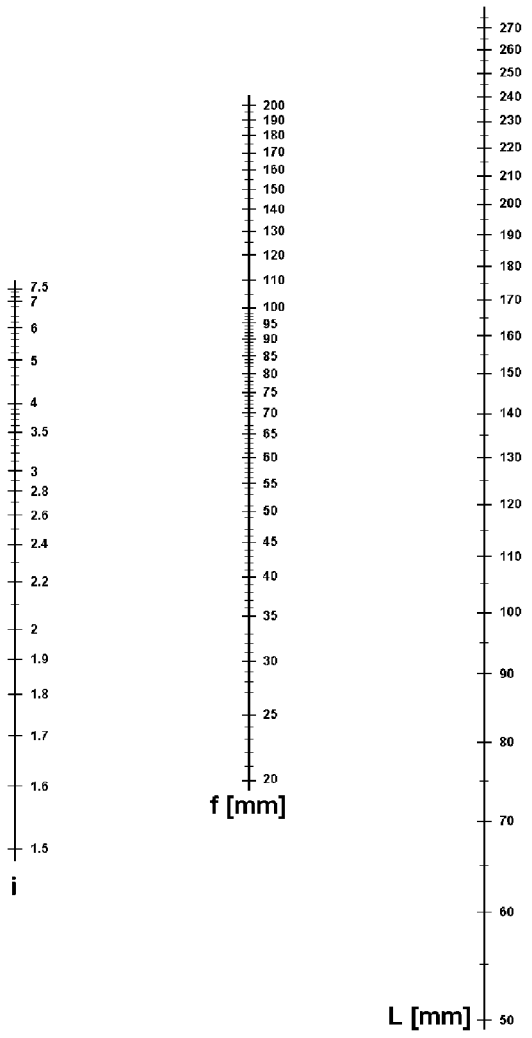
– Visit the WABCO website: http://www.wabco.info/i/64.

– Click the link *WABCO LSV*

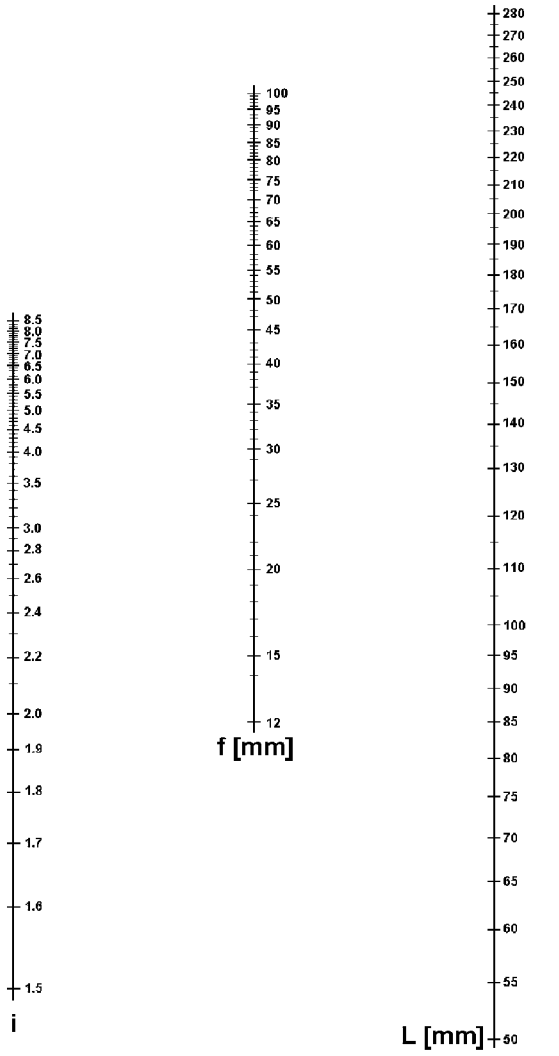
Note: The hydraulic pressures of the unladen and laden vehicle must be entered into the "WABCO Load-Sensing Valve Program (LSV)" calculation program.
If it is these values can be calculated theoretically (as for air suspension), they must be measured directly on the trailer. The vehicle must be parked on the ground for this procedure.

Nomographs

Nomograph for LSV controller 475 713 500 0



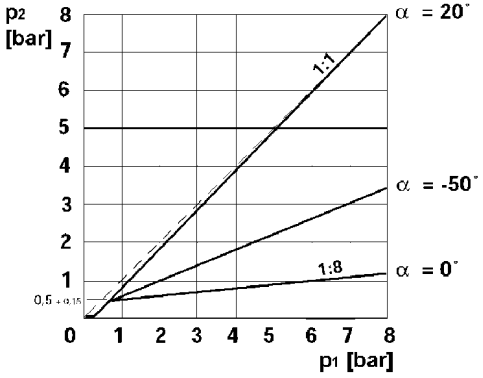
Nomograph for LSV controller 475 713 501 0

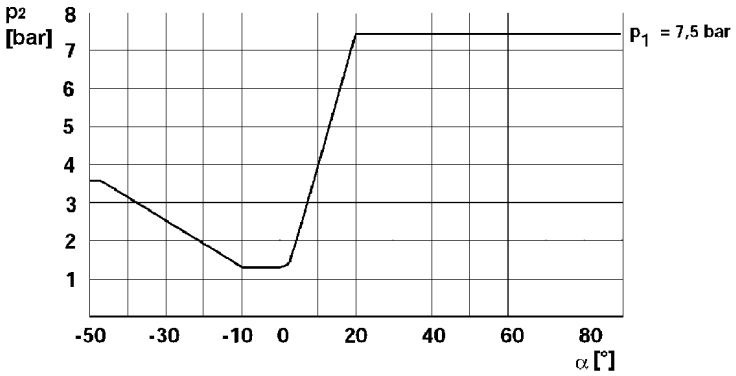


LEGEND					
i	Control ratio = p_{on} -0.8 / p_{off} -0.5	**f**	Spring deflection	**L**	Lever length

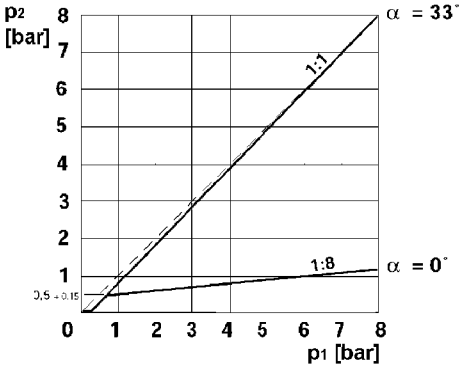
Characteristics

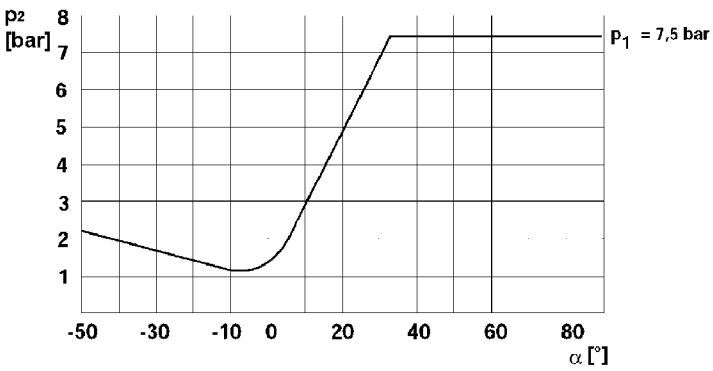
475 713 500 0





475 713 501 0





LEGEND					
p_1	Control pressure	p_2	Output pressure	α	Lever travel in degrees

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.42 Automatic load-controlled, load-sensing valve (LSV) 475 714 50X 0 / 475 714 60X 0

Design

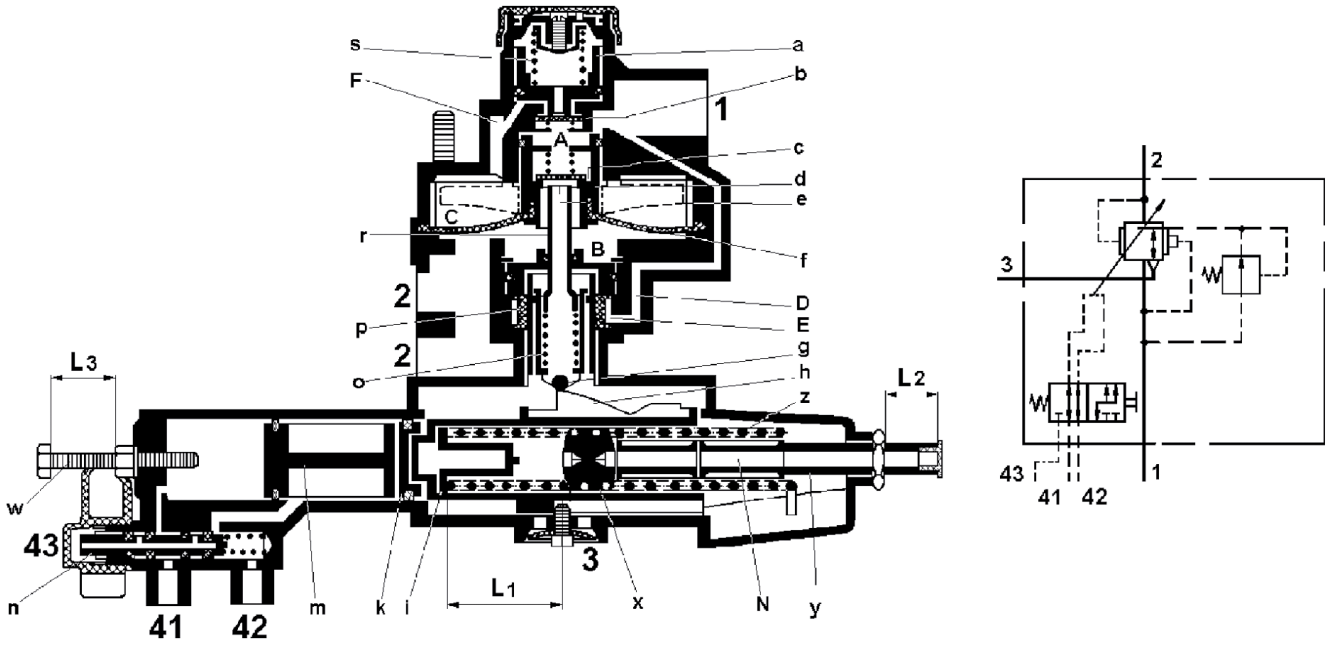
475 714 50X 0

475 714 60X 0

Purpose

Automatic load-controlled, load-sensing valves control the braking pressure of pneumatic brake cylinders on air suspension axles (axle assemblies) dependent upon on the control pressure of the air springs. They are static controllers that are used for air suspension vehicles without EBS.

Operating principle



The air pressure (control pressure) from the air springs acts on the pistons (**m** and **k**). Depending on the air pressure (corresponding to the load status), the guide sleeve (**i**) is pushed against the spring (**z**) with the indicated control curve (**h**) and set to a control position corresponding to the load status.

When the pneumatic braking system is actuated, the output compressed air from the trailer brake valve flows into the chamber **A** via the port **1** and acts on the piston (**d**). The piston (**d**) is forced downwards, closes the outlet (**e**) and opens the inlet (**c**). The air now flows into the chamber **B** below the diaphragm (**f**) and to the downstream pneumatic brake cylinders via the ports **2**. At the same time, compressed air flows via the opened valve (**b**) and the duct **F** into the chamber **C** and acts on the top of the diaphragm (**f**). This pressure predominance causes the reduction in the partially-laden range to be neutralised at low control pressures. If the control pressure continues to rise, the piston (**a**) is forced upwards against the force of the compression spring (**s**) and the valve (**b**) closes.

During the downward motion of the piston (**d**), the diaphragm (**f**) detaches itself from the support in the controller and rests against the fan-shaped part of the piston (**b**). The effective diaphragm surface on the underside of the diaphragm (**f**) expands continuously until the forces from the top of the piston and the bottom of the piston are equal to the underside of the diaphragm. As a result, the piston (**d**) is lifted again and the inlet (**c**) is closed. A final end position is reached (the inlet (**c**) only remains open in the fully laden position). The pressure that is then measured in the brake cylinders corresponds to the load status and the braking pressure applied by the towing vehicle or the trailer brake valve.

When the braking pressure is reduced (the brake is released), the piston (**d**) is forced upwards by the pressure in the chamber **B**. The outlet (**e**) opens, and the compressed air escapes into the open air via the valve tappet (**r**) and the vent **3**. Every time the brakes are applied, compressed air flows into the chamber **E** via the duct **D** and acts on the rubber fitting (**p**). The rubber fitting (**p**) is pushed against the valve tappet (**r**), and a frictional connection is established between the valve tappet (**r**) and the housing at every braking pressure > 0.8 bar. This blocks the reduction ratio of the controller, which is also maintained during a braking action with a dynamic axle load transfer. If the air cushion pressure increases in the partially laden range, the roller (**g**) is pressed against the spring (**o**). The tappet (**r**) stays in the control position it was in when the braking action was initiated.

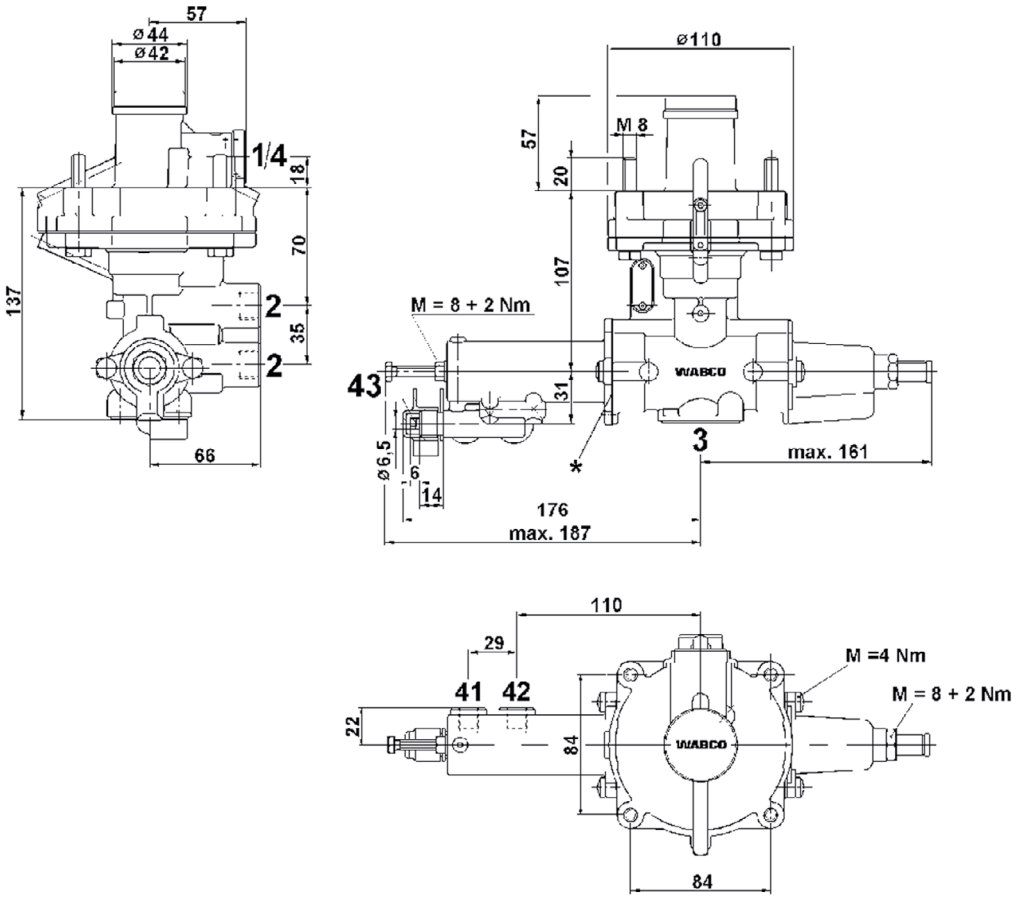
Technical data

PRODUCT NUMBER	475 714 500 0	475 714 509 0	475 714 600 0	475 714 603 0
Max. operating pressure p_1 [bar]	10			
Max. control ratio	1:8			-
Max. control pressure $p_{41, 42}$ [bar]	12		160	
Thermal range of application [°C]	-40 to +80			
Weight [kg]	1.8		2.0	1.9

Installation recommendation

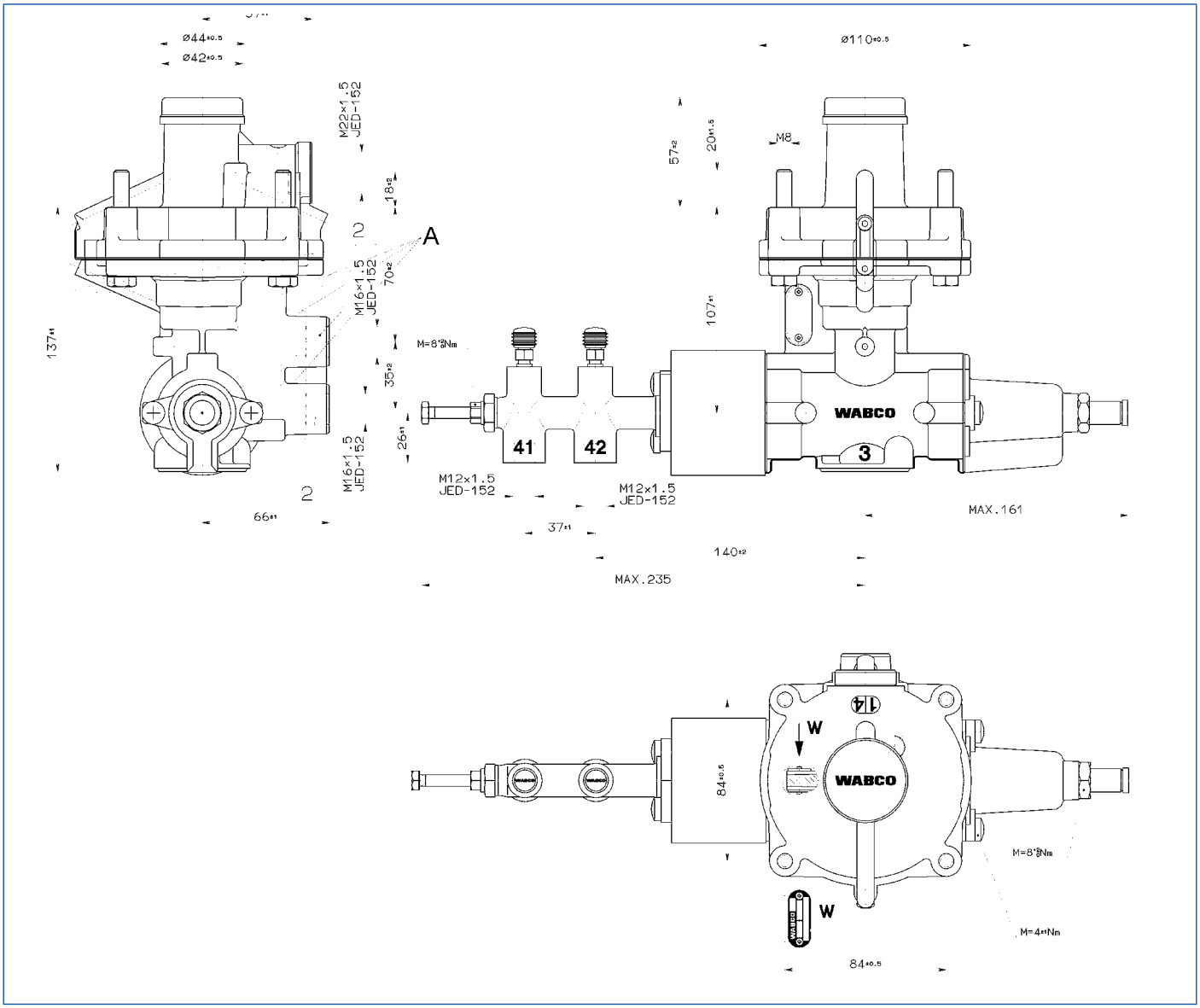
- Fasten the LSV to the frame of the vehicle so that the vent **3** faces downwards.
- Connect the ports **41** and **42** with the air cushions on the right and left-hand sides of the vehicle.

Installation dimensions for 475 714 500 0



LEGEND					
1/4	Energy supply M 22x1.5	**2**	Energy discharge M 16x1.5	**3**	Venting
43	Test connection	**41, 42**	Control connection M 12x1.5	*	When releasing the air from the device, air can escape at the sealing surfaces.

Installation dimensions for 475 714 600 0 and 475 714 603 0



LEGEND					
1/4	Energy supply M 22x1.5	**2**	Energy discharge M 16x1.5	**A**	Connection permissible
3	Venting	**41, 42**	Control connection M 12x1.5		

Setting instructions for load-sensing valve programme (LSV)

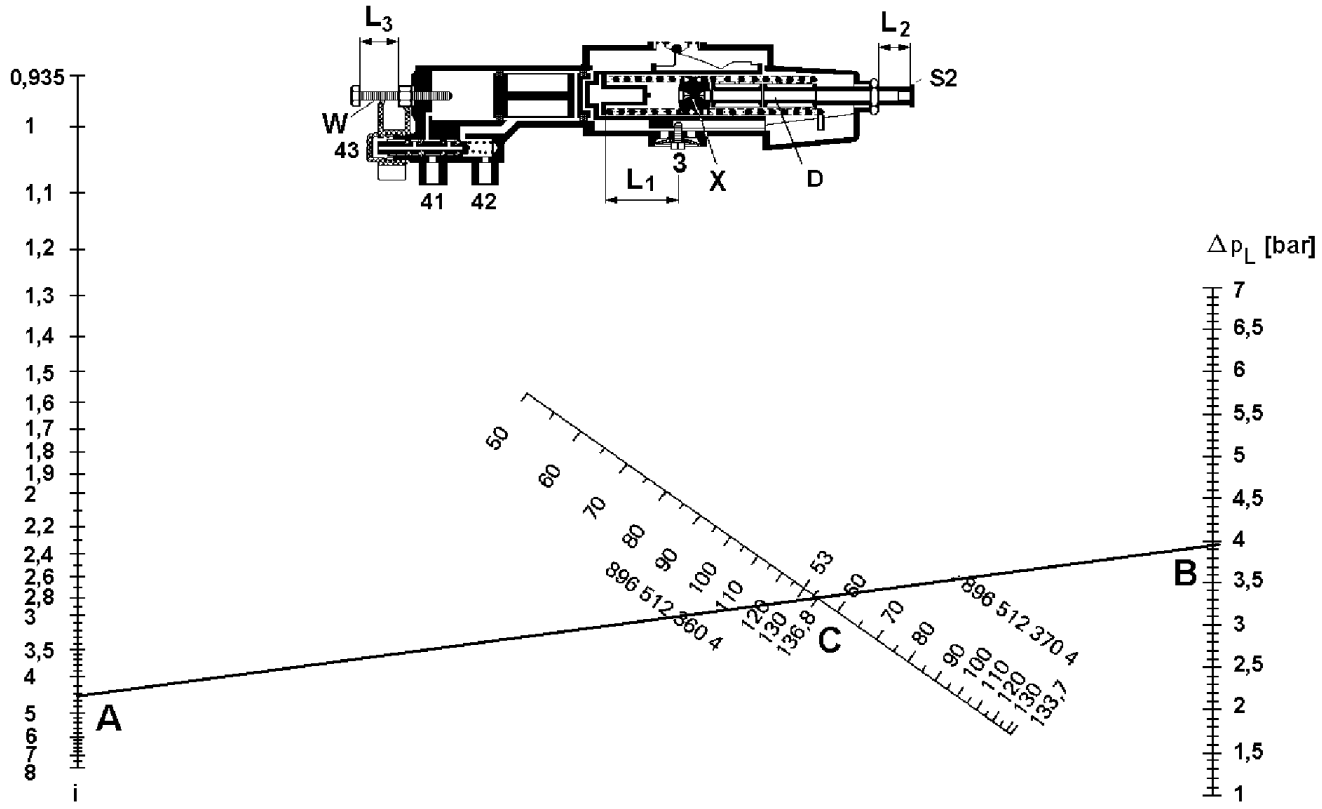
The required lever length can be also determined with our calculation program instead of using nomographs.

– Visit the WABCO website: http://www.wabco.info/i/64.

– Click the link *WABCO LSV*

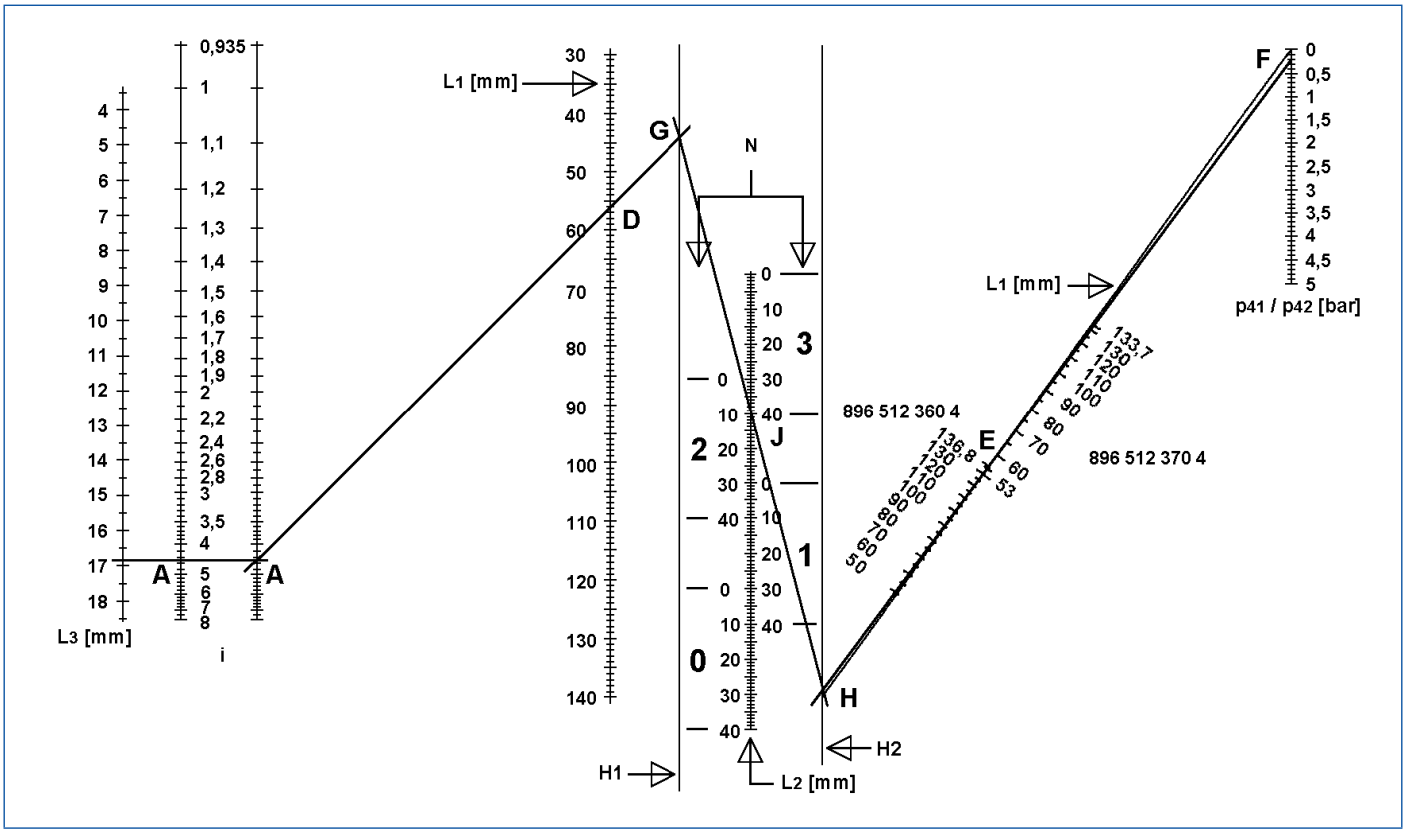
Note: The hydraulic pressures of the unladen and laden vehicle must be entered into the "WABCO Load-Sensing Valve Program (LSV)" calculation program.
If it is these values can be calculated theoretically (as for air suspension), they must be measured directly on the trailer. The vehicle must be parked on the ground for this procedure.

Nomograph I for determining the compression spring and spring length L_1



LEGEND					
i	p_{on} -0.8 / p_{off} -0.5	**S2**	Screw	**896 512 360 4**	Compression spring (wire ø 4 mm)
Δp_L	Air cushion - pressure differential; Unladen - Laden	**D**	Spacer	**896 512 370 4**	Compression spring (wire ø 3.2 mm)

Nomograph II for determining the screw setting length L_2 and the spacers N as well as L_3



LEGEND							
L_1	Spring length	**N**	Number of spacers	**H1**	Reference line 1	**896 512 370 4**	Compression spring
L_2	Screw length	**i**	Control ratio (p_{on} - 0.8) / (p_{off} - 0.5)	**H2**	Reference line 2	**896 512 360 4**	Compression spring
L_3	Unladen stop screw (**W**) (see nomograph I)	p_{41}/p_{42}	Air cushion pressure "unladen"				

Determining the compression springs and setting length L_1

REQUIRED ADJUSTMENT VALUES	
p_{on} (p_1) = 6.5 bar	$p_{Bellows\ laden}$ = 4.1 bar
$p_{Bellows\ unladen}$ = 0.2 bar	p_{off} = $p_{2\ unladen}$ = 1.75 bar

Calculate control ratio: i = (p_{on} - 0.8) / (p_{off} - 0.5) = (6.5 - 0.8) / (1.75 - 0.5) = 4.56

– Enter the control ratio in nomographs I and II (point A).

– In addition, mark the air cushion pressure differential in nomograph I ($p_{Bellows\ laden}$ - $p_{Bellows\ unladen}$), here 3.9 bar (point B).

– Connect points A-B to obtain point C at the cross-point with the identified suspension.

⇨ You can now read off the spring length L_1 (free hanging) and the springs to be used here.

– In nomograph II, enter the spring length L_1 (point D) and the used spring with spring length L_1 (point E).

– After you have entered the air cushion pressure for the unladen vehicle (point F), join up points A-D and E-F and extend them past D and E up to reference lines 1 and 2.

⇨ Join up the resulting points G and H.
At the crossing point with the help lines, you have point J, at which you can read off the required number of spacers and the length of bolt L_2.
The values that are determined using the nomograph are guidelines and may have to be corrected.

Setting the LSV

Before each adjustment to the screws and the pressure p_4, the port 1 must be depressurised because otherwise the required values cannot be set due to the integrated LSV statics.

Due to production tolerances and the hysteresis, after adjusting the pressures (p_1 and $p_{41/42}$) it is always practicable to readjust the input starting from 0 bar if nothing else is specified.

– After you have installed the right springs with clamp X (set dimension L_1) and the number of spacers N in the LSV, screw in screw 2 (L_2) until you can feel a noticeable resistance.

Setting the unladen end stop screw

After charging p_1 with the calculated pressure (in this case 6.5 bar), the LSV must output the unladen braking pressure (in this case 1.75 ± 0.1 bar) at the port 2.

– If the unladen braking pressure is too high, unscrew the unladen end stop screw W (L_3); if the unladen braking pressure is too low, screw in the unladen end stop screw.

Note: Unscrew the unladen end stop screw W up to max. 23 mm.

Setting the unladen braking pressure

After charging the ports 41 and 42 with the unladen air cushion pressure + 0.2 bar (in this case 0.4 bar) and the port 1 with the calculated pressure, the LSV must output a pressure that is 0.2 bar higher than the unladen braking pressure with a tolerance of ± 0.1 bar (in this case 1.95 ± 0.1 bar).

– If the pressure is too low, unscrew screw 2; if the pressure is too high, screw in screw 2.

– Lock the screw 2.

Setting the braking pressure for the laden vehicle

After charging the ports 41 and 42 with the bellows pressure for the laden vehicle -0.1 bar (in this case 4.0 bar), the LSV must output the input pressure -0.3 bar with a tolerance of ± 0.2 bar (in this case 6.2 ± 0.2 bar).

Output pressure too low

– Determine Δp (pressure differential between the nominal value and actual value).

– Lower the input pressure to 0 bar.

– Lower the bellows pressure to 0 bar and increase the value for the unladen vehicle +0.2 bar (in this case 0.4 bar).

– Unscrew the screw 2 (Δp = 0.1 bar corresponds to 3 mm).

– Unscrew the spring clamp until the nominal value (in this case 1.95 ± 0.1 bar) is attained.

– Repeat the test "Setting the braking pressure for the laden vehicle".

Output pressure too high

– Determine Δp.

– Lower the input pressure to 0 bar.

– Lower the bellows pressure to 0 bar and increase to the value for the unladen vehicle +0.2 bar (in this case 0.4 bar).

– Screw in the screw 2 (Δp = 0.1 bar corresponds to 3 mm).

– Screw in the spring clamp until the nominal value (in this case 1.95 ± 0.1 bar) is attained.

– Repeat the test "Setting the braking pressure for the laden vehicle".

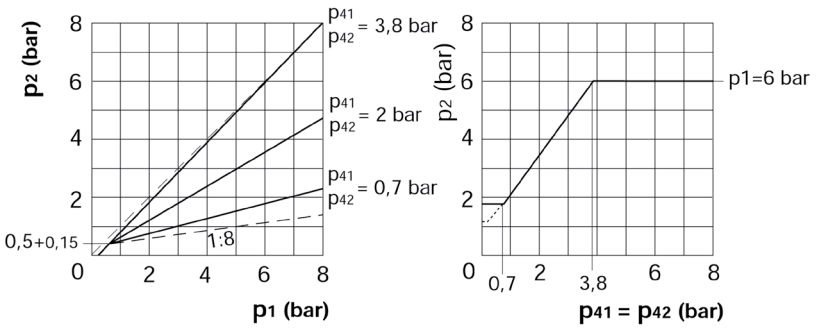
– Actuate all the test points again after setting the LSV.

– Tighten the lock nuts on the screws W and 2 to the specified torque (8 + 2 Nm).

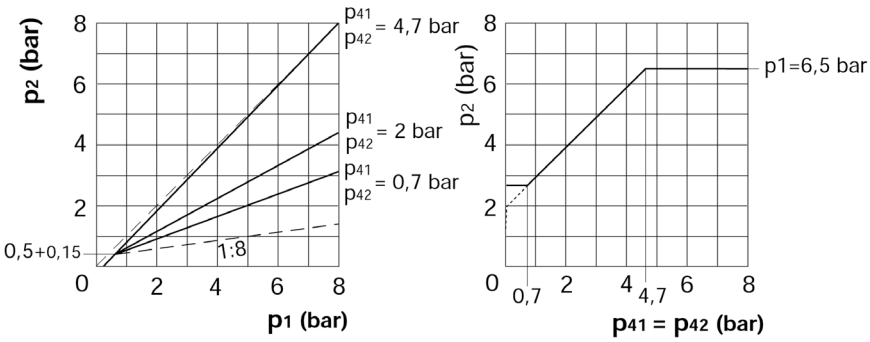
– Enter the data on the LSV plate (order number 899 144 631 4) and fasten it onto the vehicle.

Pressure curve

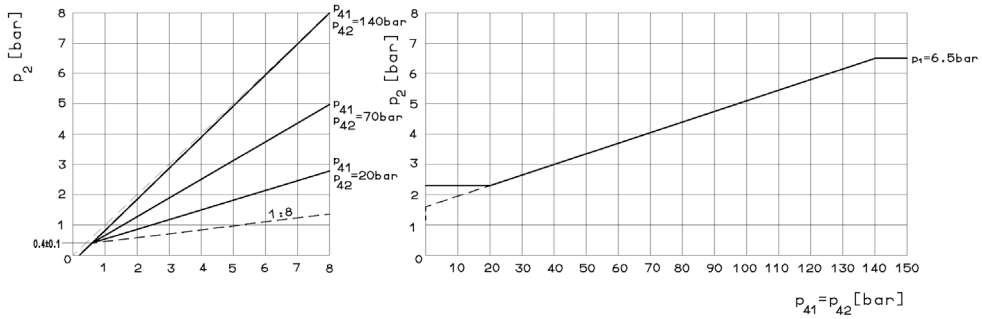
475 714 500 0



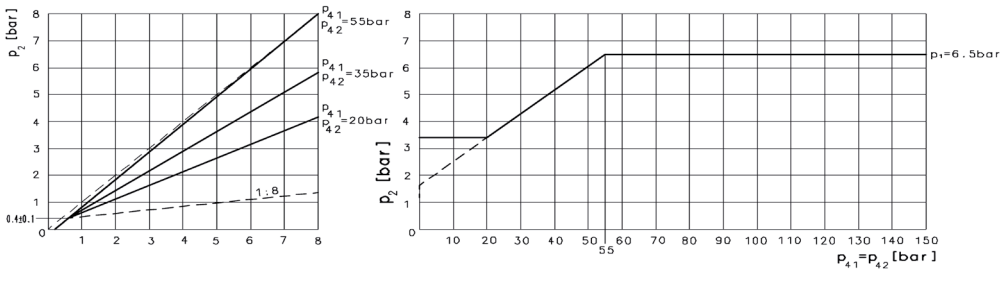
475 714 509 0



475 714 600 0



475 714 603 0



LEGEND					
p_1	Input pressure	p_2	Output pressure	$p_{41} = p_{42}$	Control pressure

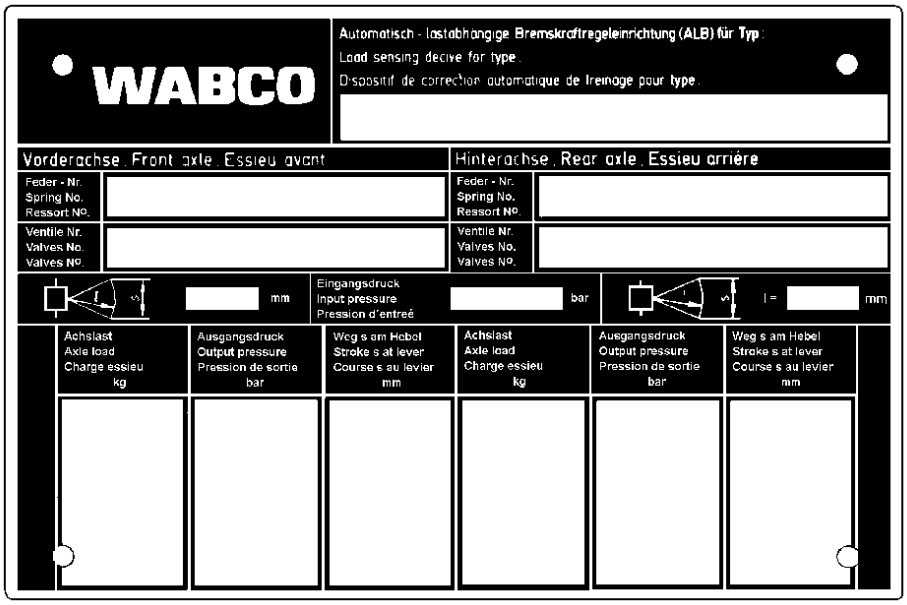
Maintenance

To test the LSV, attach a test hose to the port **43**. Screwing on the hose presses the piston (**n**) into the housing, thereby interrupting the connection between the ports **41** and **42** and the pistons (**m** and **k**). At the same time, a pneumatic connection is established between the port **43** and the pistons (**m** and **k**). In this state, the LSV sets itself to a control position corresponding to the air pressure in the test hose.

(See illustration of the operating principle)

5.43 Plate "LSV setting values" 899 144

Design



Product number: 899 144 630 4 for mechanically actuated LSV controllers

Purpose

The vehicle must be labelled with the specifications required for testing the LSV controller in accordance with EEC Guideline 71/320, Appendix II, Annex to II/1.1.4.2, Paragraph 7, and ECE provision No. 13, Appendix 10, Paragraph 7. The respective signs as shown below can be obtained through WABCO for this.

These signs correspond to the draft for the standard DIN 74267 from September 1982 Form C and D. They are provided in three languages and allow axle loads and the output pressures of the LSV controller to be entered in tables.

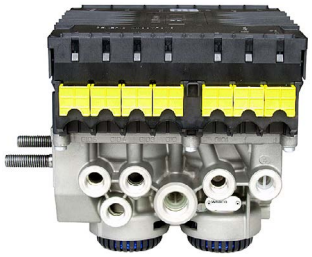
Note: The pressures to be entered in the LSV plate must be measured immediately before and after the LSV controller so that it is not influenced by the characteristics of other devices of the braking system.
In the configuration of the braking systems, test connections are to be designed according to standard ISO 3583/1974 before and after the LSV controller.
With mechanically hinged LSV controllers, the required load status for checking the LSV controller is achieved with a manual adjustment.

In the case of two LSV controllers with different input pressures, both pressures are to be noted on the LSV plate, e.g. 6.5/5.7

LSV CONTROLLER	NOMOGRAPH
475 713 50X 0	475 713 902 3

5.44 Trailer EBS E modulator (multi-voltage) 480 102 080 0

Design



Purpose

The EBS E trailer modulator is used to control and monitor the electro-pneumatic braking system. It ensures optimum braking control, provides for non-blocking wheels and lateral accident protection (RSS control) when cornering, and individually adapts itself to the specific characteristics of the vehicle. The modulator is installed close to the axles on the vehicle frame in the electro-pneumatic braking system between the air reservoir or the EBS trailer brake valve and the brake cylinder (e.g. on the cross member above the second axle of a 3-axle semi-trailers).

The modulator consists of a respectively coordinated combination of the required solenoid valves and the electronic control system. The EBS modulator is used in the agricultural sector as multi-voltage version. This allows the modulator to process voltages between 8 and 32 volts. An integrated diagnostic memory simplifies troubleshooting.

Trailer EBS E system description

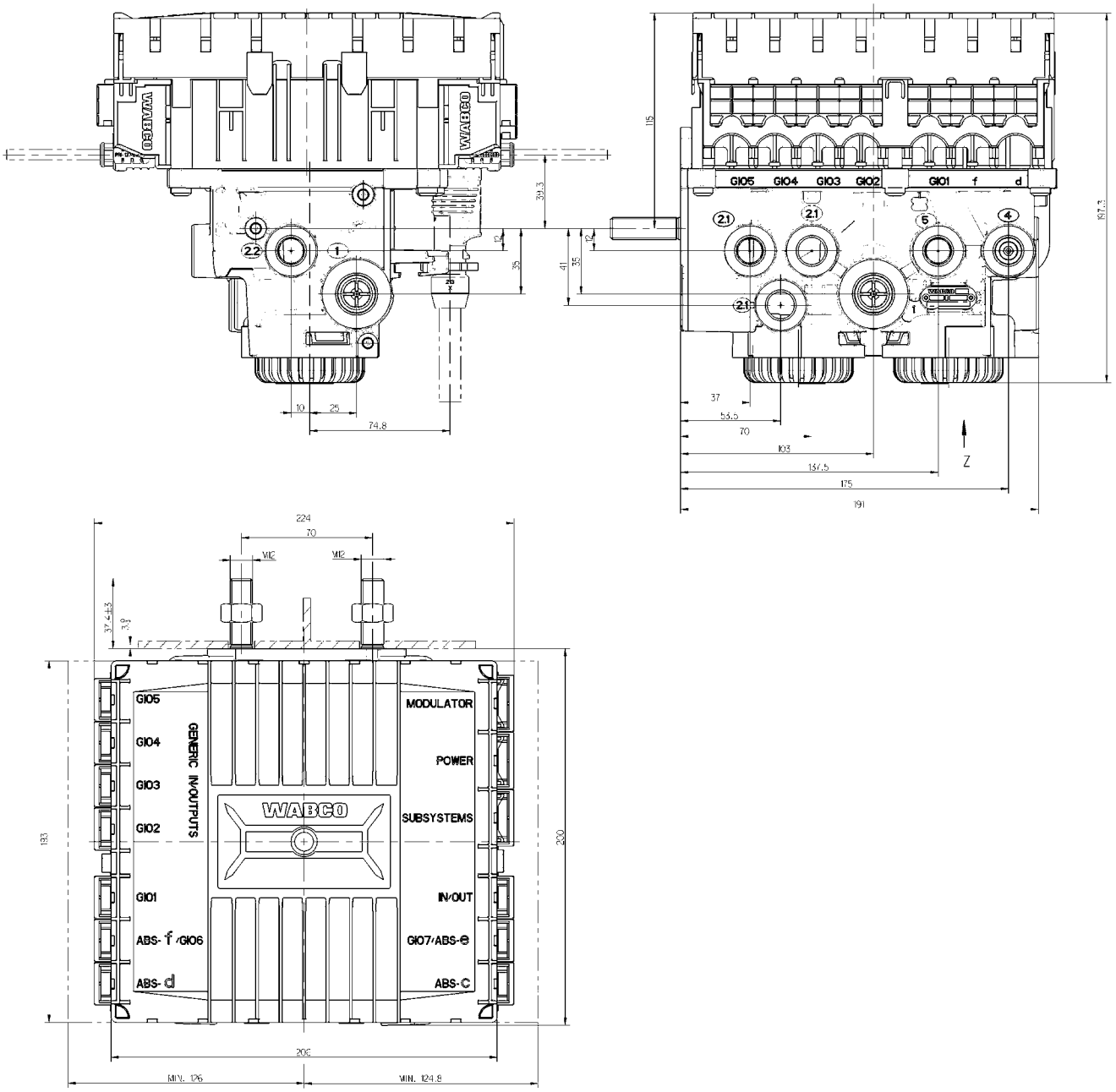
- Open WABCO Customer Centre: https://www.wabco-customercentre.com
- Enter the search term *"TEBS E"* in the Index field.
- Click the *Start* button.
- Click the link *Publications.*
- Select the required language from the language list.
- Click the *Start* button.

System requirements

The towing vehicle must be equipped with a connection in accordance with the ISO 7638 standard. If the towing vehicle is equipped with a modern EBS system with a CAN bus, the WABCO Trailer EBS E can be used for adjusted brake control of the entire tractor-trailer combination.

Installation dimensions for 480 102 080 0

Note: The reduced number of components and use of quick screw couplings provide for simplified and uncomplicated installation.

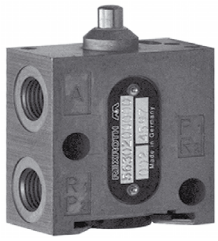


Maintenance

The TEBS E system does not require maintenance.

5.45 3/2 directional control valve 563 020

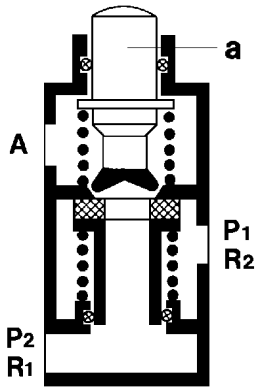
Design



Purpose

3/2 directional control valves alternately connect the supply line or the vent when the control line is actuated.

Operating principle



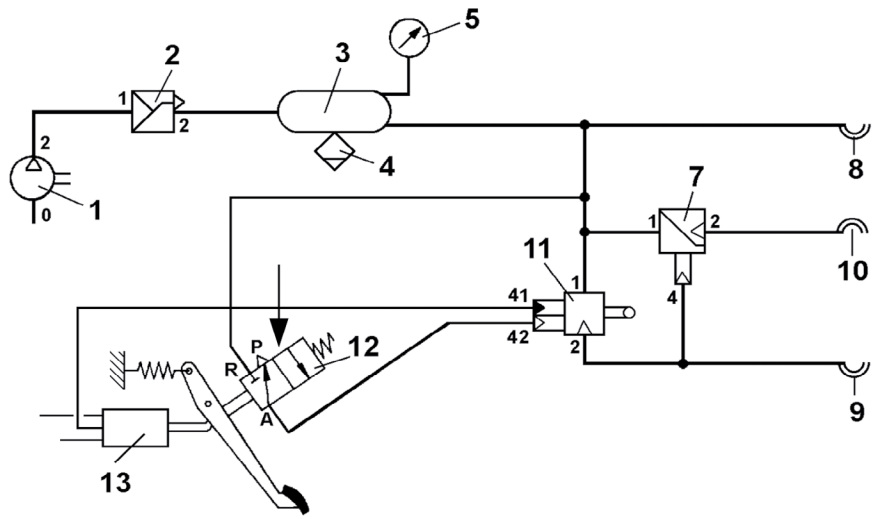
When the tractor brake pedals are actuated, the piston (**a**) is moved to its top end position by the spring force. The supply air at the port **P2** now flows via the port **A** to the downstream trailer control valve. This causes the output of a trailer braking pressure even before the hydraulic tractor brake becomes effective.

When the tractor brake is released, the piston (**a**) is moved downwards again by the brake pedal and the passage is closed. The compressed air from the control line is now relieved via the opened passage to the port **R2**.

Technical data

PRODUCT NUMBER	563 020 000 0
Max. operating pressure [bar]	10
Thermal range of application [°C]	-25 to +80
Nominal width [mm]	4
Weight [kg]	0.16

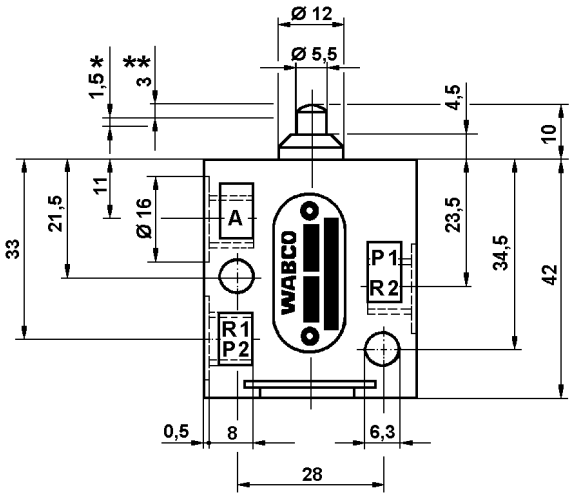
Installation diagram

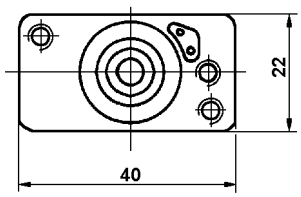


Installation recommendation

- Install the 2/3 directional control valve in any position.
- Fasten the valve with two screws using the two holes in the housing ø 6.3 mm.

Installation dimensions





LEGEND									
P1, P2	Energy supply M 10x1	**R1, R2**	Vent M 10x1	**A**	Energy discharge	*	Overstroke	**	Stroke

5.46 Compressor 912 126

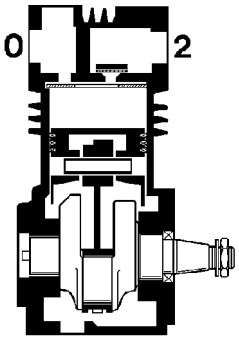
Design

912 126 002 0

Purpose

Compressors generate the compressed air required by all the compressed air consumers in a vehicle. The compressor is designed as a single-stage piston compressor and its major parts are as follows: monobloc housing, lamellar valve, valve plate, air-cooled cylinder head, a crankshaft on two composite plain bearings, the drive sealed with a shaft seal, a connecting rod with a composite plain bearing, and pistons with piston rings.

Operating principle



As the piston of the compressor moves downwards, it sucks in fresh air via the air intake port **0** and the intake vanes. As the piston moves upwards, the air is compressed and forced through the pressure vane and pressure port **2** into the line leading to the air reservoir.

To lubricate the moving parts, the compressor is connected to the engine oil circuit to supply it with oil, which flows to the single bearings though oil ducts (in the crankshaft) or as oil mist.

The oil is returned either directly into the engine crankcase through the compressor base or through a pipe.

Technical data

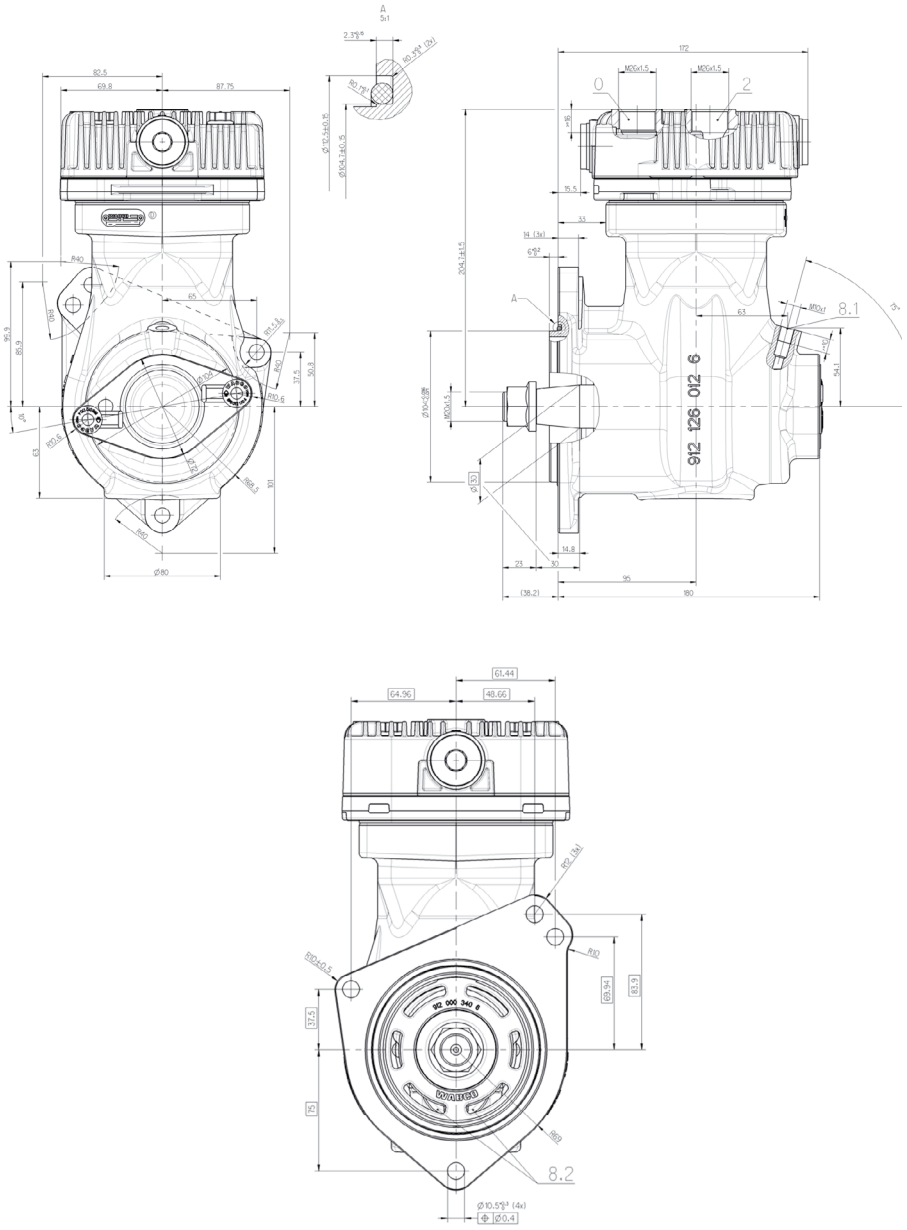
PRODUCT NUMBER	912 126 002 0	912 126 004 0
Bore diameter [mm]	85	
Stroke [mm]	42	56
Capacity [cm³]	238	318
Max. operating pressure [bar]	8.5	
Max. operating speed [rpm]	3000	
Temporary overspeed	1.3 x n_{max}	
Temporary highest pressure [bar]	12	
Cooling air speed [m/s]	4	
Weight [kg]	13.6	12.7

Maintenance and installation recommendations

Document "Installation recommendation and maintenance for compressors" (de/en)

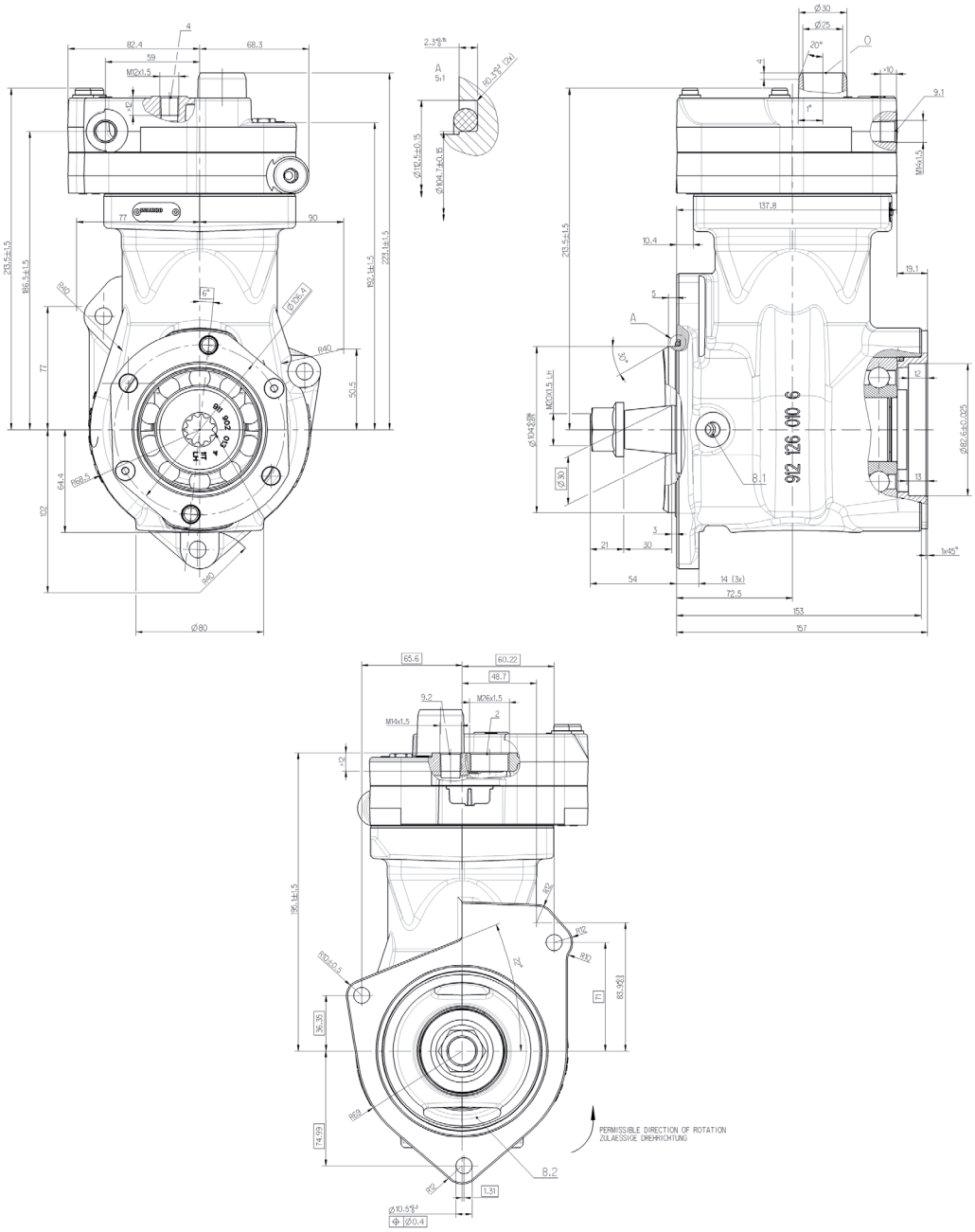
- Open WABCO Customer Centre: https://www.wabco-customercentre.com
- Enter the number 826 001 099 3 in the *Product Number* field.
- Click the *Publications* radio button.
- Click the *Start* button.

Installation dimensions for 912 126 002 0



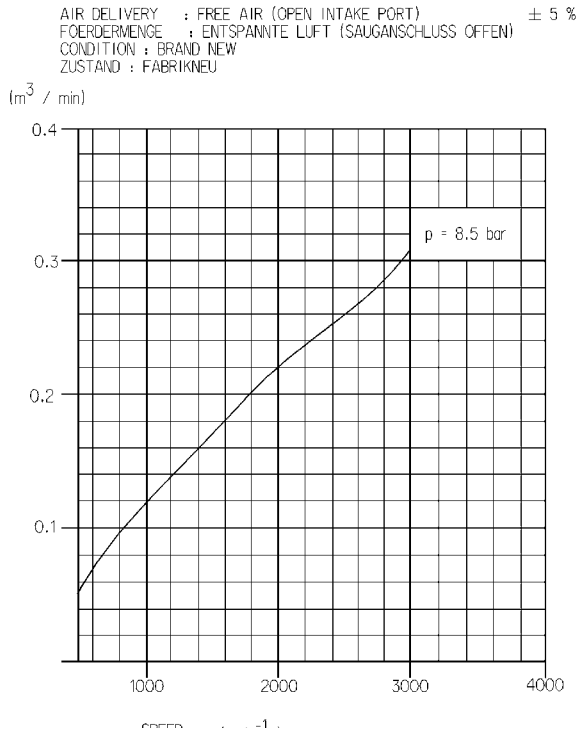
LEGEND							
0	Air intake port M 26x1.5	**2**	Pressure port M 26x1.5	**8.1**	Hydraulic oil connection	**8.2**	Oil return

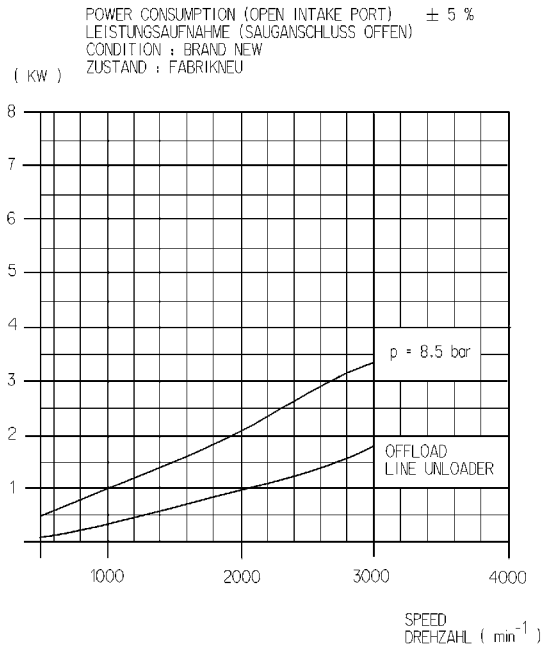
Installation dimensions for 912 126 004 0



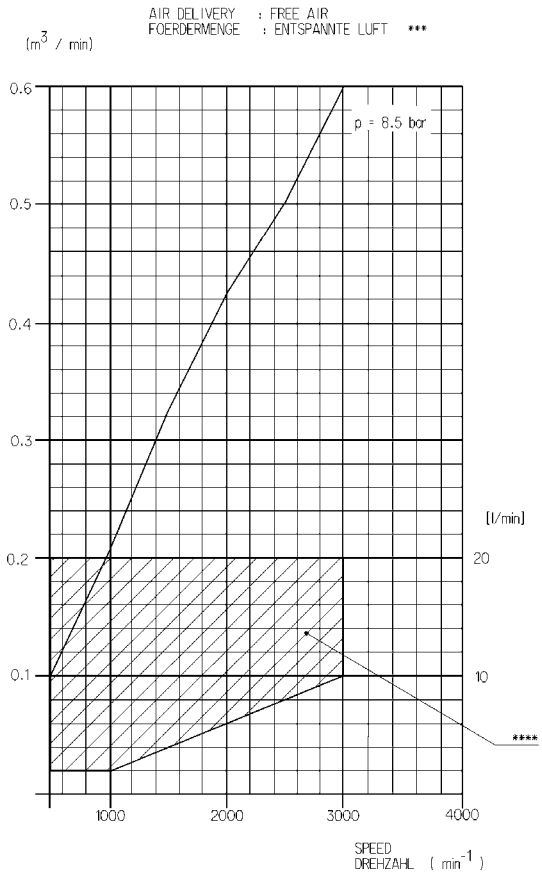
LEGEND					
0	Suction port M 26x1.5	**2**	Pressure port M 26x1.5	**8.1**	Hydraulic oil connection
8.2	Oil return	**9**	Cooling water port		

Performance diagram for 912 126 002 0

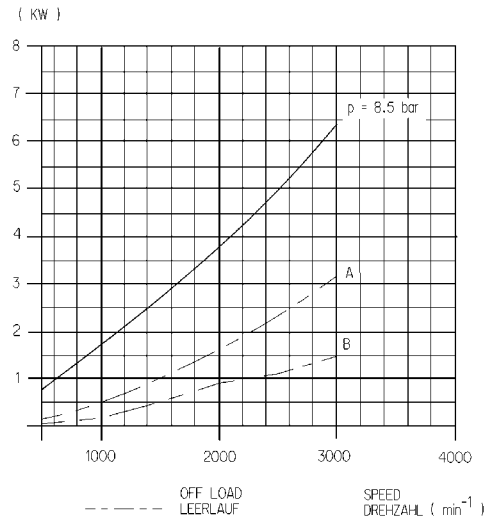




Performance diagram for 912 126 004 0



*** DIAGRAM FOR NATURALLY ASPIRATED COMPRESSOR ONLY
DIAGRAMM NUR FUER NICHTAUFGELADENEN KOMPRESSOR



(...) AUXILIARY DIMENSION
HILFSMASS

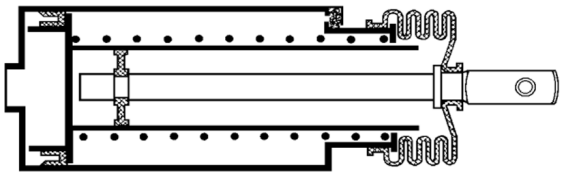
5.47 Piston cylinder 921 00X

Design

Purpose

Piston cylinders generate the braking force for the wheel brakes. They are also used to actuate (e.g. clamp, raise and switch) different mechanisms.

Operating principle



As soon as compressed air acts on the piston of the brake cylinder, that cylinder is forced out. The piston force acts on the brake lever and brake linkage via the push-rod. When the cylinder is vented, the preloaded spring pushes the piston back to its initial position. The piston force of a brake cylinder is dependent upon the piston surface and the pressure acting on that surface.

A fabric filter fitted in front of the cylinder cover air outlets prevents dirt and dust from penetrating into the cylinder as the piston is retracted.

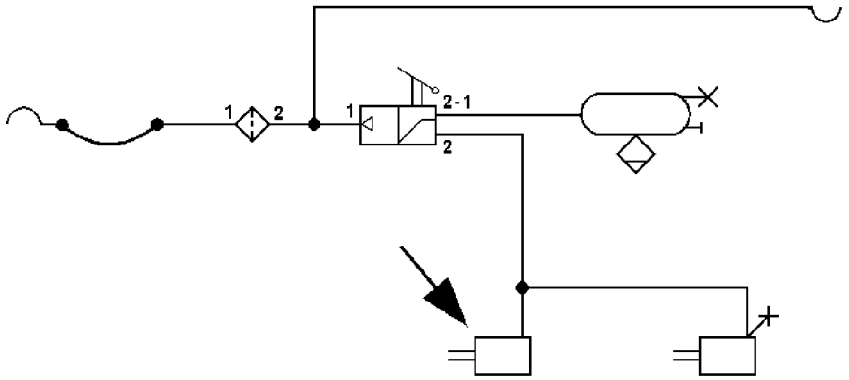
Technical data

PRODUCT NUMBER	921 002 000 0	921 003 000 0	921 004 000 0	921 006 000 0
Max. service braking pressure [bar]	8.0			
Piston diameter [mm]	3" (76.2)	4" (101.6)	5" (127)	6" (152.4)
Maximum stroke [mm]	110	140	110	175
Thermal range of application [C°]	-40 to +80			
Volume [litres]	0.55	1.24	1.89	3.34
Permissible medium	Air			
Weight [kg]	3.0	4.0	5.5	8.0

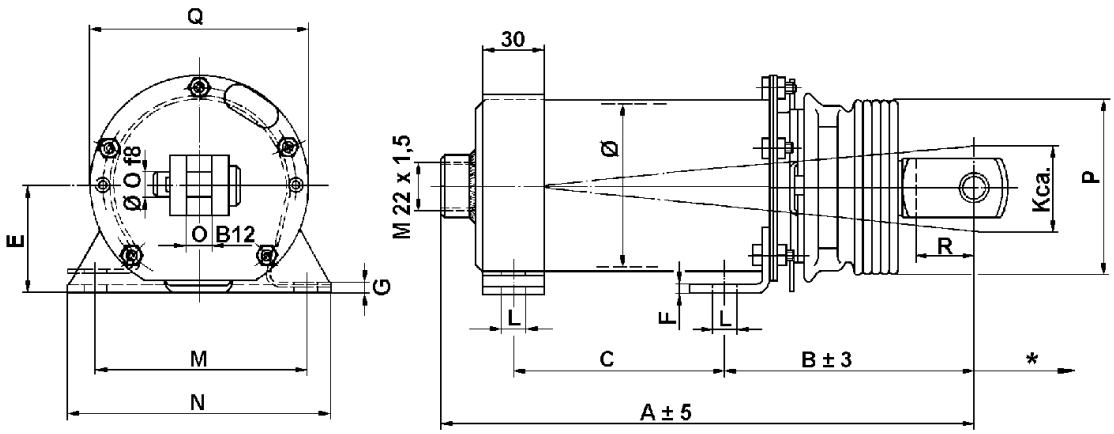
Installation recommendation

- Install the brake cylinders horizontally, or better still at an angle to the forked joint to ensure that if the bellows have been damaged, any water which has seeped in can run out.
- Please make sure that the brake lever and the piston rod form a right angle at half stroke to achieve the most effective possible transmission of power.
- If possible the piston rod should, in its idle position, not come be contact with the piston head but have a slight clearance (approx. 1 to 2 mm).
  When the brakes are properly adjusted, the piston stroke is approx. one third of the maximum stroke shown (readjustment is required if it is 2/3 of that maximum stroke).
- Adapt the pipes so that they are free of tension after tightening the union nuts. Otherwise the cylinders might be damaged, e.g. cracking of the cylinder base. It is better to use hoses.

Installation diagram



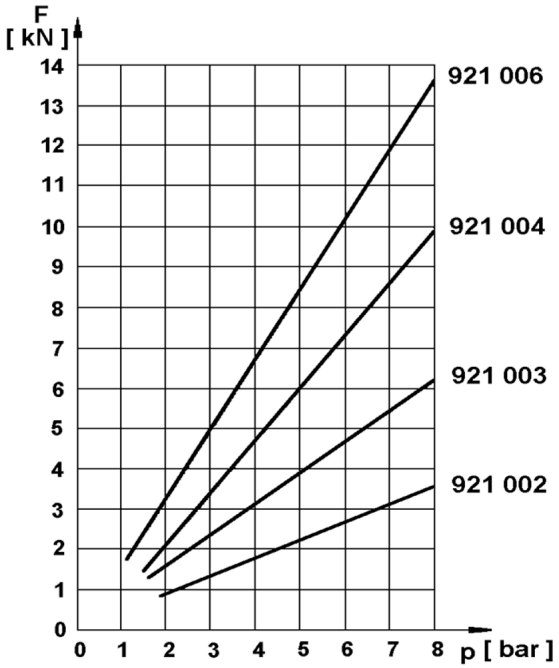
Installation dimensions for 912 002 000 0



LEGEND	
*	Stroke

PRODUCT NUMBER	921 002 000 0	921 003 000 0	921 004 000 0	921 006 000 0
A	254	307	340	371.5
B	120	140	168	157
C	50-100	60-120	80-120	120-160
E	50	60	70.5	87
F	4		5	7
G	5	7		
K	40			37
L	11.5	14.0	16.0	
M	100	120	155	175
N	125	150	190	205
O	12	14		
P	85			
Q	105	136	163	200
R	28	30		

Force-pressure diagram



Maintenance

If the visual or functionality test detects faults, replace the brake cylinder or repair it. Even if they are functioning properly (no leakages, response pressure not greater than 0.5 bar, bellows not damaged), replace the brake cylinders with new or reconditioned cylinders at 2-year intervals. If the bellow has been damaged, replace it immediately (WABCO order number: 897 752 365 4).

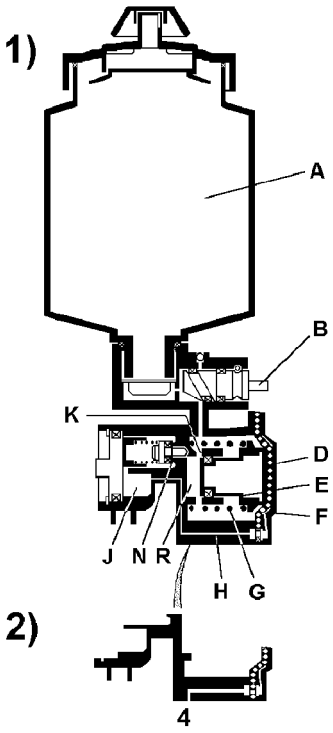
5.48 Anti-freeze pump 932 002

Design

Purpose

Anti-freeze pumps automatically inject the anti-freeze into the braking system to prevent icing in the piping and downstream devices.

Operating principle



Depending on its type, the anti-freeze pump can be fitted in front of or behind the unloader valve. If the anti-freeze pump is fitted in front of the unloader valve, the control pulse is taken directly from the feed line via an internal bore as the unloader valve switches from the idle to the load cycle. This control pulse has to be taken from a separate line if the anti-freeze pump is fitted behind the unloader valve. In both cases, however, anti-freeze is only injected into the system after the unloader valve has switched to the compressor load cycle, i.e. for feeding compressed air into the system.

Fig. 1) Without a separate control port

The compressed air supplied by the compressor flows through the anti-freeze pump from the port **1** to the port **2** (bore **J**). The pressure that now builds up in the chamber (**F**) via the bore (**H**) moves the piston (**E**) to the left. The bore (**K**) closes, preventing anti-freeze from flowing into the chambers (**C**) and (**J**). The fluid in the chamber (**R**) is displaced by the further movement of piston (**E**). It passes the valve seat (**N**), flows into the bore (**J**), and is dispersed in the braking system by the air flow.

When the operating pressure has been attained in the air reservoir, the unloader valve switches to the idle position. The pressure drops in the bore (**J**), and therefore in the chamber (**F**) as well via the bore (**F**). The compression spring (**G**) pushes the piston (**E**) back to its initial position. The anti-freeze starts flowing again from the reservoir into the chamber (**R**) through the re-opened bore (**K**).

These processes are repeated every time the unloader actuates the compressor.

Fig, 2) With a separate control port

The operating principle is the same as described under Fig. 1). With this variant, the control pressure is supplied from an external component (e.g. the unloader valve) via the port **4**.

Technical data

PRODUCT NUMBER	932 002 102 0	932 002 100 0	932 002 101 0
Max. operating pressure [bar]	18		
Flow rate per pulse [cm³]	0.2		
Anti-freeze agent	WABCOTHYL anti-freeze, ethyl alcohol, methanol		
Thermal range of application [°C]	-40 to +80		
Medium temperature [°C]	-40 to +150		
Max. inflow air temperature [°C]	+130		
Activation pressure [bar]	≥ 6		
Nominal width [mm]	Ø 15		
Direction of flow	Optional		
Weight [kg]	0.59		
With reservoir	yes		
Reservoir capacity [dm³]	0.5		
Flow rate per injection [dm³]	0.2	0.5	
Control port 4	no	yes	
Symbol (see installation diagram below)	A	A	B

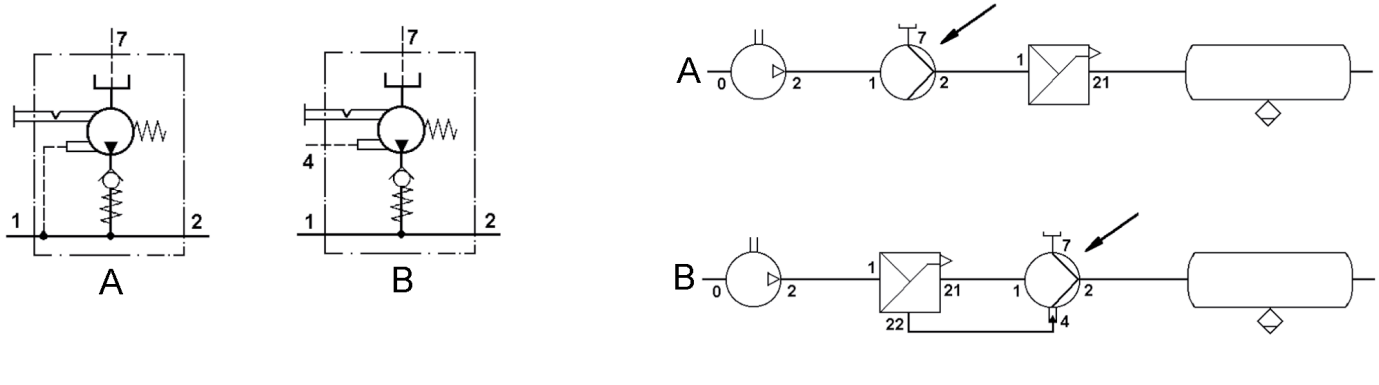
WABCOTHYL™ anti-freeze for pneumatic braking systems

1 litre bottle	830 702 087 4
10 litre canister	830 702 088 4
30 litre canister	830 702 089 4
200 litre canister	830 702 090 4

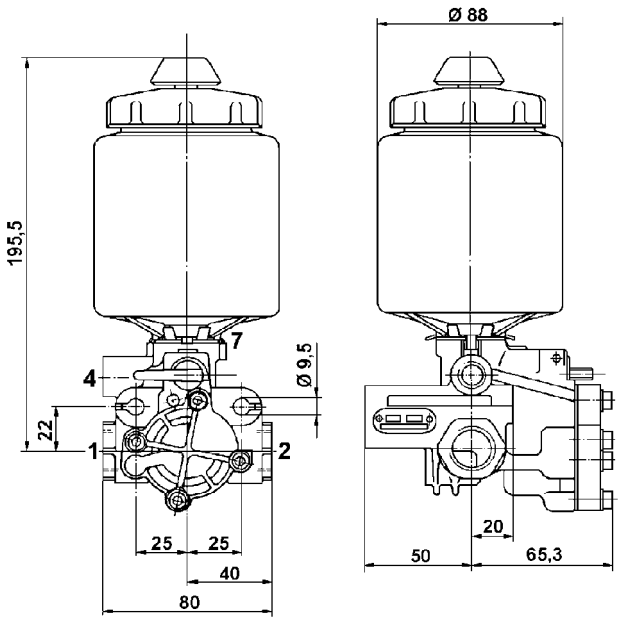
Installation recommendation

- Install the anti-freeze pump so that the reservoir is vertical and facing upward. A tolerance in excess of 15° is not permitted.
- If the reservoir is being fitted separately from the device, it has to be mounted above the pump.
- The anti-freeze pump has two fastening holes ø 9.5 mm.

Installation diagram



Installation dimensions



LEGEND			
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5
4	Control port M 12x1.5	**7**	Anti-freeze port M 22x1.5

Operation and maintenance

- At temperatures below +5 °C, the pump has to be put into operation by turning the lever (**B**) to the position I.
- Check the level of the anti-freeze daily.
- At temperatures above +5 °C, the pump can be switched off by turning the lever (**B**) to the position 0.

The anti-freeze pump does not require any special maintenance.

Note: During warm months, the supply reservoir does not have to be filled with fluid. The position of the lever (B) is then irrelevant (see illustration of the operating principle).

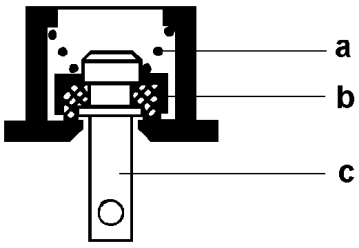
5.49 Drain valve 934 300

Design

Purpose

Drain valves drain the condensation from the air reservoir and vent the compressed air lines and reservoirs as required.

Operating principle



The valve (**b**) is held closed by the spring (**b**) and the pressure in the reservoir. Pulling or pushing the actuating pin (**c**) to the side opens the tilting disk valve. This allows both compressed air and condensation water to escape from the reservoir. The valve (**b**) closes in the absence of pressure or tension.

Technical data

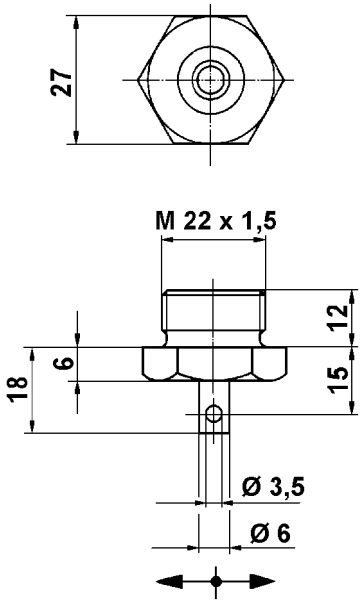
PRODUCT NUMBER	934 300 001 0	934 300 003 0
Max. operating pressure [bar]	20	
Permissible medium	Air, water, mineral oil	
Thermal range of application [°C]	-40 to +80	
Corresponds to standard	DIN 74 292	DIN 74 292-C
Material	Brass	
Weight [kg]	0.05	

Installation recommendation

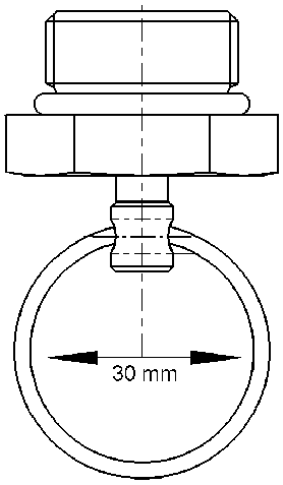
Note: The condensate from the air reservoir can contaminate other parts. Do not install any devices underneath the drainage valve.

Screw the drain valve into the base connection of the air reservoir. Seal the drain valve with a ring seal. The actuating bolt has a hole for attaching a wire pull.

Installation dimensions



934 300 003 0



Maintenance

If contaminated, unscrew the drain valve out of the reservoir and clean it.
Special maintenance that extends beyond the legally stipulated inspections is not required.

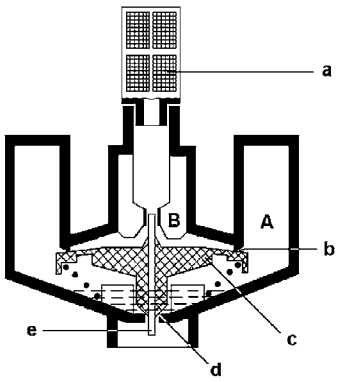
5.50 Automatic drain valve 934 301

Design

Purpose

Automatic valves protect the pneumatic braking system against condensation by draining the air reservoir.

Operating principle

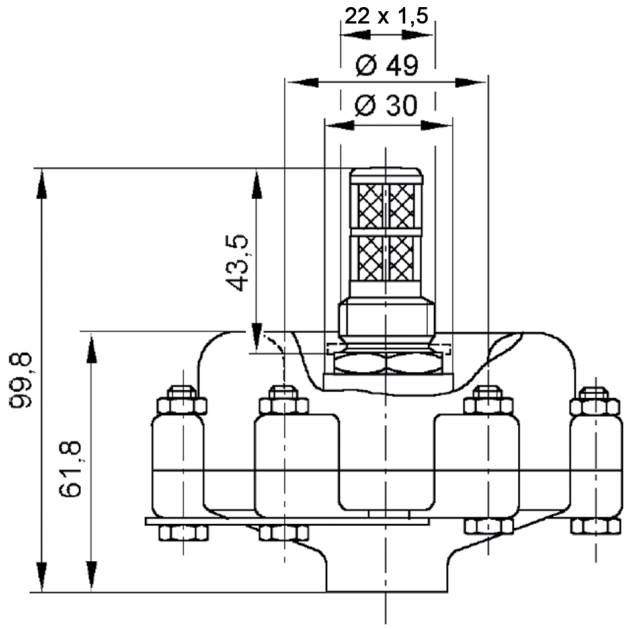


When filling the air reservoir, compressed air flows through the filter (**a**) into the chamber **B** and onto the valve body (**c**). This lifts itself off the inlet (**b**) at its outer circumference. Compressed air flows together with any accumulated condensation water out of the air reservoir and into the chamber **A**, whereby the condensation accumulates above the outlet (**d**). After pressure equilibrium is established between the two chambers, the valve diaphragm (**c**) closes the inlet (**b**). If the pressure in the air reservoir falls, for example due to a braking action, the pressure in the chamber **B** is also reduced, while the full pressure is initially maintained in the chamber **A**. The higher pressure in the chamber **A** acts from underneath on the valve body (**c**) and lifts it off the outlet (**d**). The condensation water is forced out by the air cushion in the chamber **A**. When the pressure in the chamber **A** has fallen far enough to establish a pressure equilibrium between the chambers **A** and **B** again, the valve body (**c**) closes the outlet (**d**). To check the functional readiness of the drain valve, the outlet (**d**) can be opened manually by pressing in the pin (**e**) in the outlet port.

Technical data

PRODUCT NUMBER	934 301 000 0
Max. opening pressure [bar]	20
Permissible media	Air, water, mineral oil
Thermal range of application [°C]	-40 to +80
Weight [kg]	0.42

Installation dimensions



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

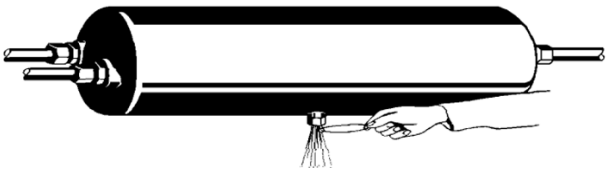
5.51 Air reservoir 950 XXX

Design

Purpose

Air reservoirs store the air that is made available by the compressor.

Operating principle



The reservoir consists of the cylindrical portion in the centre with welded-in arched bases and screw necks for connecting pipes. A further port is located in the centre section where a draining facility can be attached for regular draining of condensation water.

Technical data

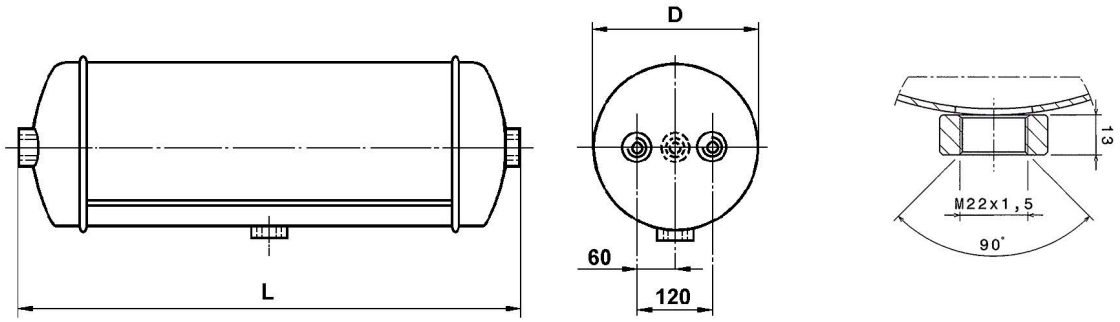
PRODUCT NUMBER	950 410 004 0	950 415 005 0	950 420 003 0	950 520 003 0	950 530 002 0	950 540 001 0	950 740 002 0	950 760 002 0	950 060 003 0	950 060 004 0	950 080 002 0	950 100 002 0
Content [litres]	10	15	20		30	40		60			80	100
L [mm]	368	527	691	495	709	927	758	1108	893	580	750	915
D [mm]	206			246			276		323	396		
In accordance with 87/404/EEC & EN286-2	yes											
Maximum operating pressure [bar]	15.5						14.5		12.5		10	
Weight [kg]	5.0	6.8	8.4	7.6	10.5	8.8	11.5	17.2	16.0	14.0	17.0	21.7

Installation recommendation

- Attach the clamp bands so that the connecting seams do not touch the base and the reservoir is not subjected to any tension that could jeopardise operational safety. They are fastened with straps or the brackets of the reservoir. Place insulation strips between the reservoir and the straps if necessary.
- Install the reservoir horizontally or vertically. Make sure that one drain pipe is located at the lowest point of the reservoir. Make sure that any condensation can be emptied and/or the collection of condensation is prevented. The reservoir plate must be easily legible in the specified installation point when the reservoir is installed.

Note: No heat treatment or welding is to be done on the walls of the reservoir that are under pressure.

Installation dimensions



Clamp band

FIGURE	CYLINDER Ø	PRODUCT NUMBER
	206	451 999 206 2
	246	451 999 246 2
	276	451 999 276 2
	310	451 999 310 2
	396	451 999 396 2

Rubber pad: 451 999 999 0 (50 m roll)

Maintenance

Drain the air reservoir daily.

Note: We recommend using drain valves which are available for both manual and automatic actuation.

5.52 Coupling head 952 200 / 452 XXX

Design types

Type A1

Type A2

Type B1

Type B2

Type C

The coupling head variants **A1**, **B1** and **C** for the supply line have a red cap and an axial interchange catch.
The variants **A2** and **B2** for the brake line have a yellow cap and a lateral interchange catch.
The variants **B** and **C** are fitted with a valve which blocks the passage of compressed air if the mating coupling head is not connected.

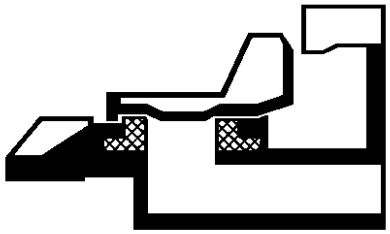
Purpose

Coupling heads are required respectively on the supply and brake lines between the tractor and trailer. Their purpose is to connect both lines with a built-in catch to prevent interchanging. Coupling heads in the towing vehicle have a valve.

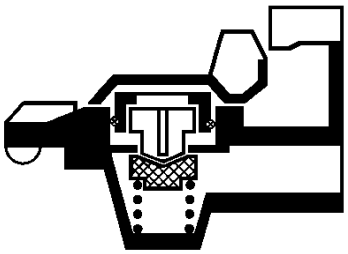
Note: Coupling heads from the older 452 200 series can be safely connected to 952 200 series coupling heads.

Operating principle

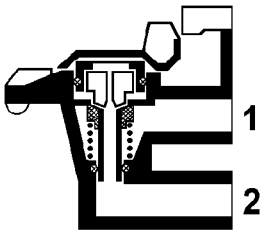
Type A



Type B



Type C



When the trailer is connected to the tractor, the coupling head with its connected coupling head is fitted to the coupling head attached on the tractor with a twist at the same time as interlocking the opposing guides. The two coupling heads are securely connected when they engage at the end of the rotation.

The interchange catches ensure that only the matching coupling heads can be connected to one another (see the installation diagram below).

- Connecting **C** with **A1**, **B1** with **A1** and **B2** with **A2**:
  When they are being connected, the ring seal of the type **A** coupling head opens the valve in the head of types **B** or **C**, establishing the pneumatic connection between the respective lines and sealing that connection. When the two coupling heads are uncoupled, the valve closes again automatically.
- Connecting **A2** to **A2**:
  When connecting two identical coupling heads without a valve, the sealing tightness is achieved by the two ring seals being pressed together.

For tractors and Unimog

Solution no. 1: Two identical coupling heads with valves (**B1** and **B2**) can be used.

Solution no. 2: A coupling head without a valve (**A2**) can be used for the brake line; in this case, a type **C** coupling head (with 2 connecting holes) must be used for the supply line. When connecting the two, the valve in the coupling head C opens, and the compressed air at the port **1** flows both via the supply line to the trailer and via the port **2** to the trailer control valve. If the tractor is being driven without a trailer, the valve in the coupling head **C** is closed, and the line leading to the trailer control valve is not supplied with compressed air. A shut-off valve is therefore not required in the coupling head of the brake line because no compressed air is outputted by the trailer control valve when the brakes are actuated.

For trailers

Always use the coupling heads without a valve (**A1** and **A2**).

Technical data

PRODUCT NUMBER	452 30X XXX 0	452 200 XXX 0	952 200 XXX 0
Max. operating pressure [bar]	20	8	10
Permissible media	Air, water, mineral oil	Air	Air
Thermal range of application [°C]	-40 to +80		
Weight [kg]	approx. 0.6	approx. 0.25	approx. 0.21
Line connection thread	M 22x1.5 - 17	M 22x1.5 - 15	M 16x1.5

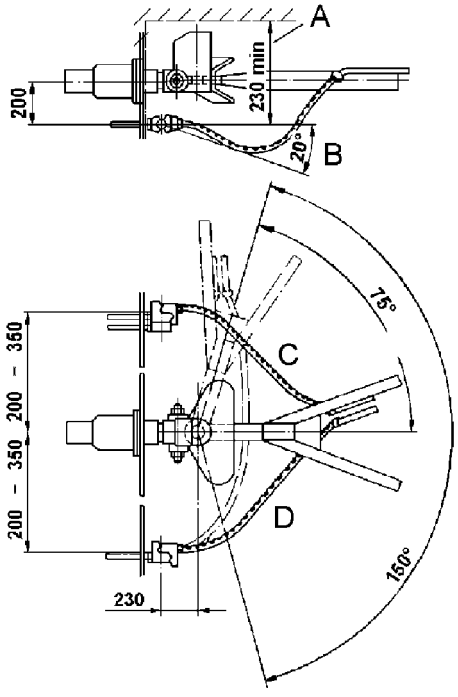
Overview of the coupling heads

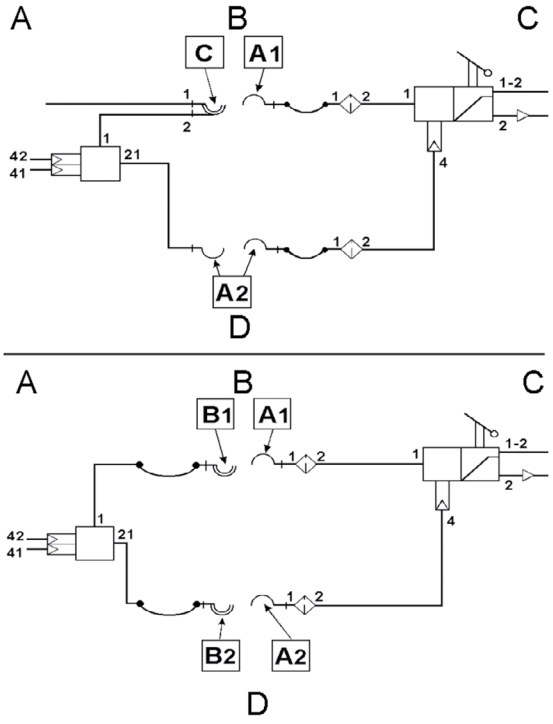
TOWING VEHICLE	TYPE	TRAILER	TYPE	THREAD	COLOUR	COMMENT
Single line braking system						
452 300 031 0		452 201 010 0		M 22x1.5	black	Brake line
For Swiss braking systems						
452 303 031 0		452 203 031 0		M 22x1.5	red	Supply
452 303 032 0		452 203 032 0		M 22x1.5	yellow	Brake line
Dual line braking systems						
452 200 211 0	B1	452 200 011 0	A1	M 22x1.5	red	Supply
952 200 221 0	B1	952 200 021 0	A1	M 16x1.5		
452 200 212 0	B2	452 200 012 0	A2	M 22x1.5	yellow	Brake line
952 200 222 0	B2	952 200 022 0	A2	M 16x1.5		
With two connections						
952 200 210 0	C			2 x M 16x1.5	red	Supply

A coupling head with an M 22x1.5 thread can be replaced with a coupling head with an M 16x1.5 thread using the double connector 893 100 138 4.

Installation recommendation

The coupling heads must be fitted in accordance with the ISO 1728 standard as shown in the drawings below.

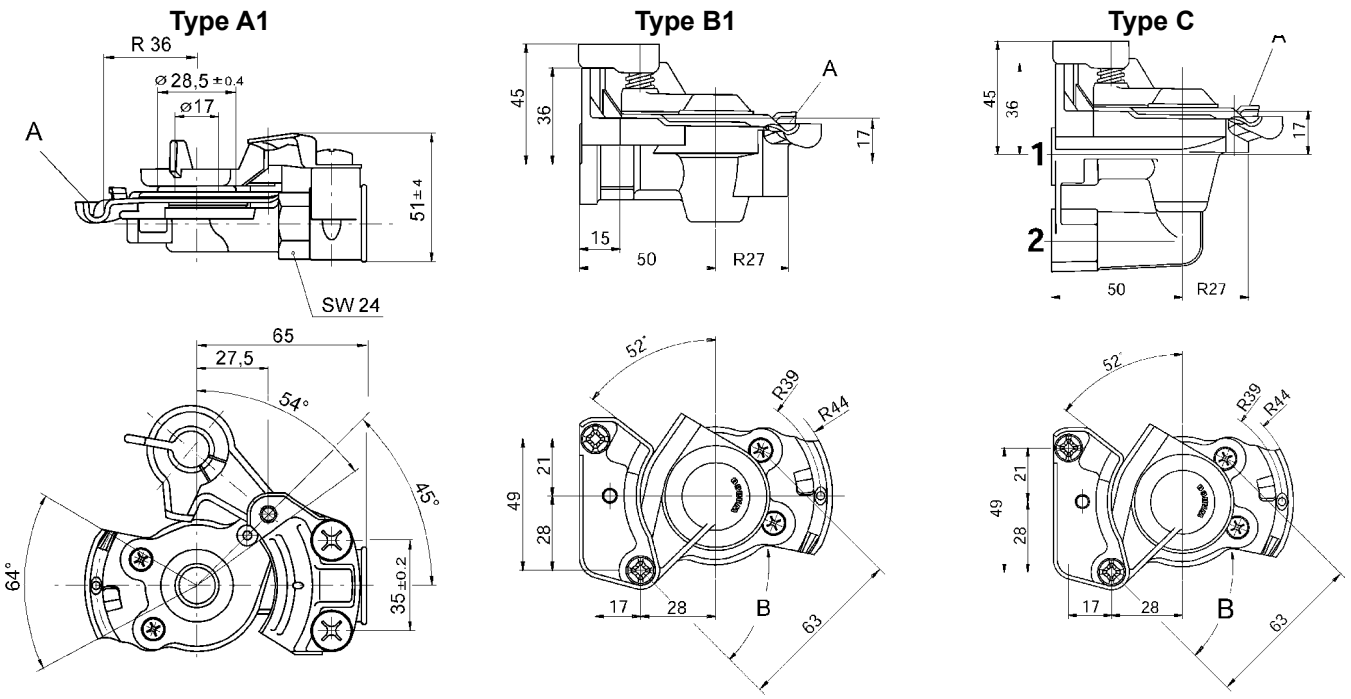




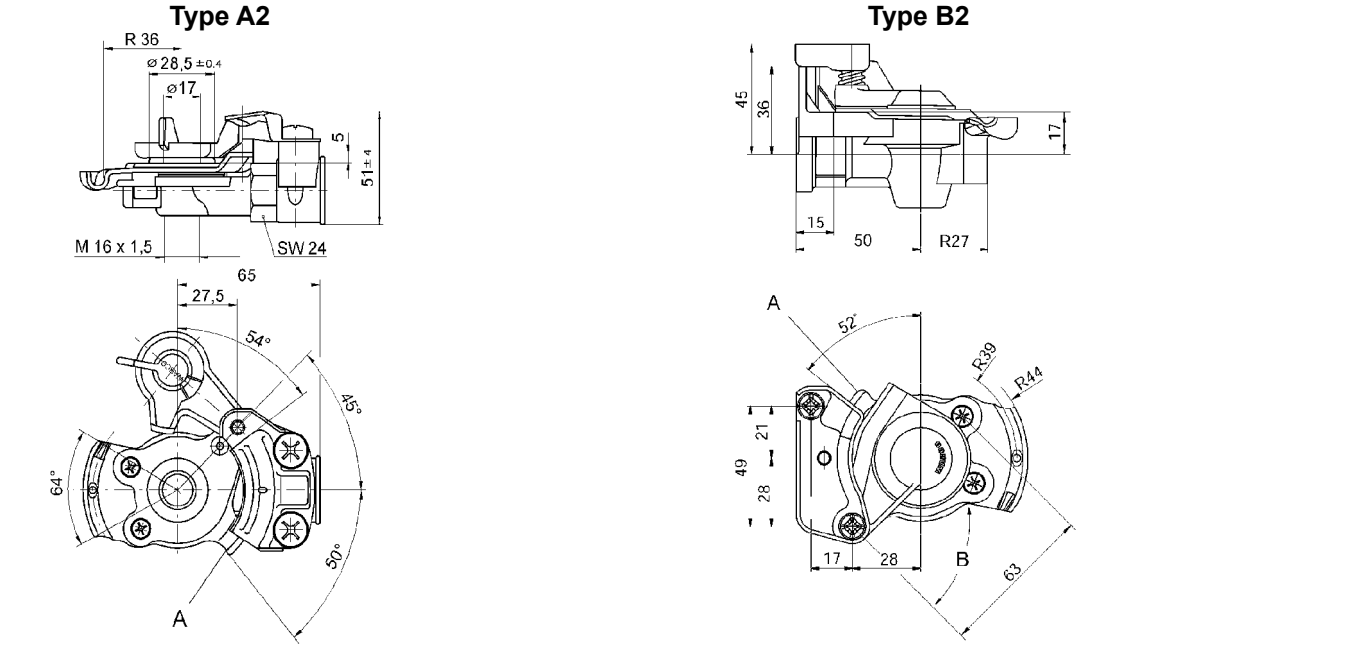
LEGEND - ILLUSTRATION LEFT				LEGEND - ILLUSTRATION RIGHT			
A	Free space for coupling	**B**	Max. deviation from horizontal	**A**	Tractor	**B**	Supply line
C	Supply line	**D**	Brake line	**C**	Trailer	**D**	Brake line

Installation dimensions

Supply line



Brake line



LEGEND							
1	Energy supply	**2**	Energy discharge	**A**	Interchange catch	**B**	Direction of rotation of cap

Maintenance

When connecting, make sure that the sealing surfaces which come into contact with each other are clean. Replace damaged ring seals. After uncoupling, close the dust cap again.

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.53 Coupling head with integrated filter 952 201

Design types

952 201 001 0

952 201 002 0

Purpose

Coupling heads are required respectively on the supply and brake lines between the tractor and trailer. Their purpose is to connect both lines with a built-in catch to prevent interchanging. Couplings are only suitable for installation in the trailer.

Operating principle

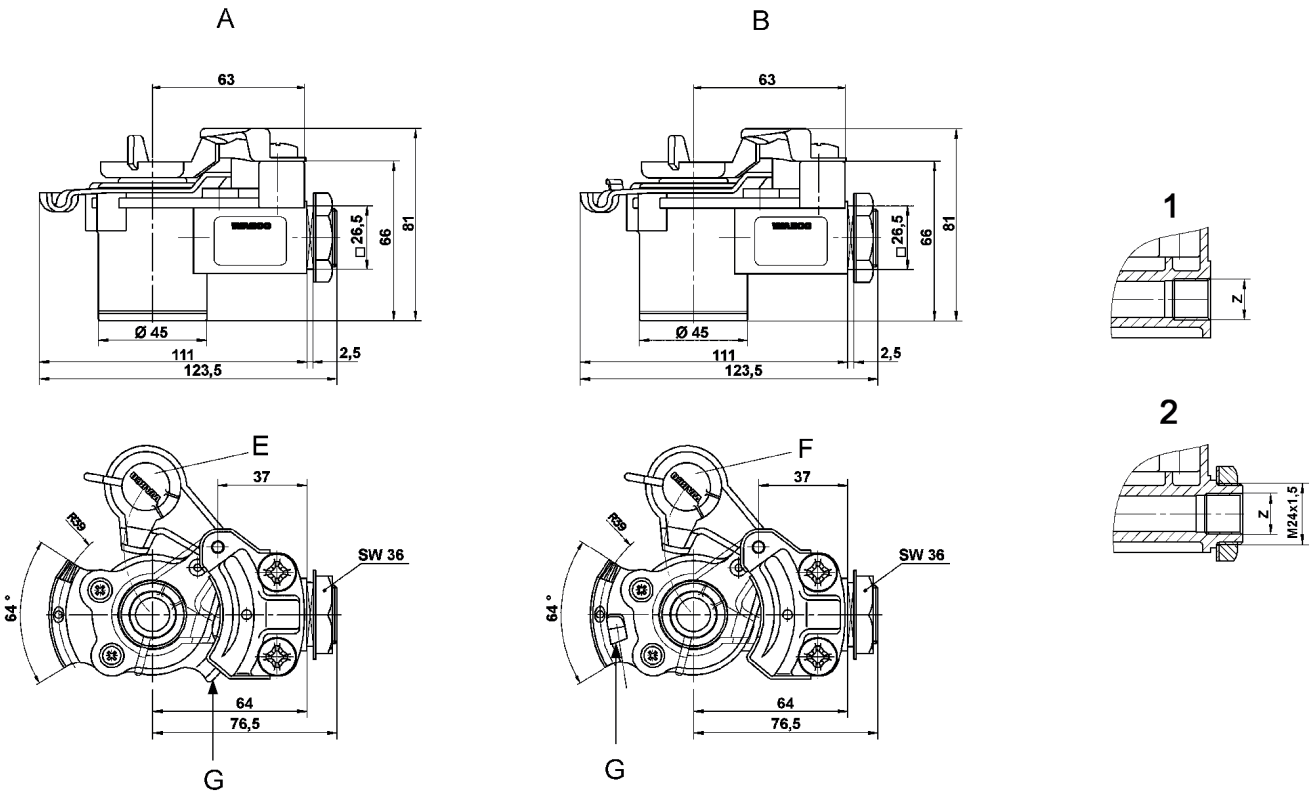
When the trailer is connected to the tractor, the coupling head with its connected coupling head is fitted to the coupling head attached on the tractor with a twist at the same time as interlocking the opposing guides. The two coupling heads are securely connected when they engage at the end of the rotation.

The interchange catches ensure that only matching coupling heads can be connected together. The air passing through the line filter is filtered at the same time. The separately installed line filters 432 500 XXX 0 are therefore no longer required.

Technical data

PRODUCT NUMBER		952 201 001 0	952 201 003 0	952 201 002 0	952 201 004 0
Design	Supply line (red cap)			X	X
	Brake line (yellow cap)	X	X		
Variant		1	2	1	2
Max. operating pressure [bar]		8.5			
Thermal range of application [°C]		-40 to +80			
Corresponds to standard		ISO 1728			
Weight [kg]		0.35	0.31	0.35	0.31

Installation dimensions



LEGEND					
A	Brake line	**B**	Supply line	**E**	Yellow cap
F	Red cap	**G**	Interchange catch	**Z**	Connecting thread M 16x1.5

Maintenance

When connecting, make sure that the sealing surfaces which come into contact with each other are clean. Replace damaged ring seals. After uncoupling, close the dust cap again.

Special maintenance that extends beyond the legally stipulated inspections is not required.

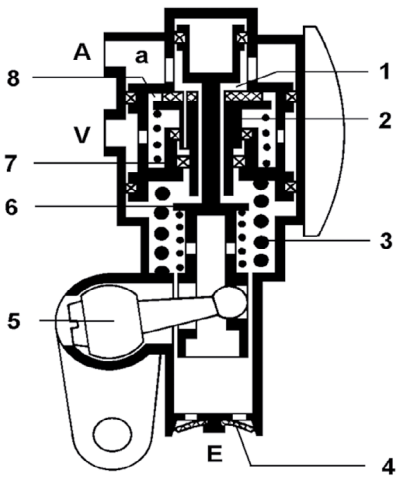
5.54 Force-actuated trailer control valve 961 106

Design

Purpose

Force-actuated trailer control valves control the dual line trailer braking system in conjunction with the mechanical or hydraulic foot brake of agricultural tractors of all makes and sizes.

Operating principle



In the release position, the trailer brake line leading from the port **A** is vented via the opened outlet (**1**) of the valve (**2**) and the vent valve (**4**). When the foot brake is actuated, the housing affixed to the foot brake lever turns around the ball pivot (**5**). This causes the valve tappet (**6**) to be pulled downwards and the inlet (**1**) is closed. As the step plate is depressed further down, the inlet (**8**) opens. The trailer brake line is vented at the port **V** by the supply reservoir corresponding to the applied foot pressure.

The rising pressure in the chamber (**a**) acts on the piston (**7**), and after the counterforce of the compression spring (**3**) has been overcome, the piston moves downwards and the inlet (**8**) closes. The trailer control valve is now in its end position.

Only a small amount of foot force is required to operate the trailer control valve. The trailer brake will thus respond earlier than the brake of the tractor actuated via the same foot brake lever. This advancement of the trailer brake prevents bumping or jack-knifing of the trailer.

As the brake force on the tractor is increased, the pressure in the trailer line rises as well. It continues to increase until the full reservoir pressure passes to the trailer just before full braking of the tractor.

When the brake is released, the valve tappet (**6**) opens the outlet (**1**) as it moves back upwards to its original position. The trailer brake line is vented via the vent valve (**4**), releasing the trailer brake. Venting the chamber (**a**) also causes the piston (**7**) to return to its initial position.

The design of the trailer control valve permits highly sensitive graduation of the braking and release processes.

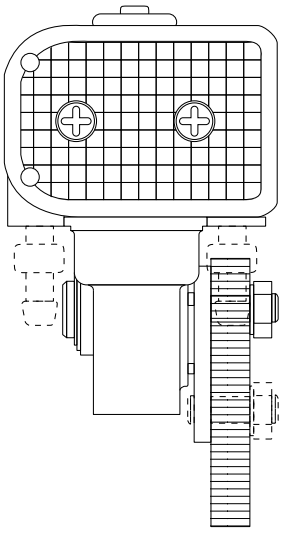
Technical data

PRODUCT NUMBER	961 106 000 0
Max. operating pressure [bar]	10
Thermal range of application [°C]	-40 to +80
Nominal width [mm]	7
Weight without compensator actuation [kg]	1.2
Weight with compensator actuation [kg]	2.17

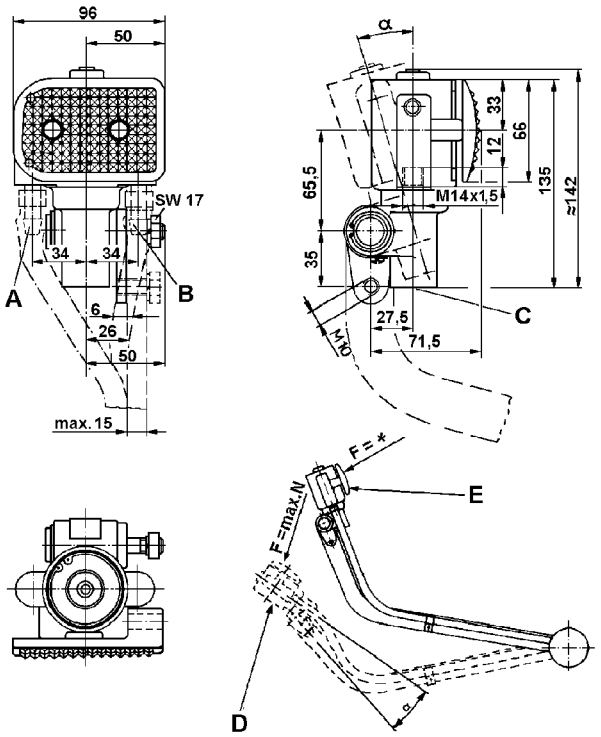
Installation recommendation

Attach the trailer control valve to the foot brake lever of the tractor. The step plates must be removed for retrofitting. The device is available with the mounting tab on the left or right-hand side to accommodate the available installation space.

Installation diagram

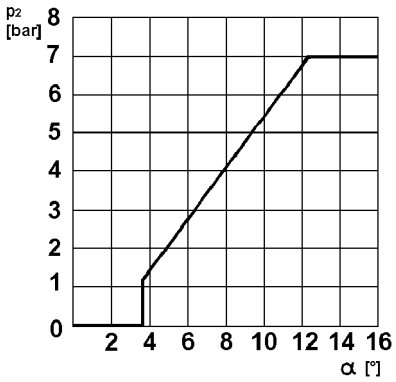


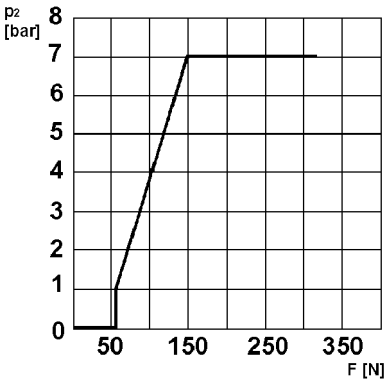
Installation dimensions



LEGEND					
A	Trailer	**B**	Reservoir	**C**	Venting
D	Braking position	**E**	Driving position	*	ON

Pressure diagrams





LEGEND					
α	Angular deflection	**p**	Output pressure p_2 in bar	**F**	Force on the pedal plate

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.55 Hand brake valve 961 723

Design

Purpose

Hand brake valves progressively actuate the linkage-free auxiliary braking system and the parking brake system in conjunction with spring brake cylinders in solo operation.

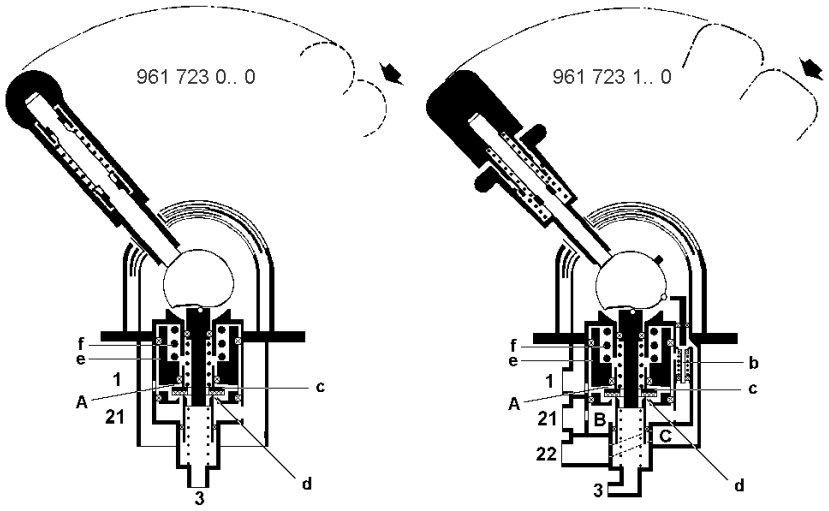
With the hand brake valve 961 723 1XX 0, the additional port (**22**) enables the trailer control valve to be controlled and the braking effect to be transferred to the trailer. A control position is integrated for checking the effect of the towing vehicle's parking brake.

In the parked position, the spring brake chambers of the Tristop® cylinders are completely vented so that the tensioned springs brake the vehicle.

Valves with a lever that can be moved to an additional control position are used on vehicles that tow trailers. In this test or control position, the braking power of the towing vehicle can be checked. The trailer control valve is changed again (pressurised) to release the trailer brake again while the brakes of the towing vehicle are still applied with the spring-loaded brake. The towing vehicle must now be able to hold the entire tractor-trailer combination on an incline of 18 %. The basis of this test is that a tractor-trailer unit must be able to remain parked securely on a hill if the trailer equipped with diaphragm or piston cylinders loses its air supply while it is parked. Since the trailer is then no longer braked, the towing vehicle must be capable of holding the entire tractor-trailer combination.

The hand brake is also used for the auxiliary brake: Even if both service brake circuits fail, the Tristop® cylinder can brake the vehicle with the spring chambers. The hand brake must have a gradual effect on the spring brake in this case and must also control the trailer vehicle with the trailer brake valve.

Operating principle



The spring brake actuators are pressurised in the valve driving position, the brakes are released.

Auxiliary brake

In the driving position, the valve (**c**) keeps the connection between the chambers **A** and **B** open, and the supply air at the port **1** flows via the port **21** into the spring brake chambers of the Tristop® cylinders. At the same time, compressed air flows through the test valve (**b**) and the chamber **C** to the port **22**, and charges the port **43** of the trailer control valve.

When the auxiliary braking system is actuated with the hand lever (**a**), the valve closes (**c**) the connection between the chambers **A** and **B**. The compressed air from the spring brake chambers escapes into the open air through the opening outlet (**d**) at the port **3**. This also causes the pressure in the chamber **B** to drop, and the piston (**e**) is forced downwards by the force of the compression spring (**f**.)

As the outlet closes, a neutral position is reached in all partial braking positions, thereby ensuring that the spring brake chambers always contain the appropriate pressure for the desired retardation.

Parking position

When the hand lever (**a**) is moved further beyond the pressure point, the parking position is reached. The outlet (**d**) stays open and all the compressed air escapes from the spring brake chambers. Within the auxiliary braking range from the driving position to the pressure point, the hand lever (**a**) automatically returns to the driving position when it is released. The test valve combined with the basic valve can be used to ascertain whether the mechanical forces of the towing vehicle's parking braking system are capable of holding the tractor-trailer combination on a certain uphill or downhill gradient when the trailer's braking system is not actuated.

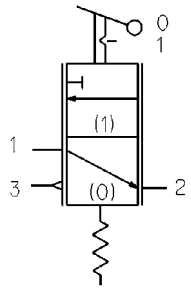
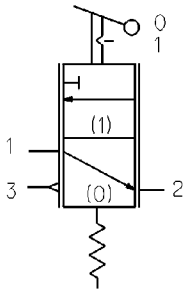
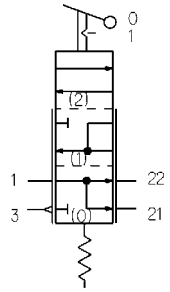
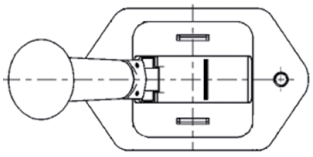
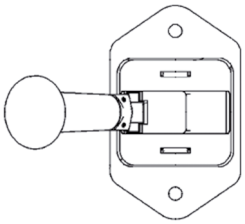
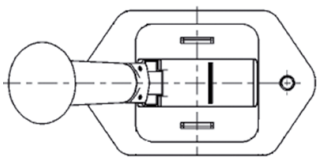
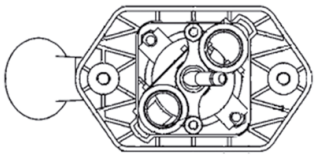
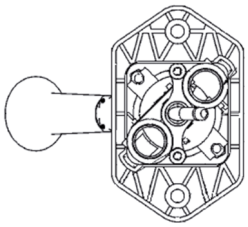
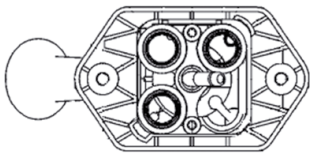
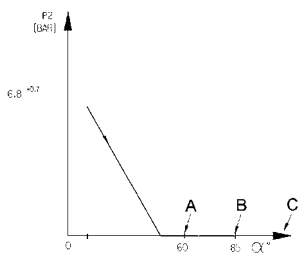
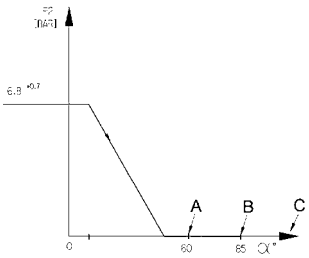
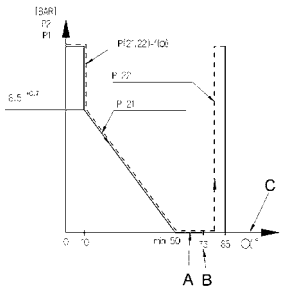
Test position

In the driving position, the chambers **A**, **B** and **C** are interlinked, and the supply pressure flows through the port **21** to the spring brake chambers and through port **22** to the trailer control valve. When the hand lever (**a**) is actuated, the pressure in the chambers **B** and **C** is reduced until it is completely relieved when the pressure point is reached.

If the pressure point is exceeded, the hand lever (**a**) reaches an intermediate position: the locked parking position. If the lever is moved further to the test position, the compressed air in the chamber **A** flows into the chamber **C** through the open valve (**b**). Charging the port **22** controls the trailer brake valve, which in turn now releases the pneumatic brake actuation on the trailer that was effected when braking with the auxiliary or parking brake. The entire tractor-trailer combination is now being held by the mechanical forces of the towing vehicle's spring brake cylinders.

As soon as the operating lever (**a**) is released again, it returns to the parking brake position.

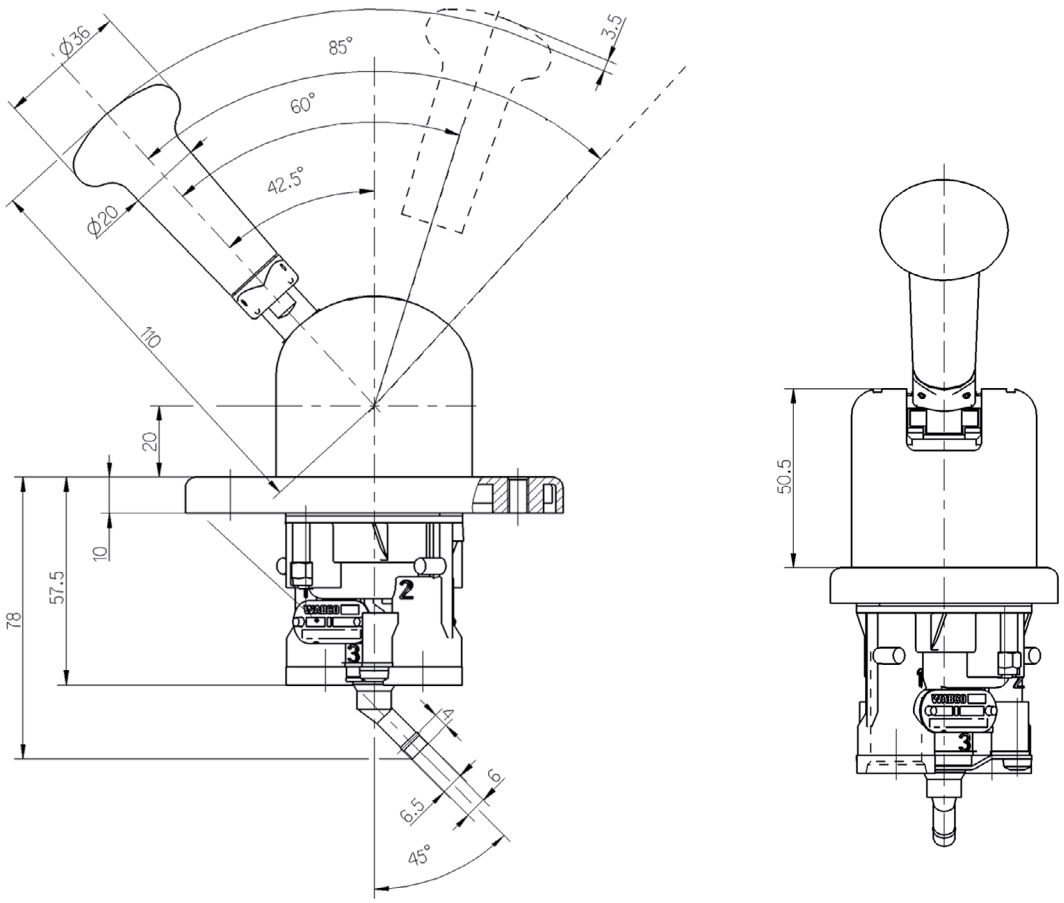
Technical data

PRODUCT NUMBER	961 723 044 0	961 723 053 0	961 723 144 0
Symbol			
Position of the support plate and lever			
Lever position and position of the ports			
Characteristic curve			
Medium	Air		
Operating pressure (P1) [bar]	10		
Operating pressure (P2) [bar]	$6.8^{+0.7}$		
Thermal range of application [°C]	-40 to +80		
Port threads	M 16x1.5		
Mounting holes [mm]	Ø 6.5		
Lever colour	Orange RAL 2010		
Weight [kg]	0.5		

Installation recommendation

The hand brake valve is to be mounted on the dashboard with two M6 or M8 screws.

Installation dimensions for 961 723 044 0



LEGEND					
1	Supply	**2**	Spring brake cylinder	**3**	Venting

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

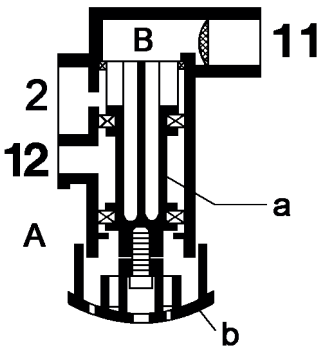
5.56 Trailer release valve 963 001

Design

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 brake-type parking brake systems to release and actuate the braking system.

Operating principle



In this variant, the supply air connection flows via the port **11** into the chamber **B**. If the piston (**a**) is still in the release position, it is pushed out into the driving position by the supply pressure. The supply air then flows via the port **2** to the trailer brake valve and into the trailer's supply reservoir.

When uncoupled, the port **11** and consequently the chamber **B** are vented. To release the braking system, the piston (**a**) is pushed in up to the end stop by hand using the actuating button (**b**). This blocks the passage from the port **11** to the port **2** and a connection is established between the chamber **A** and the port **2**.

The supply air pressure for the semi-trailer at the port **12** flows via the port **2** to the trailer brake valve, which causes the valve to switch to the driving position, thereby venting the brake cylinder.

Technical data

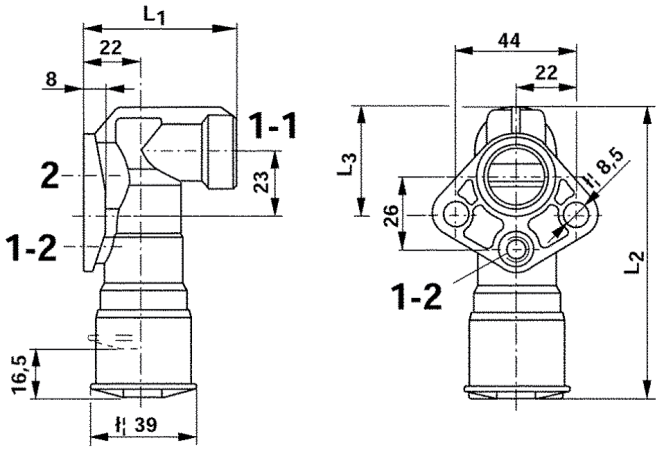
PRODUCT NUMBER		963 001 012 0	963 001 013 0	963 001 051 0	963 001 053 0
Max. operating pressure [bar]		8.5			
Min. nominal diameter	1-1 => 2	Ø 8		–	
	1-2 => 2	Ø 6		–	
Port threads		M 16x1.5 - 13	M 22x1.5 - 13	M 16x1.5 - 13	
Installation dimensions [mm]	L_1	51	54.5	–	
	L_2	104.5	107	–	
	L_3	36.7	39	–	
Button colour		black		black/red	
Thermal range of application		-40 °C to +80 °C			
Weight [kg]		0.11	0.14	0.63	

Installation recommendation

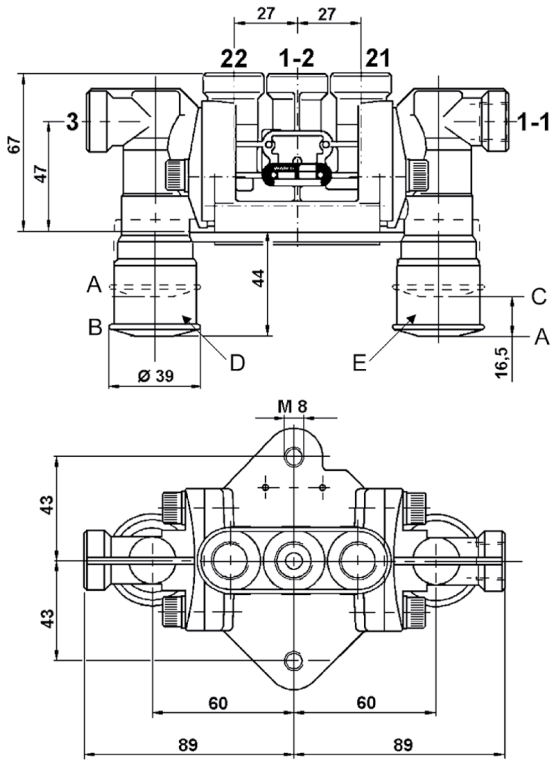
- Install the trailer release valve in an accessible location in the frontal area of the trailer vehicle.
- Install the trailer release valve vertically so that the actuation knob points downward; a deviation of ± 90° is permitted.
- Flange the trailer release valve 963 001 012 0 and 963 001 013 0 directly onto the trailer brake valve.

Installation dimensions 963 001 012 0 and 963 001 051 0

963 001 012 0



963 001 051 0



LEGEND							
1-1	Energy supply M 16x1.5	**1-2**	Energy supply (Reservoir) M 16x1.5	**A**	Driving position	**B**	Parking position
2	Energy discharge M 16x1.5	**3**	Venting	**C**	Release position	**D**	Black
21	Energy discharge (Trailer brake valve) M 16x1.5	**22**	Energy discharge (Spring brake cylinder) M 16x1.5	**E**	Red		

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.57 Trailer brake valve with adjustable predominance 971 002

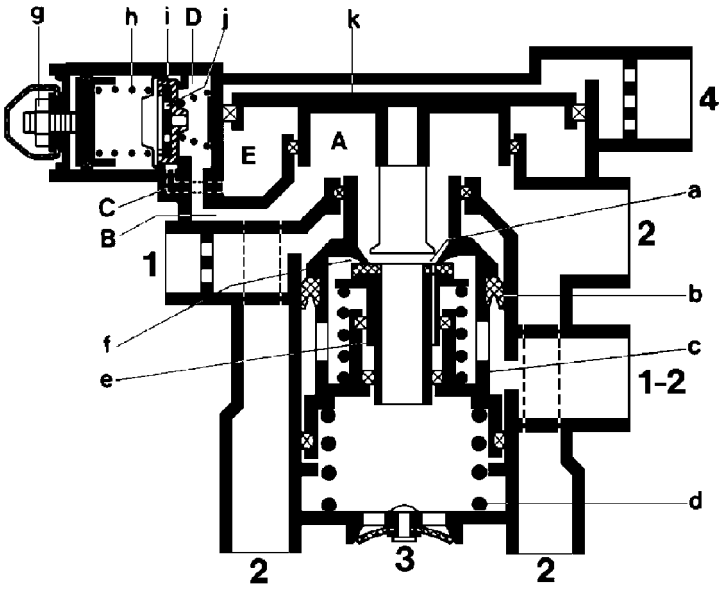
Design

Purpose

Trailer brake valves are used in dual line trailer braking systems. They are each controlled from the towing vehicle by means of a trailer control valve.

The purpose of trailer brake valves is to gradually brake the trailer regardless of 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. The predominance can be adjusted in accordance with the compatibility band.

Operating principle



Trailer brake valve

The compressed air flows from the towing vehicle via the "supply" coupling head via the port **1** of the trailer brake valve, past the grooved ring (**c**) to the port **1-2**, and on to the trailer supply reservoir.

When the tractor braking system is actuated, compressed air flows via the "brake" coupling head and the port **4** to the top of the piston (**a**). The piston moves downwards and rests on the valve (**f**), closing the outlet (**b**) and opening the inlet (**g**). The compressed air from the trailer reservoir (port **1-2**) now flows via the ports **2** to the downstream brake valves and into the chamber **C** as well as via the duct **A** into the chamber, and builds up energy at the valve (**k**). As soon as the energy in the chamber **C** predominates, the valve (**k**) is opened against the force of compression spring (**i**).

The compressed air flows into the chamber **D** via the duct **B** and acts on the bottom of the piston (**a**). As a result of the compound energy in the chambers **D** and **E**, the control pressure acting on the top of the piston (**a**) is overcome and the piston (**a**) moves upwards.

Within the partial braking range, the downstream valve (**f**) closes the inlet (**g**) and a final position is reached. During full braking, the inlet (**g**) is kept open by the piston (**a**) during the entire braking action.

A maximum predominance of 1 bar can be established between the ports **2** and **4** by adjusting the tension of the compression spring (**i**) with the set screw (**h**).

After releasing the tractor's brakes and the subsequent venting of the port **4**, the piston (**a**) is moved upwards to the top of its stroke by the pressure in the ports **2**.

The inlet (**g**) closes and the outlet (b) opens. The compressed air at the ports **2** escapes into the open air via the valve (**f**) and the vent **3**. Due to the drop in pressure in the chamber **C**, the compressed air in the chamber **D** flows via the bores (**j**) of the valve (**k**) back into the chamber **C**, and from here to the vent **3**.

When the trailer is uncoupled or in the event of a rupture in the supply line, the port **1** is vented and the pressure acting on the top of piston (**d**) is relieved. The force of the compression spring (**e**) and the supply pressure at the port **1-2** moves the piston (**d**) upwards, and the valve (**f**) closes the outlet (**b**). As the piston (**d**) continues moving upwards, it is lifted off the valve (**f**) and the inlet (**g**) opens. The trailer supply pressure at the port **1-2** flows to the downstream brake valves via the ports **2** without any loss.

Trailer release valve

When using the trailer brake valve in conjunction with an automatic load controlled, load-sensing valve or a manually adjustable load-sensing valve without a release position, the trailer release valve 963 001 allows the trailer to be moved when it is unhitched. For this purpose, the piston (**l**) is pushed in up to the end stop by hand with the actuating button (**m**). This closes the passage from the port **11** of the trailer release valve to the port **1** of the trailer brake valve, and a connection is established between the port **1** of the trailer brake valve and the port **12**. The trailer supply reservoir pressure at the port **12** flows into the port **1** of the trailer brake valve, which causes the valve to switch to the driving position, thereby venting the brake cylinder.

If the piston (**l**) is not pulled out manually up to the end stop when the trailer is hitched up again to the towing vehicle, it is forced out by the supply pressure from the towing vehicle via the port **11**. The release valve is then once more in its normal position in which a connection is established between the port **11** of the release valve and the port **1** of the trailer brake valve.

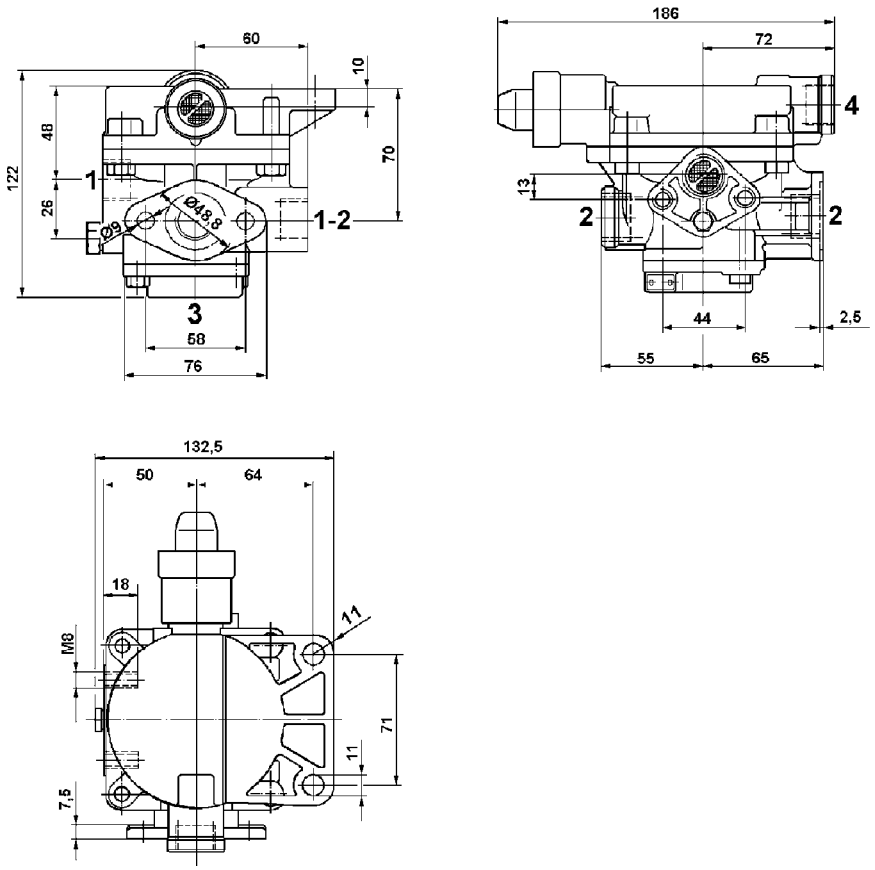
Technical data

PRODUCT NUMBER		971 002 150 0	971 002 531 0	971 002 570 0	971 002 620 0	971 002 300 0	971 002 301 0	971 002 700 0	971 002 701 0
Max. operating pressure [bar]		10				8.5			
Release valve		–	963 001 012 0	–	963 001 012 0	–	–	963 001 013 0	963 001 012 0
Load-sensing valve		–	–	475 604 011 0	475 604 013 0	–	–	–	–
Brake valve		–	–	–	–	–		971 002 300 0	
Works setting for the predominance [bar]		0					without	0	
Max. brake cylinder pressure in lever position (delivery state) [bar]	Releasing	–		0	–	–	–	–	–
	Unladen	–		1.9 to 2.1		–	–	–	–
	Half laden	–		3.8 to 4.0		–	–	–	–
	Fully laden	–		Supply pressure		–	–	–	–
Setting range in lever position [bar]	Unladen	–		1.4 to 2.3		–	–	–	–
	Half laden	–		3.4 to 4.3		–	–	–	–
Dead volume in litres		0.205	0.213	0.283	0.291	–	–	–	–
Thermal range of application [°C]		-40 to +80							
Weight [kg]		1.8	2.1	2.5	2.8	1.5	1.4	1.7	1.7

Installation recommendation

- Install the trailer brake valve vertically so that the vent faces downwards.
- Fasten the trailer brake valve with two M10 screws.

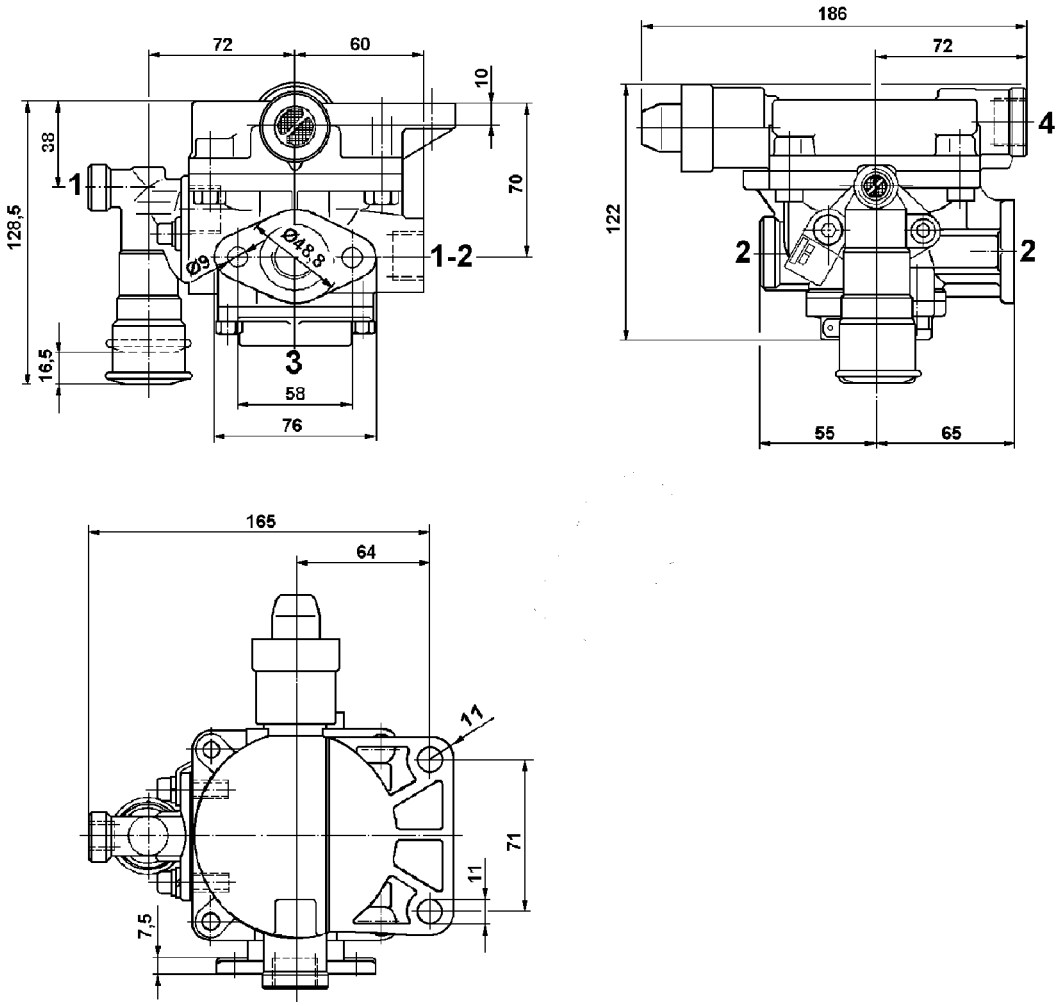
Installation dimensions for 971 002 150 0



LEGEND							
1-2	Energy supply/discharge (supply reservoir) M 22x1.5	**1**	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**4**	Control connection M 22x1.5

WHEN NOT IN USE, SECOND PORT 2 MUST BE CLOSED USING	PRODUCT NUMBER
Screw plug M 22x1.5	893 010 070 4
Ring seal A 22x27 DIN 7603-Al	811 401 080 4

Installation dimensions for 971 002 531 0 – Combination of trailer brake valve 971 002 150 0 with release valve 963 001 012 0



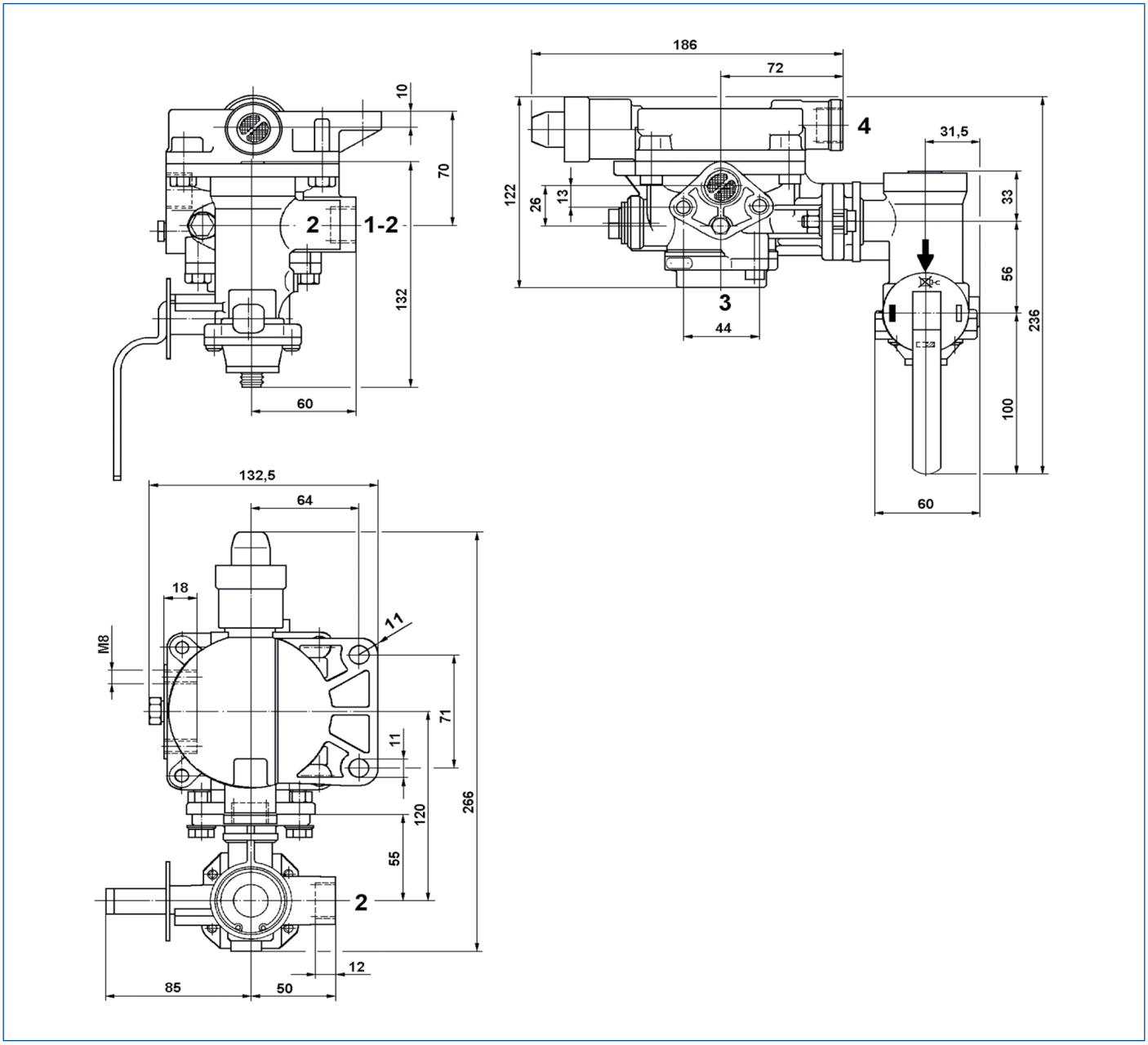
LEGEND					
1	Energy supply M 16x1.5	**1-2**	Energy supply or discharge (supply reservoir) M 22x1.5	**2**	Energy discharge M 22x1.5
3	Venting	**4**	Control connection M 22x1.5		

Seals between release valve and trailer brake valve:

- O-ring Ø 24 – 897 086 680 4
- O-ring Ø 8.9 – 897 086 670 4

WHEN NOT IN USE, SECOND PORT 2 MUST BE CLOSED USING	PRODUCT NUMBER
Screw plug M22 x 1.5	893 010 070 4
Ring seal A22 x 27 DIN 7603 - Al	811 401 080 4

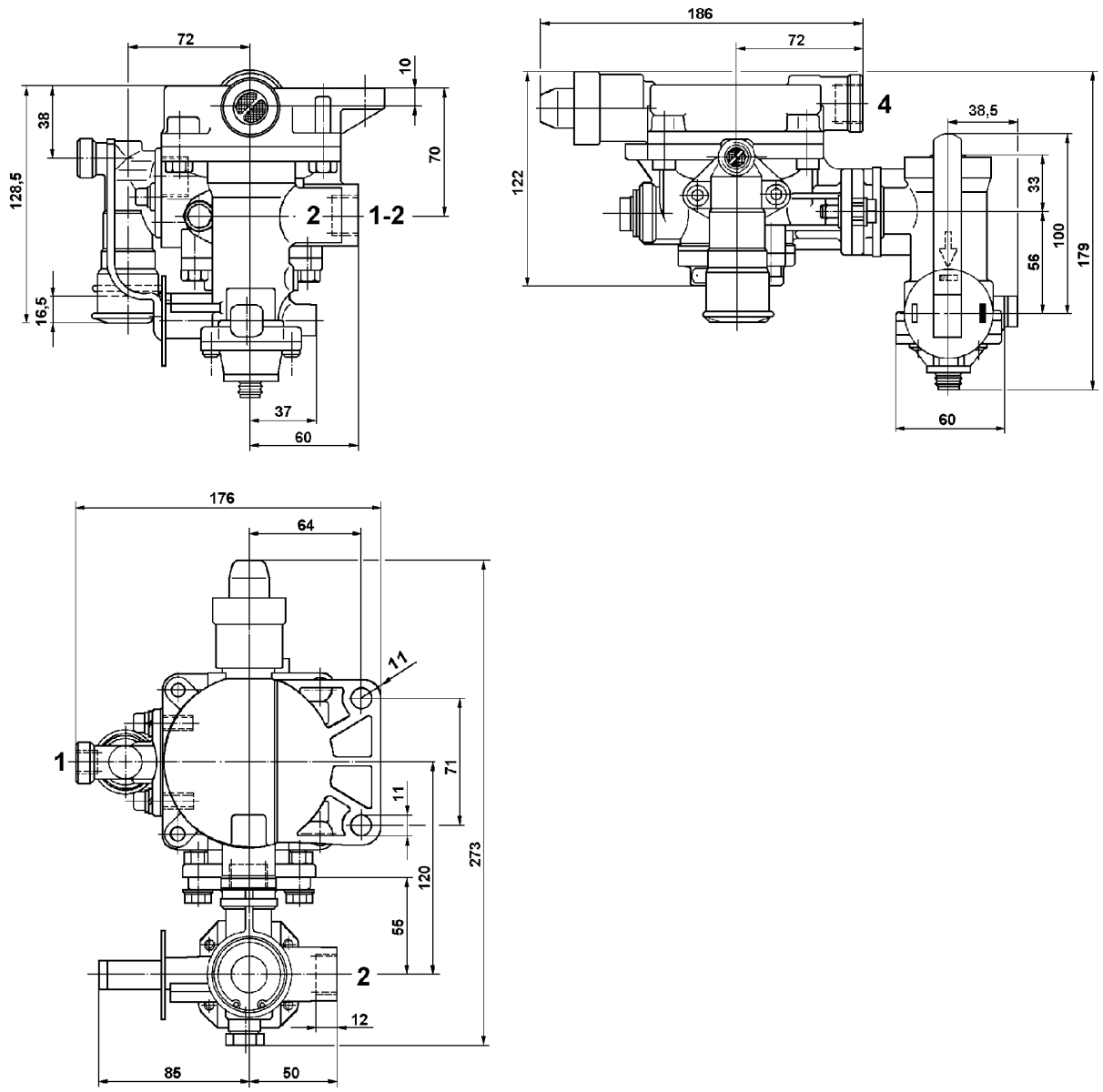
Installation dimensions for 971 002 570 0 – Combination of trailer brake valve 971 002 150 0 with load-sensing valve 475 604 011 0



LEGEND									
1	Energy supply M 22x1.5	**1-2**	Energy supply or discharge (Reservoir) M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting	4	Control connection M 22x1.5

Ring seal between load-sensing valve and trailer brake valve: 897 010 300 4

971 002 620 0 – Combination of trailer brake valve 971 002 150 0 with load-sensing valve 475 604 013 0 and release valve 963 001 012 0



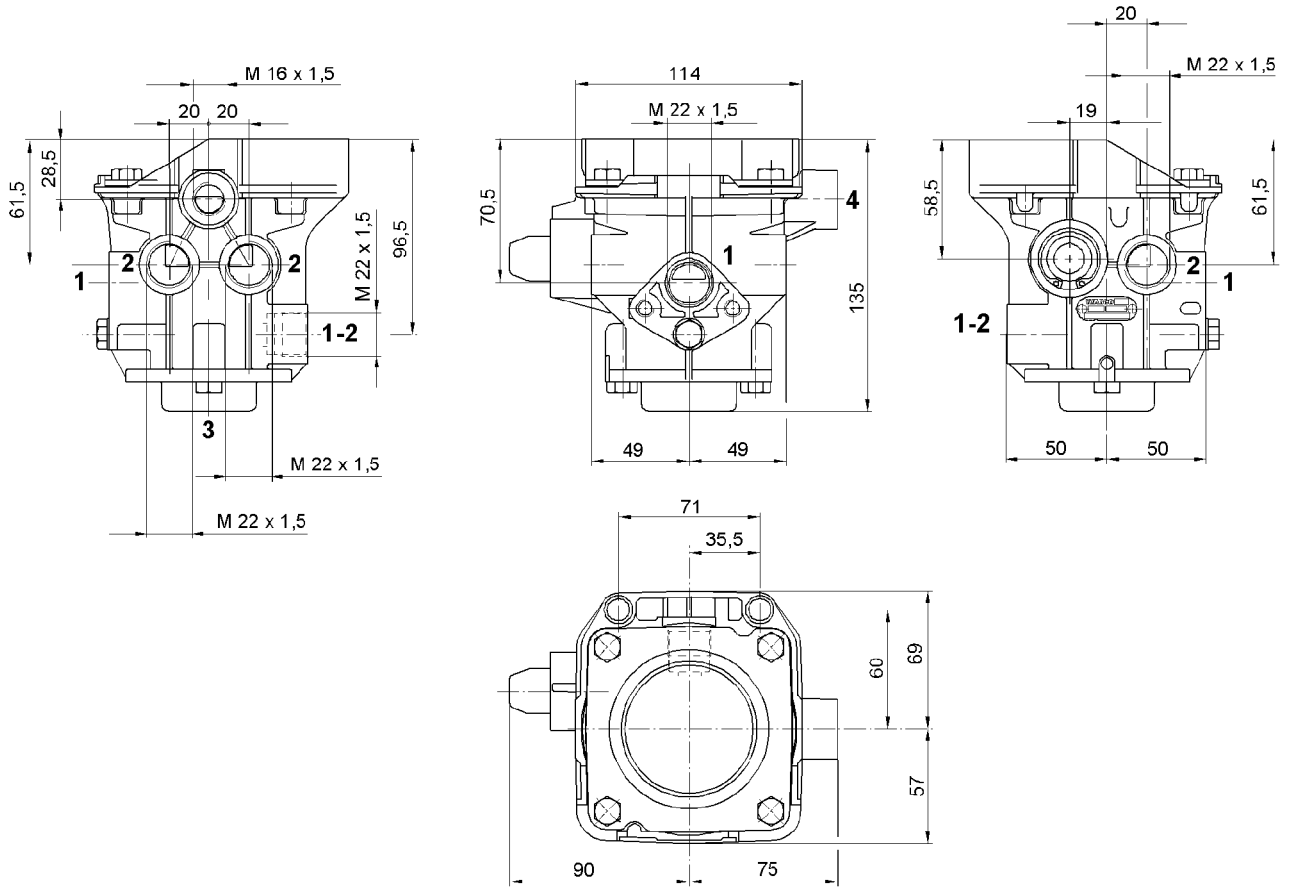
LEGEND							
1	Energy supply M 22x1.5	**1-2**	Energy supply or discharge (supply reservoir) M 22x1.5	**2**	Energy discharge M 22x1.5	4	Control connection M 22x1.5

Ring seal between load-sensing valve and trailer brake valve: 897 010 300

Seals between release valve and trailer brake valve:

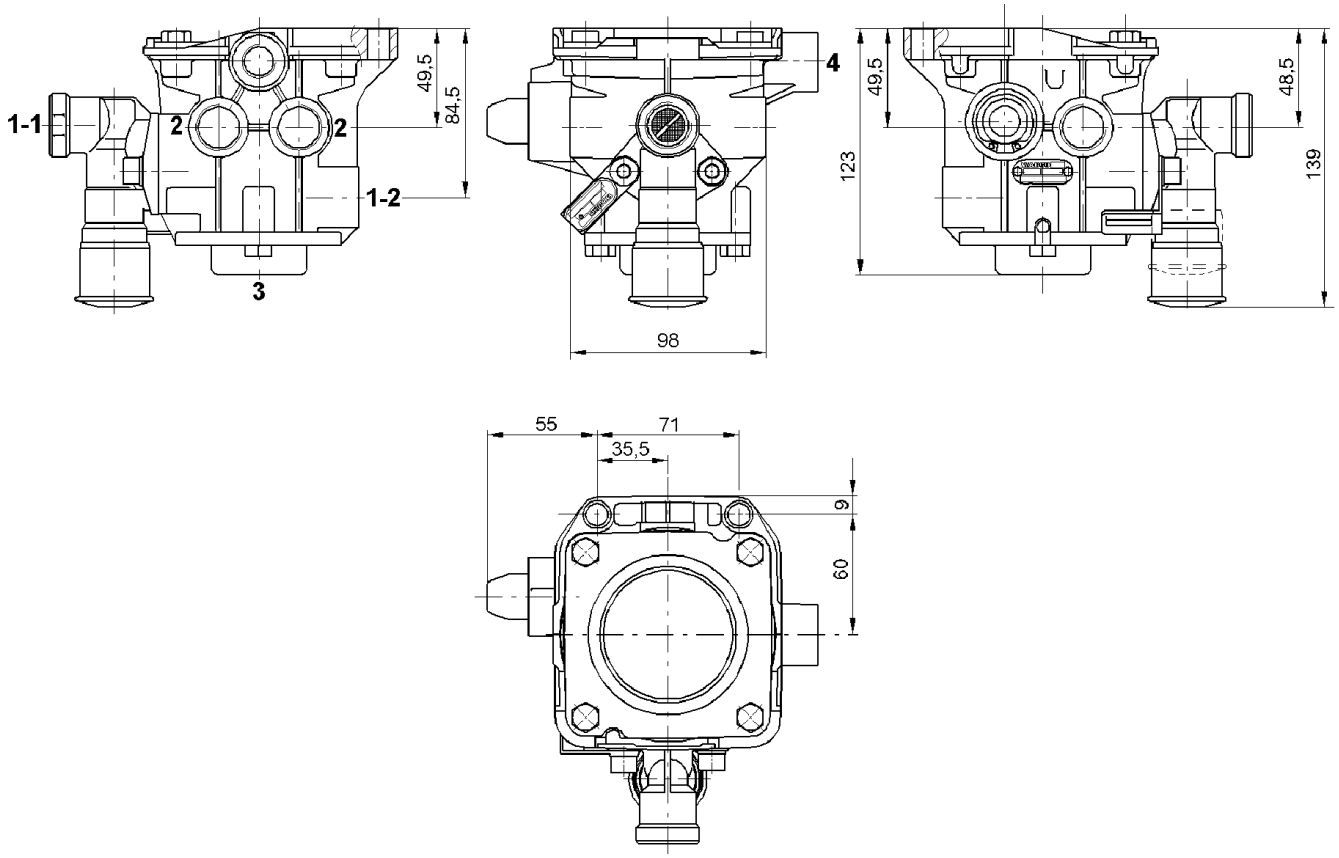
- O-ring Ø 24 – 897 086 680 4
- O-ring Ø 8.9 – 897 086 670 4

Installation dimensions for 971 002 300 0



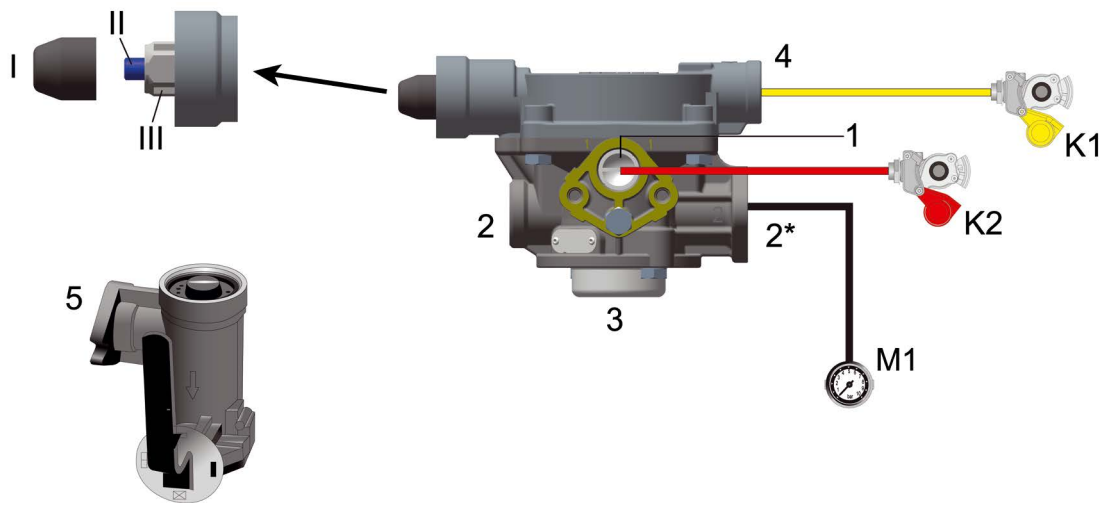
LEGEND									
1-2	Energy supply or discharge (Reservoir) M 22x1.5	**1**	Energy supply M 22x1.5	**2**	Venting M 22x1.5	**3**	Energy discharge M 22x1.5	4	Control connection M 16x1.5

Installation dimensions for 971 002 700 0



LEGEND					
1	Energy supply M 22x1.5	**1-2**	Energy supply or discharge (supply reservoir) M 22x1.5	**2**	Energy discharge M 22x1.5
3	Venting	**4**	Control connection M 16x1.5		

Adjusting the trailer predominance

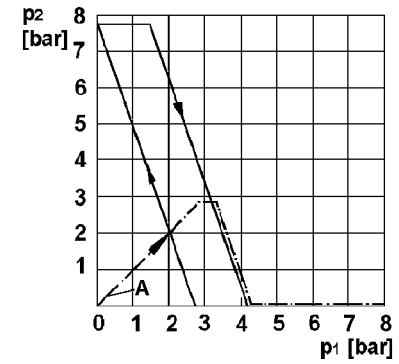


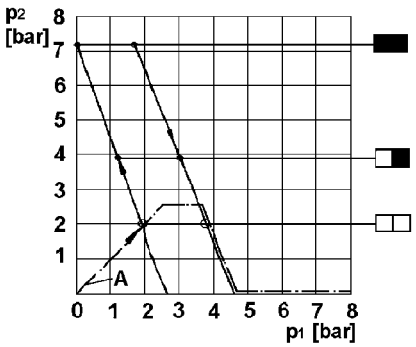
– Fit a test connection (if none is provided) and a pressure gauge M1 to connection 2*.
– Remove the rubber cap I.
– Apply full supply pressure of 7.3 bar to port 1 (coupling head "supply red").
– Apply a pressure of 2.0 bar to port 4 (coupling head "brake yellow").
– The pressure gauge M1 (at the test port) must indicate a pressure of 2 $^{+0.2}$ bar.
– Adjust the grub screw to set the predominance of 0 to max. 1 bar. When doing this, secure the plastic nut III.
– Fit the rubber cap I.

Note: When moving the vehicle, the load-sensing valve must be set to the right position for the load being transported on the trailer.

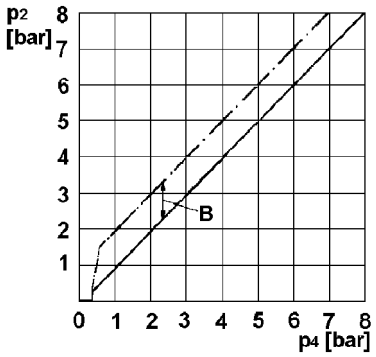
Pressure diagrams

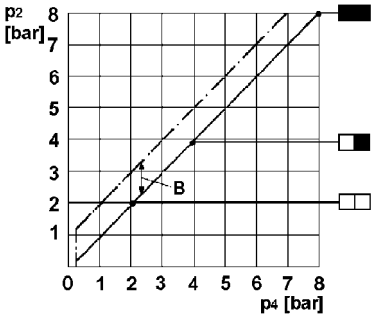
Automatic braking





Service brake application





LEGEND									
p_1	Input pressure	p_2	Output pressure	p_4	Control pressure	A	Initial fill	B	Setting range

Unladen

Half laden

Fully laden

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.58 Relay valve 973 001 / 973 011

Design types

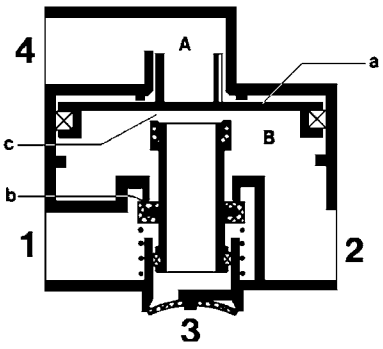
973 001

973 011

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.

Operating principle



When the braking system is actuated, the compressed air flows via the port **4** into the chamber **A** and moves the piston (**a**) downwards. This causes the outlet (**c**) to close and the inlet (**b**) to open. The supply air at the port **1** now flows into the chamber **B** and via the port **2** to the downstream brake cylinders.

The pressure building up in the chamber **B** acts on the bottom of the piston (**a**). As soon as this pressure is slightly higher than the control pressure in the chamber **A**, the piston (**a**) moves upwards. The inlet (**b**) closes and a final position is reached.

If there is a partial reduction in pressure in the control line, the piston (**a**) is moved upwards again, causing the outlet (**c**) to open, and the excess pressure at the port **2** escapes into the open air through the vent **3**. To completely relieve the control pressure at the port **4**, the pressure in the chamber **B** moves the piston (**a**) to its top end position and the outlet (**c**) opens. The downstream brake cylinders are fully vented via the vent **3**.

Technical data

PRODUCT NUMBER		973 001 010 0	973 001 020 0	973 011 000 0
Max. operating pressure [bar]	p_1	22		13
	p_2	8	10	
	p_4	8	10	
Port threads		M 22x1.5	1 = M 22x1.5 2, 4 = M 16x1.5	1, 2 = M 22x1.5 4 = M 16x1.5
Thermal range of application [°C]		-40 to +80		
Weight [kg]		1.1		0.6

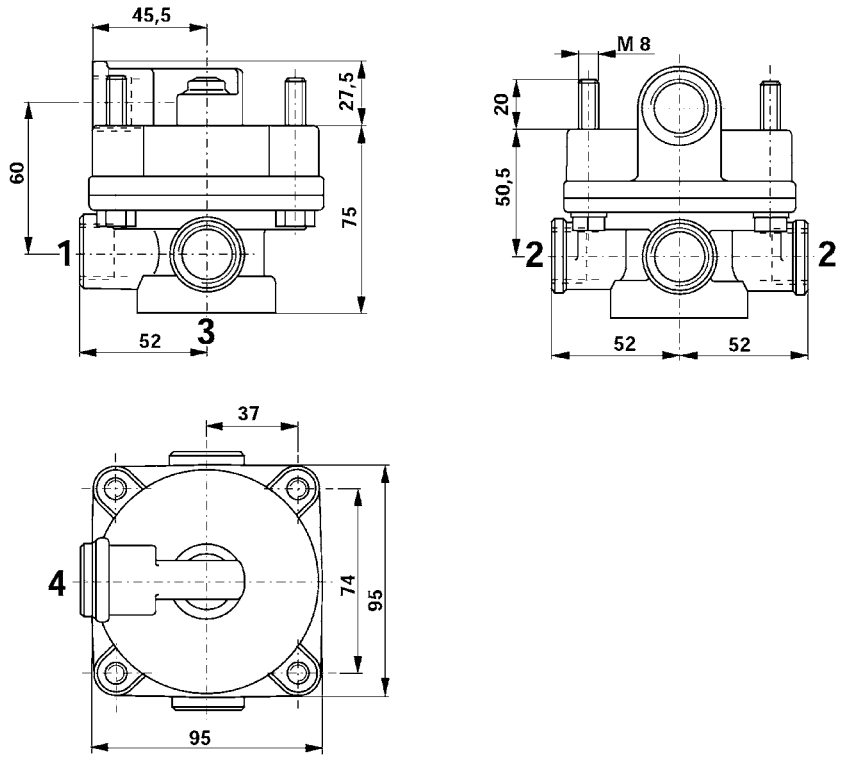
Installation recommendation

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

Install the relay valve so that the vent **3** faces downwards. For version 973 011 000 0, a deviation of ± 90° is permitted.

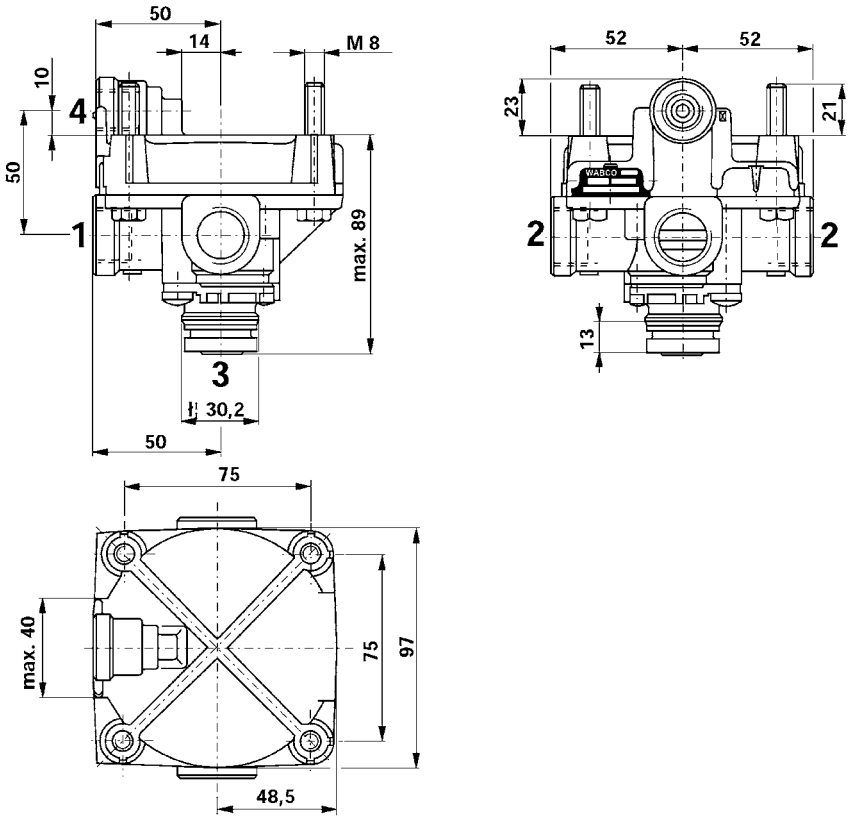
Fasten the relay valve with either two of the four M8 housing fastening screws.

Installation dimensions for 973 001 010 0



LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**4**	Control connection M 22x1.5

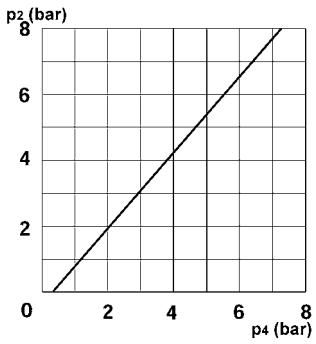
Installation dimensions for 973 011 000 0



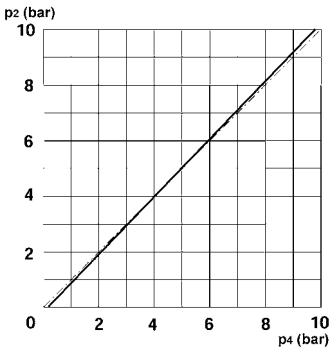
LEGEND							
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting	**4**	Control connection M 16x1.5

Pressure diagrams

973 001 010 0 / 973 001 020 0



973 011 000 0



LEGEND			
p_2	Output pressure	p_4	Control pressure

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.59 Quick-release valve 973 500

Design types

973 500 000 0

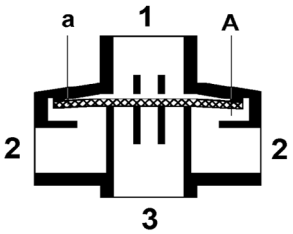
973 500 051 0

Purpose

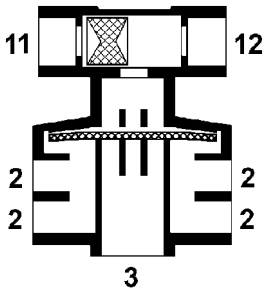
Quick-release valves vent longer control cables or brake lines and brake cylinders very quickly. The brake is therefore released without a delay.

Operating principle

973 500 000 0



973 500 051 0



In an unpressurised state, the slightly prestressed diaphragm (**a**) lies on the vent **3** and closes with its outer edge the passage from the port **1** to the chamber **A**. Compressed air flowing through the port **1** pushes back the outer edge and flows to the downstream brake cylinders via the ports **2**.

If the pressure at the port **1** falls, the higher pressure in the chamber **A** forces the diaphragm (**a**) to arch upwards. The downstream brake cylinders are now partially or completely vented via the vent **3** corresponding to the reduction in pressure at the port **1**. The quick release valve 973 500 051 0 is equipped with an integrated double cut-off valve, enabling actuation and venting of the Tristop® cylinder via an upstream double release valve.

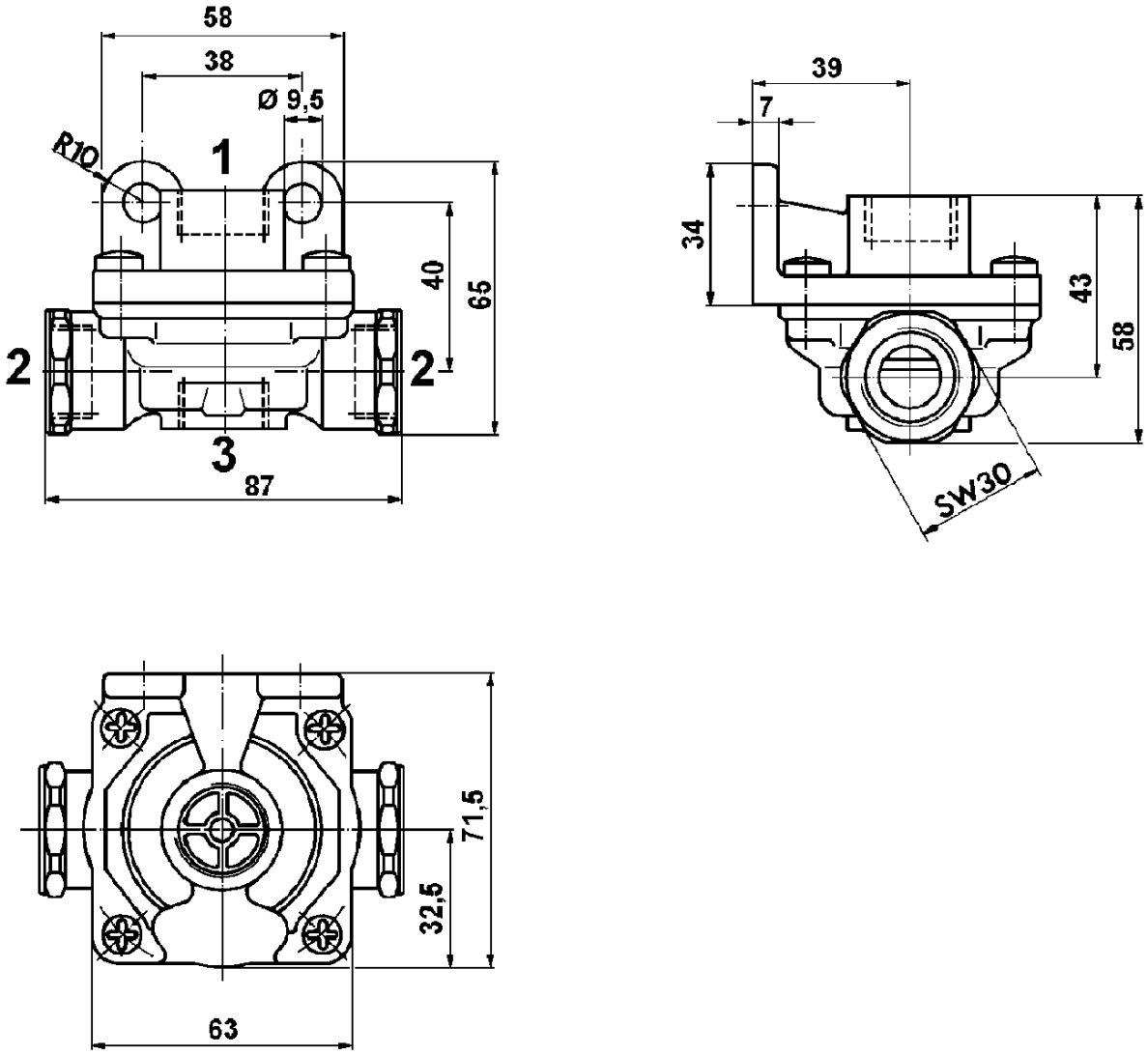
Technical data

PRODUCT NUMBER	973 500 000 0	973 500 051 0	973 500 053 0
Max. operating pressure [bar]	12		
Thermal range of application [°C]	-40 to +80		
Nominal width [mm]	14	-	-
Weight [kg]	0.3	0.4	0.5

Installation recommendation

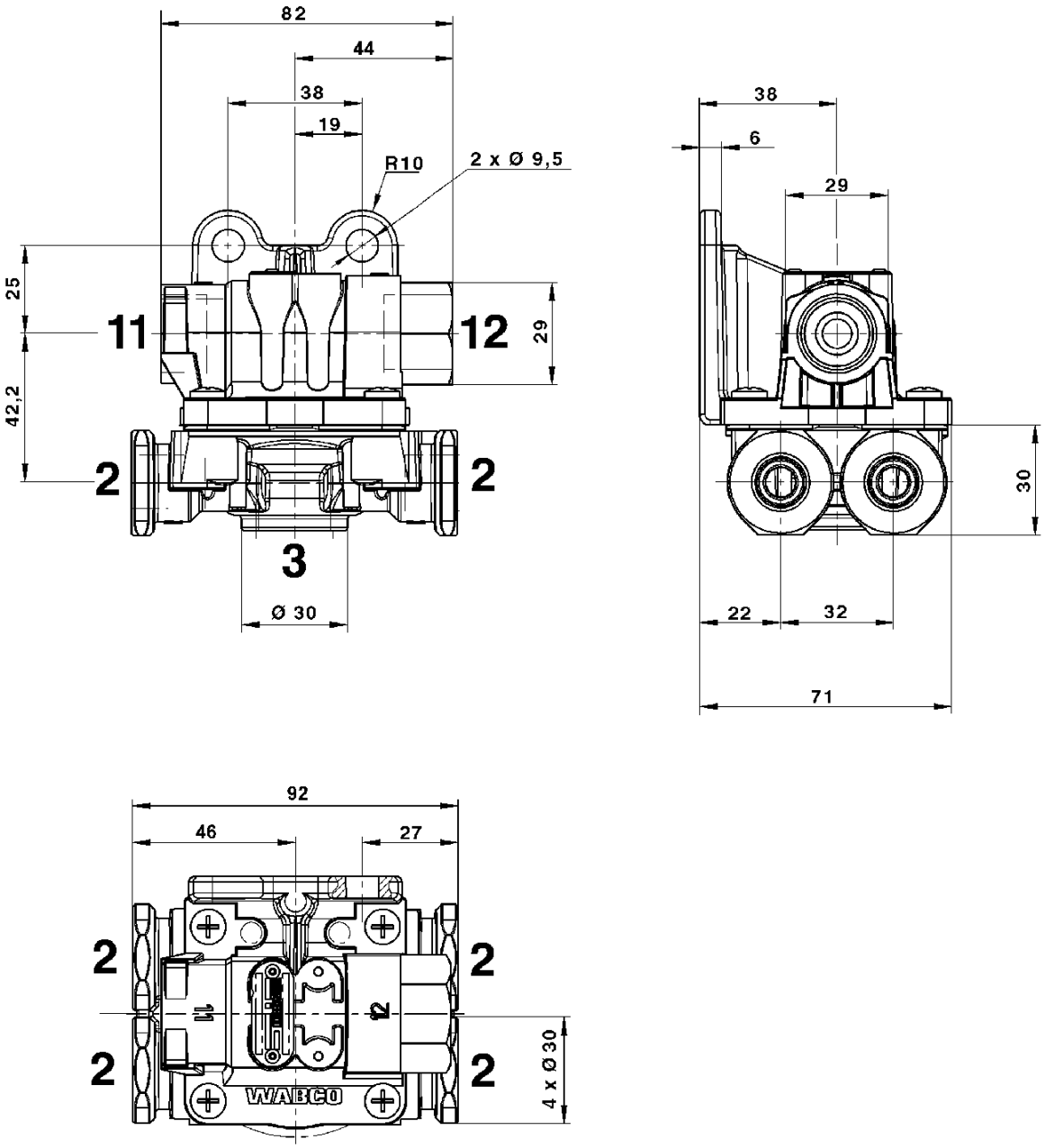
- Install the quick release valve vertically so that the vent 3 faces downwards.
- Fasten the quick release valve with two M8 screws.

Installation dimensions for 973 500 000 0



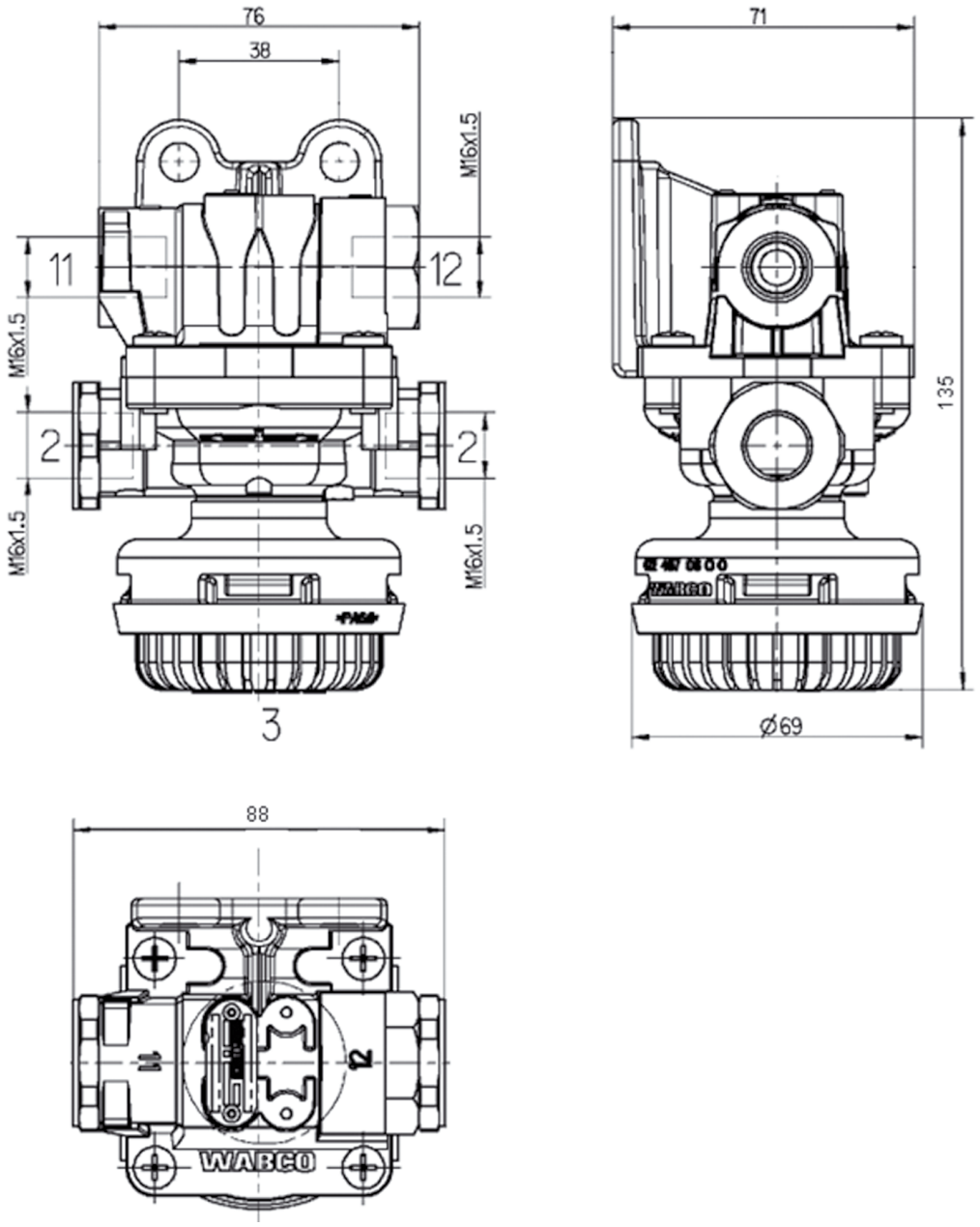
LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting

Installation dimensions for 973 500 051 0



LEGEND					
2	Energy discharge M 16x1.5 (4x)	**3**	Venting M 22x1.5	**11, 12**	Energy supply M 22x1.5

Installation dimensions for 973 500 053 0



LEGEND					
2	Energy discharge M 16x1.5 (4x)	**3**	Venting	**11, 12**	Energy supply M 16x1.5

Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

5.60 Pressure ratio valve with straight characteristic curve 975 001

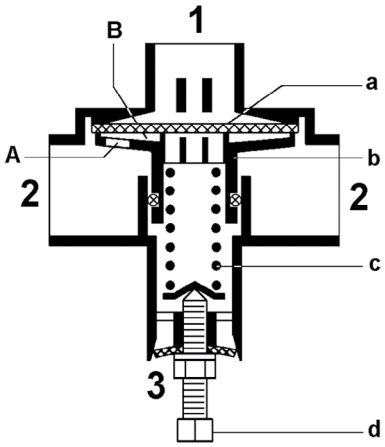
Design

Purpose

Pressure ratio valves reduce the braking force of adjusting axles during partial braking actions and quickly vent the brake cylinder.

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.

Operating principle



The piston (**b**) is held in its top end position by the force of the compression spring (**c**). The diaphragm (**a**) closes the passage from the port **1** to the ports **2**. When the braking system is actuated, the compressed air flows via the port **1** to the top of the diaphragm (**a**), where force builds up. As soon as this force exceeds the force of the compression spring (**c**) set with the screw (**d**), the piston (**b**) is forced downwards. The compressed air flows over the outer edge of the diaphragm (**a**) and via the ports **2** to the downstream brake cylinders.

The pressure building up at the ports **2** also acts on the underside of the diaphragm (**a**) and supports the force of the compression spring (**c**). As soon as this force is greater than the force acting on the top of the diaphragm (**a**), the piston (**b**) is moved back to its top end position. A final position has now been reached. If the pressure at the port **1** continues to increase, the force of the compression spring (**c**) is gradually overcome, and the compressed air finally reaches the brake cylinders without any loss. After the pressure at the port **1** is relieved, the compression spring (**c**) forces the piston (**b**) up to its top position. The pressure in the chamber **B** causes the diaphragm (**a**) to arch upwards. Depending on the reduction in pressure at the port **1**, the brake cylinders are vented either partially or fully via the bore **A** and the vent **3**.

Technical data

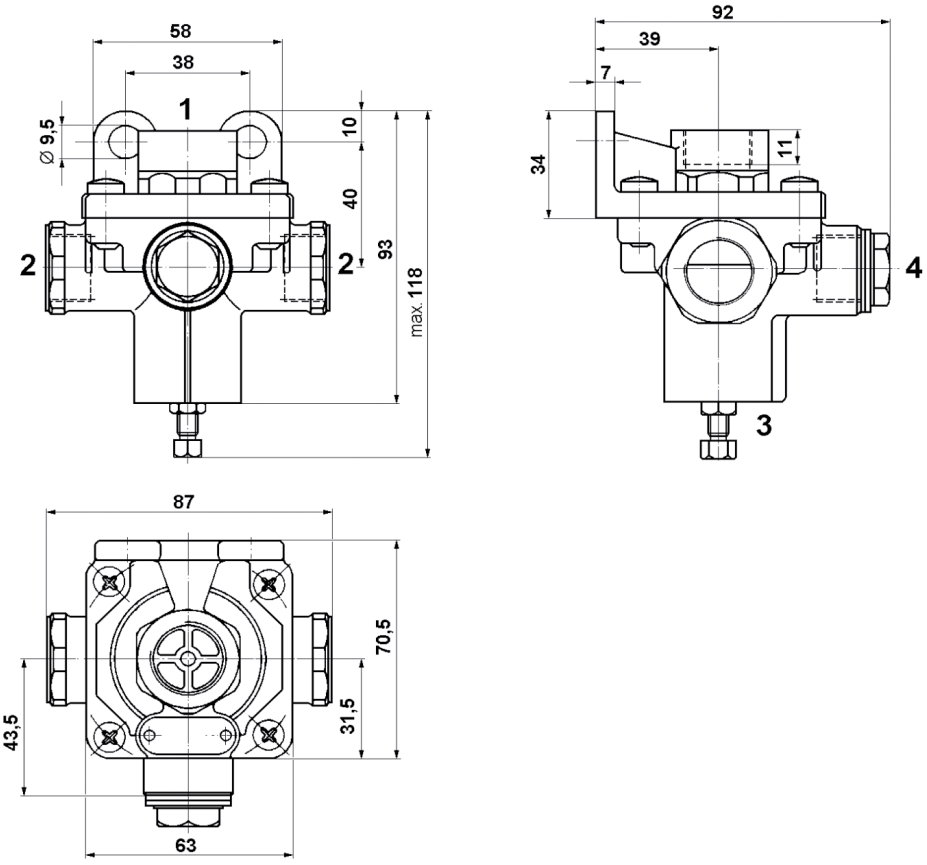
PRODUCT NUMBER	975 001 000 0	975 001 001 0	975 001 002 0	975 001 500 0
Max. operating pressure [bar]	8			10
Setting range [bar]	0.3 to 1.6			
Set to [bar]	0.7 ± 0.1	1.0 ± 0.1	0.5 ± 0.1	0.7 ± 0.1
Nominal width [mm]	12			

PRODUCT NUMBER	975 001 000 0	975 001 001 0	975 001 002 0	975 001 500 0
Thermal range of application [°C]	-40 to +80			
Weight [kg]	0.6			0.7

Installation recommendation

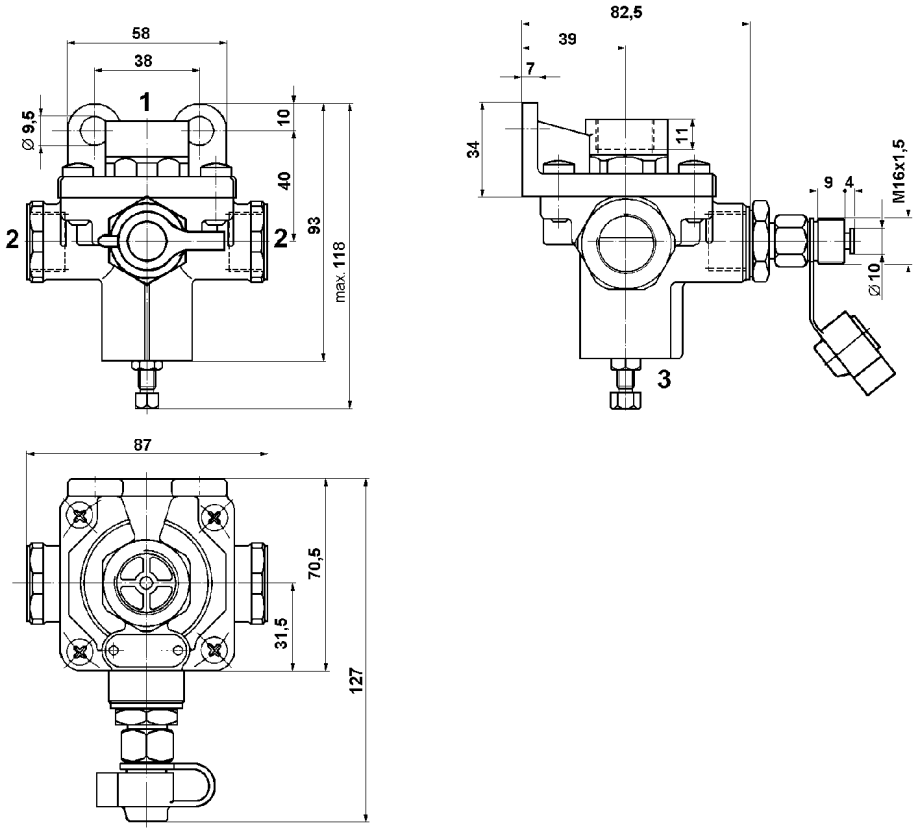
Mount the adapter valve half way between the two brake cylinders of the axle to be adapted. Install the pressure ratio valve vertically so that the vent **3** faces downwards. Fasten the pressure ratio valve with two M8 screws.

Installation dimensions for 975 001 000 0



LEGEND							
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting	**4**	M 22 x 1.5

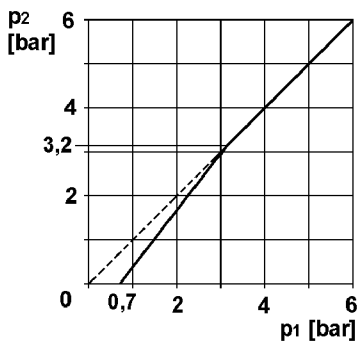
Installation dimensions for 975 001 500 0 – Combination of pressure ratio valve 975 001 XXX 0 with test valve 463 703 XXX 0



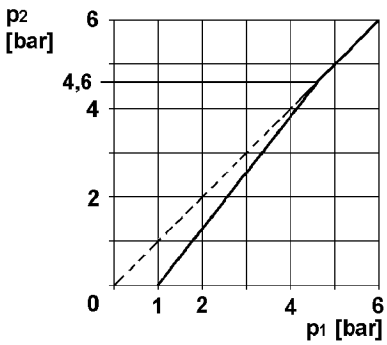
LEGEND					
1	Energy supply M 22x1.5	**2**	Energy discharge M 22x1.5	**3**	Venting

Pressure diagrams

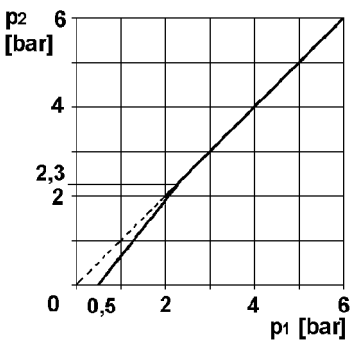
975 001 000 0
975 001 500 0



975 001 001 0



975 001 002 0



Maintenance

Special maintenance that extends beyond the legally stipulated inspections is not required.

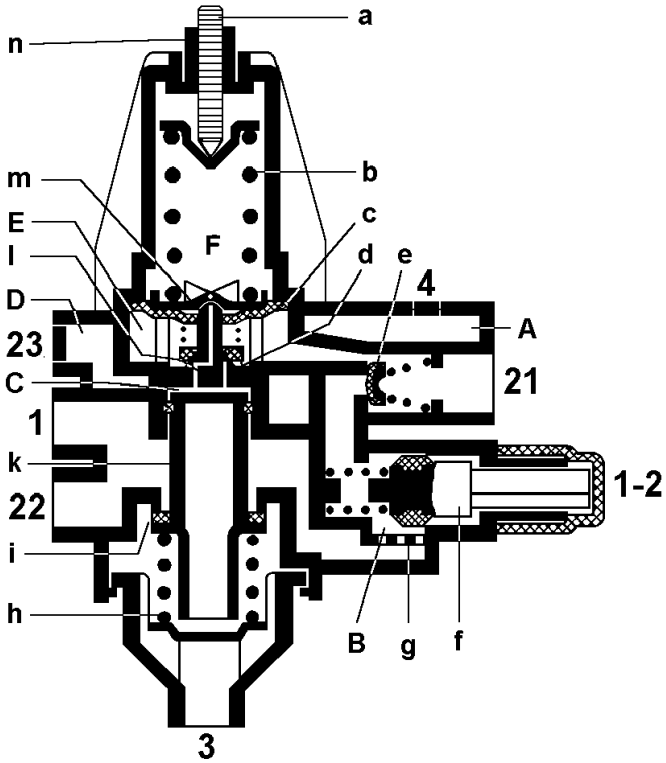
5.61 Unloader valve 975 303

Design

Purpose

Unloader valves automatically regulate the operating pressure in a pneumatic braking system and keep the piping and valves free of impurities. Depending on the variant being used, it also controls the downstream automatic anti-freeze pump or the single chamber air dryer.

Operating principle



Unloader valve

The compressed air conveyed by the compressor flows via the port **1** and filter (**g**) to the chamber **B**. When the check valve (**e**) opens, the air flows to the air reservoirs and into the chamber **E** via the line leading from the port **21**. The port **22** is intended to be used to control a downstream anti-freeze pump.

Pressure builds up in the chamber **E**, which acts on the underside of the diaphragm (**c**). As soon as the pressure is greater than the force of the compression spring (**b**) set with the screw (**a**), the diaphragm (**c**) arches upwards and takes the piston (**m**) with it. The outlet (**l**) closes and the inlet (**d**) opens, so that the compressed air in the chamber **E** flows into the chamber **C**, and the piston (**k**) moves downwards against the force of the compression spring (**h**). The outlet (**i**) opens, and the compressed air conveyed by the compressor escapes into the open air via the vent **3**. The fall in pressure in the chamber **B** causes the check valve (**e**) to close and the pressure in the system is reliably maintained. The compressor now continues running at idling speed until the pressure in the system has dropped below the cut-in pressure of the unloader valve. The pressure in the chamber **E** below the diaphragm (**c**) is relieved as well. The diaphragm is then forced downwards together with the piston (**m**) by the force of the compression spring (**b**).

The inlet (**d**) closes, the outlet (**i**) opens, and the air from the chamber **C** escapes into the open air via the chamber **F** and a connecting hole at the vent **3**. The compression spring (**h**) moves the piston (**k**) upwards and the outlet (**i**) closes. The compressed air conveyed by the compressor now flows through the filter (**g**) into the chamber **B**, and opens the check valve (**e**). The system is filled again until the cut-off pressure of the unloader valve has been attained.

Unloader valve with control port 4 and port 23

The operating principle of this type of unloader valve only varies from the one described above in the way that the cut-off pressure is controlled. This is not taken from inside the unloader valve, but from the supply line downstream of the air dryer. The connection between the chambers **B** and **E** is closed and there is no check valve (**e**). The supply air flows via the port **4** and the chamber **A** into the chamber **E** and acts on the diaphragm (**c**). The process continues as described under **a**. The connection between the chambers **C** and **D** is open, so that the control pressure from the chamber **C** can also be used to control the single chamber air dryer via the port **23**.

Tyre valve

After the protective cap has been removed, the tappet (**f**) is moved by screwing on the union nut of the tyre filling hose. The connection between the chamber **B** and the port **21** is interrupted. The compressed air conveyed by the compressor now flows from the chamber **B**, past the tappet (**f**), and into the tyre filling hose. If the pressure in the system exceeds 12+2 bar respectively 20 bar during this process, the piston (**k**), which is designed to act as a safety valve, opens the outlet (**i**) and the pressure escapes into the open air via the vent **3**.

Before filling the tyre, the air reservoir pressure must be relieved so that is less than the cut-in pressure of the unloader valve because no air can be extracted while the compressor is running at idling speed.

Technical data

PRODUCT NUMBER	975 303 060 0	975 303 441 0	975 303 447 0	975 303 473 0	975 303 580 0
Max. operating pressure [bar]	25				
Medium temperature [°C]	-40 to +150				
Ambient temperature [°C]	-40 to +100				
Installation position	α = 0° to 15°				
Weight [kg]	0.75				
Tyre 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				
Port 23/4	no				
Opening pressure of integrated safety valve [bar]	12 +2				20 +1/-2

Further variants with different cut-out pressures are available on request.

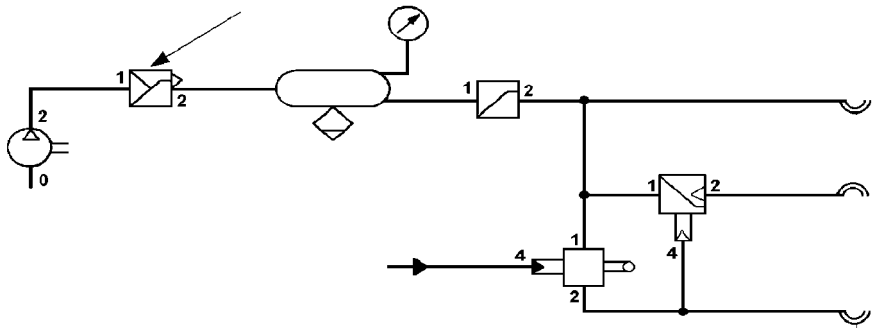
Installation recommendation

- Install the unloader valve so that the vent faces downwards.
- Fasten the unloader valve with two M8 screws.
- When installing the unloader valve, make sure that it is positioned above the level of the air reservoir. The air flow rate must not exceed 400 l/min.

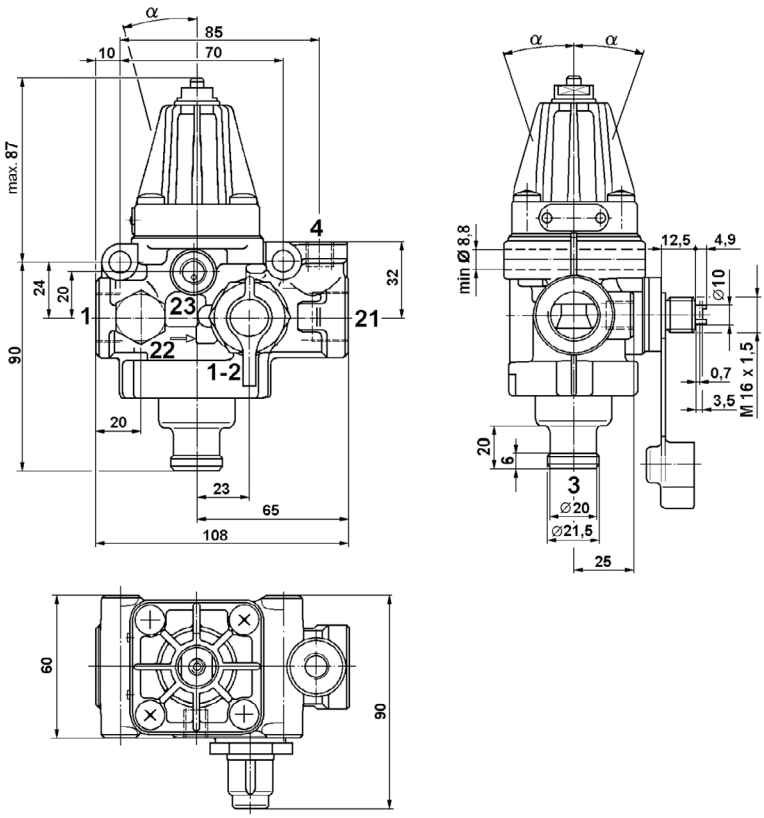
Note: To cool the heated compressed air, a pipe sized 18x1.5 to 2 m in length (possibly in a coil) should be fitted between the compressor and unloader valve to ensure that the temperature of the air flow at the unloader valve air inlet does not exceed +150 °C. On account of the risk of renewed heating in the air pressure line, never run the line close to an exhaust pipe or other heat-radiating parts of the engine.

To prevent damaging vibrations from being transmitted from the compressor and engine to the connection and mounting of the unloader valve affixed to the bulkhead or the vehicle chassis, part of the pressure line must be made flexible by using a special hose.

Installation diagram



Installation dimensions for 975 303 461 0



LEGEND					
1	Energy supply M 22x1.5	**3**	Venting	**4**	Control port M 12x1.5
21	Energy discharge M 22x1.5	**22**	Energy discharge uncontrolled (ancillary consumer) M 12x1.5	**23**	Energy discharge (control port, e.g. for single chamber air dryer) M 12x1.5

Maintenance

Clean the filter (**g**) at regular intervals depending on the operating conditions. Replace if necessary. If the setting of the unloader valve (cut-off pressure) has changed, you can correctly reset the pressure indicated in the table with the set screw (**a**), whereby the set nut (**n**) must not be twisted.

6 Installation recommendations

The installation of air compression equipment and pneumatic braking systems on tractors and trailers requires specially qualified workshop staff.

For this reason, this task should only be entrusted to authorised workshops (WABCO brake service) which, by regularly sending their staff on our technical courses, ensure the proper installation and functioning of the system as a whole. This also applies to inspections of the system in the event of faults developing during operation.

Although some tractor manufacturers already offer retrofitting kits that are usually intended for a specific type of vehicle, tractors and trailers frequently have to be retrofitted for which the manufacturer has not made any special provisions to accommodate pneumatic systems. This is where the specialist knowledge at the workshop becomes vital.

For safely mounting and driving the compressor, the workshop has to provide or specially make consoles, mountings and additional V-belt pulleys. Pneumatic systems on tractors should also be fitted in such a way that both the tractor's outer appearance and the use of additional equipment are not impaired.

6.1 Compressor

– Attach the compressor under the engine hood.

– During the installation, make sure that the console (about 8 mm plate thickness) is solid and fits flush against the engine housing. This ensures that the compressor runs without being subjected to excessive vibration and any risk of damage is avoided.

– Connect the suction side of the compressor with the engine filter (e.g. as a suction line).

– For heat-resistance reasons, seal the fitting required for the pressure connection with an aluminium ring on the outside and with a zinc ring on the inside. A fibre seal would carbonise in this location.

! At the pressure joint, the temperature of the air stream must not exceed 220 °C.

– Choose the location for the compressor so that a maximum of cooling air reaches the compressor from the fan.

– To lubricate the moveable parts, connect the compressor to the engine oil circuit with a 6x1 mm pipe.

  ⇨ The oil must be permitted to freely flow back to the oil sump. This means that there must be no rise in its reflux, and that a pipe with an inside diameter of at least 12 mm must be used.

6.2 V-belts and pulleys

The values for the compressor's driving mechanism generally apply as defined by the tractor manufacturers. Accurate alignment, the correct groove profile for the V-belt, and an appropriate belt tension are vital for the driving mechanism to function properly. The eccentricity values provided by the V-belt manufacturers are maximum values determined under specific circumstances.

Experience has shown that when fitting compressors to diesel engines, these eccentricity values can be excessive. The V-belt can expand and be destroyed prematurely. For this reason, the eccentricity should be kept as small as possible.

Narrow V-belts are preferably used in general engineering and in the motor vehicle industry. They permit top belt speeds whilst transmitting a maximum of energy. The small minimum diameters for the pulleys permit very small dimensions for the driving mechanism. In V-belt drives, the increased friction achieved by the V-shaped groove is utilised. The flanks of the fitted V-belt very effectively transmit the energy through their adherence friction and operate practically without slipping.

If properly designed, the efficiency of V-belt drives is more than 95 %. It is important that the use of narrow V-belts allows very small eccentricity values can be selected. Tension pulleys often used for increasing the arc of contact are required only if they are intended to tighten the belt; in this case, however, they should be used only so that they work from the inside outwards. The only maintenance required is to pay attention to the belt tension.

The eccentricity A should remain within predefined limits, i.e. it should be larger than 0.7 ($D_w + d_w$) and smaller than 1.5 ($D_w + d_w$).

D_w = Effective diameter of the large pulley

d_w = Effective diameter of the small pulley

Example

Crankshaft pulley D_w = 180 mm

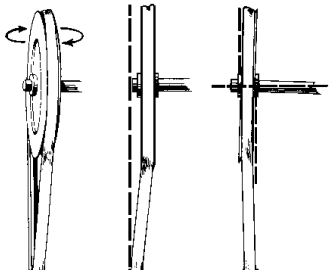
Compressor pulley d_w = 100 mm

$D_w + d_w$ = 280 mm

$A = 0.9 (D_w + d_w) = 0.9 \times 280 = 252$ mm

0.9 is an empirical value lying between 0.7 and 1.5.

Alignment errors



Before fitting the V-belt, always make sure that the pulley is not misaligned as shown above.

Proper eccentricity and alignment are vital to a long life for V-belts. Experience has shown that nearly all complaints regarding the drive following retrofitting are attributable to the errors described above.

For this reason, please make sure that proper and accurate V-belt pulley arrangements are selected and fitted.

This saves a lot of trouble and money.

Detailed information about V-belt pulleys is available free of charge from the manufacturer.

Basic principles for using V-belts

– Make sure that the driving mechanism is fitted with V-belts of the right number, type and size for the application.
To ensure that the V-belt sits properly in the groove of its pulley, V-belt pulleys that comply with DIN 2217 and Draft DIN 2211 must be used.

– Before you mount the V-belt pulleys, make sure that the grooves are free of burrs, rust and dirt.

– Put the V-belt on by hand without using any excessive force and with the smallest possible eccentricity - without using any mechanical implements.

– Apply tension to the V-belt.

  ⇨ After a running-in period of approx. 15 minutes (at full load), the V-belt will have "adapted" to the pulley grooves and undergone a certain amount of stretching.

– Retighten the V-belt.
A standard value is an initial expansion of between 0.5 and 1% of the V-belt's overall length.

– After initial re-tightening, the tension should be checked at regular intervals. Insufficient tension can cause premature damage to the V-belt and cause slippage.

! Standard V-belts must be adequately kept away from and protected against oil, grease and chemicals. It may be necessary to use special "OS" types.

The use of belt wax or similar materials is not only unnecessary but also harmful.

Standard V-belts are suitable for sustained temperatures of up to 70 °C; at higher temperatures, their life will be negatively affected.

Excess strain on the V-belt is an indication that the driving mechanism is not properly designed. Trying to achieve a higher performance by excessively tightening a V-belt will result in broken V-belts and slight bearing damage.

Multi-groove V-belt pulleys require the use of a properly designed set of V-belts. By submitting the V-belts to dynamic tests, the manufacturers ensure that the lengths of the V-belts in the set do not exceed the very small range of permissible tolerances. For this reason, only use tested and properly configured sets. If individual V-belts have to be replaced, a complete set of new V-belts should be fitted onto driving mechanism since, of course, used and new V-belts do not run together satisfactorily because of their different lengths (stretching). Used V-belts can obviously be combined to make a set.

If the use of a tension pulley becomes inevitable because the eccentricity cannot be changed, the pulley should only act on the V-belt from its inner circumference.

6.3 Air reservoir

! For further information, see chapter "6.7 Selection and arrangement of the air reservoirs" on page 243.

– Install the air reservoir underneath the running board, for instance, as here it is less likely to disturb the functionality of any other parts. Never mount an air reservoir on a mudguard!

  ⇨ It will then also form the lowest point in the compressed air system. The piping can then be fitted without water pockets forming, and the system can be drained at the most favourable location for that purpose.

6.4 Hand brake valve

For pneumatic trailer braking when the tractor-trailer combination is stationary.

– Install the hand brake valve as close as possible to the hand brake lever and connect the two with the ball and socket joints.

– Set the valve so that in the release position the balls rest in their sockets without any strain.

6.5 Tyre valve

The tyre valve should always be part of the unloader valve.

Numerous unloader valve variants are available with an integrated tyre valve.

6.6 Testing the system

Leak test

– Fill up the system until the unloader valve switches off.

– Switch off the engine.

– Check all connections for leaks using soap suds.
The system is considered to have no leaks if the pressure does not drop by more than 0.2 bar within a period of 5 minutes.

– Particularly with high-pressure systems, all screw connections should be checked, especially in the high pressure section, after an initial warm-up and after the cut-out pressure has been reached before applying soap suds to the connections.

"Single line braking system" functional test

– Connect a pressure gauge to the coupling head of the single line braking system (display range approx. 10 bar).

Hand brake
When the hand brake is released, the trailer control line must be charged (pressure reading at the coupling head is between 5.0 and 5.4 bar).
When the hand brake is applied, the trailer control line must be vented (pressure reading at the coupling head is 0 bar).

– Readjust the linkage if necessary and secure the setting with the lock nut.

Trailer control valve (961 103 XXX 0)

– Check that the pressure gauge on the coupling head indicates 5.0 to 5.4 bar when the brake is not actuated.

– Block the tractor with its rear axle up so that you can turn the wheels freely.

– Check that both wheels brake evenly by actuating the parking brake and the service brake.

  ⇨ Readjust the brakes if necessary.

– Connect a gauge to the coupling head "Brake" (yellow) as well.

– Slowly push down the pedal-operated brake valves (trailer control valve and compensator actuation) while locked.

  ⇨ At a pressure of 1.0 bar at the coupling head "Brake" (yellow), a pressure drop of 0.5 to 2.0 bar must be indicated on the gauge of the coupling head "1-line" (black).
  At full brake application in the tractor, the pressure gauge at the black coupling head must not indicate any pressure.

– Make any required corrections using the return springs on the foot brake lever.

"Dual line braking system" functionality test

– The pressure gauge connected to the coupling head of the supply line (red) must indicate a pressure of between 7.0 and 8.1 bar.

– Connect a pressure gauge to the coupling head of the brake line (yellow) (display range approx. 10 bar).

Hand brake valve

When the hand brake is released, the trailer's control line (yellow) must be vented (pressure reading at the coupling head = 0 bar).
When the hand brake is applied, the trailer brake line (yellow) must be charged (pressure reading at the coupling head is between 7.0 and $8.1^{+0.2}$ bar).

– Readjust the linkage if necessary and secure the setting with the lock nut.

Trailer control valve (961 106 XXX 0)

– Make sure that the reading at the coupling head (yellow) does not indicate any pressure when the brake is not actuated.

– Block the tractor with its rear axle up so that you can turn the wheels freely.

– Check that both wheels brake evenly by actuating the parking brake and the service brake.

  ⇨ Readjust the brakes if necessary.

– Slowly push down the pedal-operated brake valves (trailer control valve and compensator actuation) while locked. At the same time, manually turn one rear wheel.

  ⇨ As the brake starts to take effect (wheel can still be turned easily), the pressure gauge at the coupling head of the brake line (yellow) must indicate a rise in pressure of 1.5 bar.

– Make any required corrections using the return springs on the foot brake lever.

– After the performance test, the system must be inspected by the respective authorities.

6.7 Selection and arrangement of the air reservoirs

Air reservoirs for the braking system

The values listed in the table below have been taken from the calculating basis provided by the VDA (German Association of the Automotive Industry) and the annex to StVZO (German Motor Vehicle Construction and Use Regulation). To select the correct volume for the air reservoir, refer to the brake cylinder volume at the maximum permissible stroke. It can be taken from the specifications for the respective brake cylinder.

	OPERATING PRESSURE [bar]	CALCULATION PRESSURE [bar]	MAX. PERMISSIBLE DROP IN PRESSURE PER FULL BRAKING ACTION [bar] **)	VOLUME OF THE AIR RESERVOIR
Single line braking system				
Towing vehicle	4.8 to 5.3	4.5	0.3	min. 20x brake cylinder volume
Towing vehicle	6.2 to 7.3	6.0	0.7	min. 15x brake cylinder volume
Trailer *)	4.8 to 5.6	4.5	0.3 0.5	min. 8x brake cylinder volume (piston cylinder)
				min. 12x brake cylinder volume (diaphragm cylinder)
Dual line braking system				
Towing vehicle	6.2 to 7.3	6.0	0.7	min. 12x brake cylinder volume
Trailer	6.2 to 7.3	6.0	0.7	min. 8x brake cylinder volume (piston cylinder)
				min. 10x brake cylinder volume (diaphragm cylinder)

*) These values also apply to trailers fitted with a combined single and dual line braking system.

**) The permissible drop in pressure can also be calculated as follows:

$p_1 \times V_1 = p_2 \times V_2$ or $p_2 = p_1 \times V_1 / V_2$

This means that $\Delta p = p_1 - p_2$ or $\Delta p = p_1 - p_1 \times V_1 / V_2$

p_1	Reservoir pressure (absolute pressure) [bar]
p_2	Reservoir pressure (absolute pressure) after one full brake application [bar]
Δp	Pressure drop per full brake application [bar]
V_1	Reservoir volume [litres]
V_2	Reservoir volume plus all volumes of a full brake action [litres]

7 Maintenance and operating notes

Maintenance and operating notes for pneumatic braking systems on tractor-trailer combinations

Compressors

– Hand-filled compressors must have the oil level checked daily. To top up, use the same oil as for the engine. Change the oil at the same time as the engine oil.

  ⇨ The oil level shown must be between the markings on the dipstick.

! Compressors with a pressure oil connection do not need to have their oil level checked.

– Check the tension of the drive belt. Observe the respective specifications of the vehicle manufacturer.

Air reservoir

– Drain the reservoir daily.

Trailer control valve

– Lock the trailer control valve with the compensator actuation.
– Check both units to ensure that they pivot easily.
– Oil the pivot points.

Coupling head

– Close the cover on the coupling head when driving without a trailer.
– When driving the tractor with a trailer, make sure that the ring seals of the coupling heads are not damaged or dirty.
– Grease the seals regularly to increase the life-span.

Load-sensing valve

– Before moving off, bring the lever of the load-sensing valve into position for the load being transported.
– Check that the lever moves easily.

Coupling head

– Connect the coupling heads of the tractor unit after uncovering them and hook the trailer coupling heads onto the holders on the towbar bracket.

Air reservoir

– Drain the reservoir daily.

Weekly maintenance

– Check that the pressure on the gauge in the driver's cab does not exceed 0.2 bar after 5 minutes with the engine stopped.

  ⇨ Rectify any detected pressure loss.

– If the stroke of the brake cylinders on the trailer is 2/3 of the total stroke, the brake needs to be readjusted.
– Make sure that the condition and positioning of the dust protection gaiters are flawless.

Quarterly maintenance

– Clean all pipe filters of the brake unit with petrol and then dry them.
– Grease all moving parts and linkage on brake valves, brake cylinders and brake linkage.

General operating information

– If a trailer is hitched up, do not move off until the pressure gauge shows a reading of 5.0 bar.
– Check the effect of the foot and hand brakes taking into account the condition of the road surface: The trailer must not overrun the towing vehicle.

⚠ WARNING	**Danger from trailer rolling away when unhitching the trailer** A trailer rolling away can cause serious or fatal injuries. Secure the trailer against rolling away when unhitching it. – *First disconnect the red coupling head (supply).* – *Then disconnect the yellow coupling head (brake).*

⚠ WARNING	**Danger from trailer rolling away when hitching the trailer** A trailer rolling away can cause serious or fatal injuries. Secure the trailer against rolling away when unhitching it. – *First connect the yellow coupling head (brake).* – *Then connect the red coupling head (supply).*

Towing different trailers

– You have a tractor with an air compression system and two trailers, one of which has an pneumatic braking system and the other an overrun brake.
For safety reasons, the tractor-trailer combination should be connected as follows: tractor, trailer with run-up brakes, trailer with pneumatic air brakes.
Reason: Providing the braking system has been properly adjusted, the trailer that uses compressed air for its braking system has a slight lead time. This means that this trailer is braked before the tractor and the trailer is braked with the overrun brake.
The tractor-trailer combination cannot jackknife when braking!
To supply the rear trailer (the one with the pneumatic braking system) with compressed air, the trailer with the overrun brake which runs between the tractor and the trailer with the air brake must have an air line fitted.
Tests have proved that this is the only configuration for tractor-trailer combinations which allows safe braking!

! Trailers designed for speeds in excess of 25 km/h must be serviced at the intervals laid down in Annex VIII of StVZO.

8 Retrofitting

Your new tractor and trailer vehicles can be fitted with a WABCO air pressure braking system ex works which gives you optimum brake safety, including off-road, and enhances the driving comfort.

A WABCO compressed air braking system can be retrofitted as well. This is

also recommendable for older vehicles from both the driver's point of view and the aspect of operational safety.

Adapter kits comprising original WABCO brake devices, accessories, diagrams, attachments and installation manual.

! Your WABCO partner will tell you which companies can assist you in retrofitting your vehicles with complete adapter kits.

9 Braking calculation data sheet

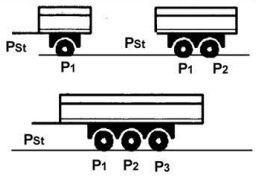
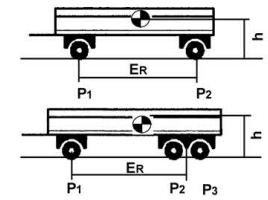
If you want to retrofit a trailer vehicle with a pneumatic braking system, you will need to calculate the required cylinder sizes, lever lengths and reservoir sizes by filling in all the details in the data sheet shown below.

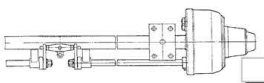
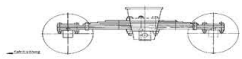
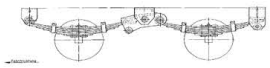
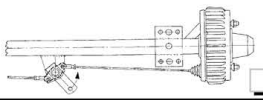
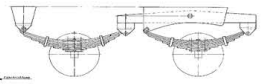
We will perform all the brake calculations that you will need to register your vehicle with the proper authorities. Please contact your WABCO partner.

WABCO

Bremsberechnungs-Datenblatt (§ 41 StVZO) für land- oder forstwirtschaftliche Anhängefahrzeuge

Die mit ☐ gekennzeichneten Felder sind entsprechend anzukreuzen !

Fahrzeughersteller:				**Fahrzeug-Typ:**	
max. zul. Geschwindigkeit	☐ bis 25 km/h			☐ über 25 km/h bis 40 km/h	
	☐ über 40 km/h bis 60 km/h			☐ über 60 km/h (ABS Pflicht)	
Land der Erstzulassung:				☐ Einleitung	☐ Zweileitung
Zentralachsanhänger				**beladen**	**leer**
	**Gesamtmasse**	P	kg		
	Stützlast	P_{St}	kg		
	tatsächliche Last Achse 1	P_1	kg		
	tatsächliche Last Achse 2	P_2	kg		
	tatsächliche Last Achse 3	P_3	kg		
	tatsächliche Last Achse 4	P_4	kg		
Deichselanhänger				**beladen**	**leer**
	**Gesamtmasse**	P	kg		
	tatsächliche Last Achse 1	P_1	kg		
	tatsächliche Last Achse 2	P_2	kg		
	tatsächliche Last Achse 3	P_3	kg		
	Schwerpunkthöhe	h	mm		
	vorhandener Radstand	E_R	mm		

Bremsentyp	**Aggregattyp**	
Nockenbremse	Waagebalken	Verbundaggregat ohne dyn. Ausgleich
 ☐	 ☐	 ☐
Spreizhebelbremse	Stummelachse	Achsaggregat mit dyn. Ausgleich
 ☐	 ☐	 ☐

Radbremshersteller:	(BPW / Knott / Peitz / ADR ...)		**TDB-Nr.:**		
Radbremstyp:	(siehe Typenschild auf Ankerplatte)				
Reifenbezeichnung:			**Hersteller:**		
Bremskraftregelung mit:	☐ Handregler		☐ ALB-Regler		
bei ALB-Regler:	☐ vor dem Anh.-Bremsv.		☐ nach dem Anh.-Bremsv.		
	☐ mit ABS (VCS)		☐ mit EBS		
gewünschte Zylinder:	☐ Kolbenzylinder	☐ Membranzylinder		☐ TRISTOP®	
welche Achse wird gebremst ?	**Achse**	**1** ☐	**2** ☐	**3** ☐	**4** ☐
Anzahl der zu verbauenden Zylinder auf dieser Achse	(1 o. 2)				
mögliche oder vorhandene Hebellängen	(mm)				

Absender:	**weitere Hinweise:**
Name:	
Tel.-Nr.:	
Fax-Nr.:	
e-mail:	

Bitte das Datenblatt so vollständig wie möglich und deutlich ausfüllen, da eine Berechnung sonst nicht möglich ist. Bei diesen Feldern ☐ entsprechend ankreuzen! 09/2011 WABCO

10 New EU 2015/68 regulation requirements

With Regulation EU 167/2013 on the „Approval and Market Surveillance of Agricultural and Forestry Vehicles“ the European Parliament and Council decided to improve the general safety level of agricultural and forestry vehicles. In particular braking systems of fast running vehicles should reach a safety level comparable to heavy trucks and trailers.

The technical requirements on braking systems of agricultural and forestry vehicles are defined in the Delegated Regulation EU 2015/68 of the European Commission and replaces from 1 January 2016 former guideline 1976/432/EEC.

The requirements of EU 2015/68 are valid for EU type-approvals of tractors and trailers. Chosen by the manufacturer trailers, track-laying tractors and single driven vehicles may also be approved according to national regulations.

In addition to EU 2015/68 the requirements of several other new Delegated Regulations e.g. for design and functional safety of the vehicles have to be fulfilled, that also influence the design of the braking system.

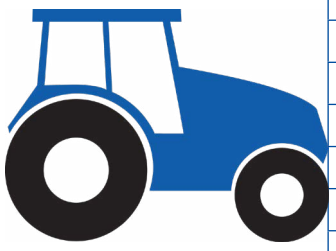
10.1 Most important provisions of EU 2015/68

The most important new or amended issues compared to 1976/432/EEC:

- Applicable also for trailers and interchangeable towed equipment
- Single line connections (pneumatic or hydraulic) are not permitted after 2019/20 (a potential transition period of 5 years is under discussion).
- Vehicles with vmax > 40 km/h must be fitted with automatic slack adjusters.
- Braking forces must be distributed between the axles of a vehicle as appropriate.
- Compatibility of the braking forces of tractors and trailers to reduce coupling forces
- Increased deceleration values required for service and parking brake systems
- Brakes of tractors with vmax > 30 km/h must act on all wheels; this can be realized by locking an interaxle differential.
- Brakes of trailers with vmax > 40 km/h must act on all wheels and distribute the braking forces in accordance with the load conditions.
- The secondary braking system of a tractor with vmax > 40 km/h must be capable of graduated braking of the towed trailer.
- Breakaway function for connections between tractor and trailer
- ABS functionality is required for tractors and trailers with vmax > 60 km/h from 2016. ABS functionality will be required for tractors with vmax > 40 km/h from 2020 if this is confirmed by an assessment by the European Commission that is to be conducted by the end of 2016.
- New requirements for vehicles fitted with an electronically controlled brake system (EBS)

10.2 Vehicle categories according to Regulation EU 167/2013

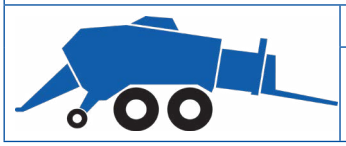
10.2.1 Tractors

On wheels			
	T1	TW > 1150 mm, UM > 600 kg, GC < 1000mm	Speed index: "a" for tractors V_{max} < 40 km/h "b" for tractors V_{max} > 40 km/h
	T2*	TW < 1150 mm, UM > 600 kg, GC < 600 mm	
	T3	UM < 600 kg	
	T4	Special purpose tractors	
	T4.1*	High-clearance tractors	
	T4.2	Extra-wide tractors	
	T4.3	Low-clearance tractors	
On tracks or tracks/wheels			
	C	Sub-categories see T category	Speed index: "a" for tractors V_{max} < 40 km/h "b" for tractors V_{max} > 40 km/h

TW = track width, UM = unladen mass, GC = ground clearance

*If the quotient of distance between the centre of gravity and the ground and track width is more than 0.9, the max speed is 30 km/h

10.2.2 Trailers and interchangeable towed equipment

Trailers			
	R1	Total permissible axle masses < 1500 kg	Speed index: "a" for trailers V_{max} < 40 km/h "b" for trailers V_{max} > 40 km/h
	R2	Total permissible axle masses 1500 - 3500 kg	
	R3	Total permissible axle masses 3500 - 21000 kg	
	R4	Total permissible axle masses > 21000 kg	
Towed equipment			
	S1	Total permissible axle masses < 3500 kg	
	S2	Total permissible axle masses > 3500 kg	

11 Structure of EU 2015/68

Both the structure and content of EU 2015/68 follow to a great extent UNECE Regulation 13, the braking regulation for on-road motor vehicles and their trailers.

The regulation comprises articles 1 to19 with references to 13 Annexes:

ANNEX	TITEL
I	Requirements applying to the construction and fitting of braking devices and trailer braking couplings
II	Requirements applying to the testing and performance of braking systems and trailer braking couplings and of vehicles fitted with them
III	Requirements applying to the measurement of the response time
IV	Requirements applying to energy sources and energy storage devices of braking systems and trailer braking couplings and to vehicles fitted with them
V	Requirements applying to spring brakes and to vehicles fitted with them
VI	Requirements applying to parking braking systems equipped with a mechanical brake-cylinder locking device
VII	Alternative test requirements for vehicles for which Type-I, Type-II or Type-III tests are not mandatory
VIII	Requirements applying to the testing of inertia braking systems, braking devices and trailer braking couplings and of vehicles fitted with them as regards braking
IX	Requirements applying to vehicles with hydrostatic drive and their braking devices and braking systems
X	Requirements applying to the safety aspects of complex electronic vehicle control systems
XI	Requirements and test procedures applying to anti-lock braking systems and to vehicles fitted with them
XII	Requirements applying to the EBS systems of vehicles with compressed-air braking systems or of vehicles with data communication via pin 6 and 7 of an ISO 7638 connector and to vehicles fitted with such an EBS system
XIII	Requirements applying to single line hydraulic connections and to vehicles fitted with them

The most important requirements for the vehicle categories are listed in the Regulation Requirements Matrix (see chapter "12 Table of new requirements" on page 262). For detailed information, please compare them against the relevant paragraphs in the respective regulations.

11.1 Definitions

Definitions are laid down in article 2 of EU 2015/68 and in most of the 13 annexes.

Most important definitions:

Service braking system means the braking system that enables the driver to control the movement of the vehicle and to halt it safely, speedily and effectively under all specified usagee conditions.

Secondary braking system means a system that enables the driver to halt the vehicle within a reasonable distance in the event of a failure of the service braking system.

Parking braking system means a system that enables the vehicle to be held stationary on an upward or downward gradient by purely mechanical means even in the absence of the driver.

Control device means the device actuated directly by the driver, i.e. the foot brake pedal(s) and the parking brake lever, to supply to the transmission with the energy required for braking or controlling the vehicle.

Transmission means the combination of the control device and brake components (e.g. the friction brake). It comprises control transmission, i.e. the combination of the components of the transmission which control the operation of the brakes and of the necessary reservoir(s) of energy, and the energy transmission, i.e. the combination of the components which supply the brakes with the energy they require to function correctly.

Automatic braking means the braking of the towed vehicle which takes place automatically in the event of a separation of any of the vehicles constituting the combination of vehicles, including separation caused by a breakage of the coupling and connecting lines.

11.2 Reduced requirements for braking systems

EU 2015/68 does not apply to tractors where v_{max} < 6 km/h. Nevertheless, these vehicles have to be fitted with a braking system with sufficient performance that can be easily activated while driving and which is capable of being locked when the vehicle is stationary.

Trailers with a maximum permissible weight < 750 kg do not require a separate braking system.

EU 2015/68 does not apply to mobile machinery.

11.3 Required braking systems

Agricultural vehicles have to be equipped with a service braking system with a graduated braking action. The driver of the vehicle must be able to effect this braking action without taking his hands off the steering wheel (EU 2015/68 Annex I 2.1.2.1, Oct. 2016).

A secondary braking system is also required. If a failure occurs in the service braking system, it must be possible for the driver to stop the vehicle with the secondary braking system while keeping at least one hand on the steering wheel. For tractors, this braking action must be graduated (EU 2015/68 Annex I 2.1.2.2, Oct. 2016).

The third required braking device is the parking braking system, which must enable safe parking of the vehicle on an upward/downward gradient in the absence of the driver by means of purely mechanical devices (EU 2015/68 Annex I 2.1.2.3, Oct. 2016).

Tractor service and secondary braking systems may comprise the same components.

Service and secondary braking system of tractors may consist of the same components.

11.4 Tractors (Category T & C)

Velocity classification	v < 30 km/h	v > 30 km/h
Minimum deceleration	3.55 m/s²	5.00 m/s²
Braking distance [m]	s = 0.15v + v²/92	s = 0.15v + v²/130
Parking brake	The parking brake system of a tractor that is permitted to tow trailer vehicles must be able to hold the vehicle combination stationary on a 12% upward/downward gradient.	

(Annex II, 3.1.1.1. and Annex I, 3.1.3.4., Oct. 2016)

11.5 Towed vehicles (Category R & S with service braking system)

Velocity classification	v < 30 km/h	v > 30 km/h
Minimum deceleration (X = % of stationary wheel load)	X = 35 %	X = 50 %
Parking brake	If the towed vehicle is fitted with a service braking system, the parking brake function must be assured even when it is separated from the towing vehicle.	

(Annex I, 2.2.2.10. and Annex II, 3.2.1.2., Oct. 2016)

11.6 Response time

11.6.1 Tractors equipped with compressed air braking systems

For the purposes of the response time test for vehicles fitted with a compressed air service braking system, the pressure in the energy reservoir at the beginning of the test must equal the pressure at which the governor on the vehicle starts to restore the system. In this test, the response time must correspond to an actuation time of 0.2 seconds. Several applications of the brake are therefore required, beginning with the shortest possible actuation time up to an actuation time of 0.4 seconds, which are to be plotted in a graph.

For the required actuation time, the response time for a pressure increase of 75% of its asymptotic value in the last favourable brake cylinder of the stationary vehicle must not exceed 0.6 seconds

11.6.2 Tractors with a pneumatic trailer control

For tractors fitted with a pneumatic trailer control system consisting of one supply line and one control line, the pressure is to be measured at the extremity of…

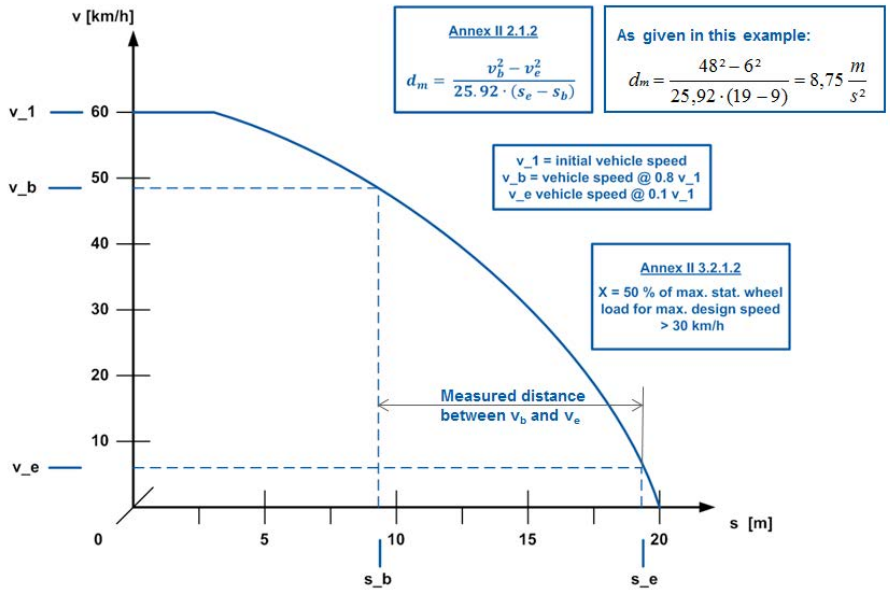
- … a pipe of 2.5 m in length with an inner diameter of 13 mm connected to the coupling head of the control line.
- … a volume of 385 ± 5 cm³ connected to the coupling head of the supply line.

The response time is measured in the control line and may not exceed 0.2 seconds between the initial actuation of the pedal and 10 % of the asymptotic pressure, as well as 0.4 seconds between the initial actuation of the pedal and 75 % of the asymptotic pressure.

11.6.3 Tractors equipped with hydraulic braking systems

The response time test for vehicles equipped with hydraulic braking systems is to be conducted at an ambient temperature between 15 °C and 30 °C. The initial pressure of the system must be equal to the pressure at which the governor starts to restore the system. In this test, the response time must correspond to an actuation time of 0.2 seconds. Several applications of the brake are therefore required, beginning with the shortest possible actuation time up to an actuation time of 0.4 seconds, which are to be plotted in a graph.

11.6.4 MFDD – Mean Fully Developed Deceleration



The described braking performance (see chapter "11.4 Tractors (Category T & C)" on page 253 and see chapter "11.5 Towed vehicles (Category R & S with service braking system)" on page 253) is based on the stopping distance and the MFDD (**M**ean **F**ully **D**eveloped **D**eceleration). The stopping distance is defined as the distance between the moment the foot brake pedal is first actuated and the moment when the vehicle is absolutely stationary.

The MFDD is measured between the two velocities of the vehicle 0.8 x initial velocity and 0.2 x initial velocity (see diagram above).

11.7 Required braking systems and functions

11.7.1 Load-sensing device

Category R and S vehicles are required to be fitted with an automatic load sensing device.

If the design speed of the vehicle does not exceed 30 km/h, and if technical reasons prevent the towed vehicle from being fitted with such a device, it is permitted to fit the trailer with a load sensing device with just three discrete settings.

Towed vehicles, where due to the purpose of the vehicle only two load conditions (laden and unladen) are possible, may be fitted with a device offering two discrete settings (laden, unladen). Category S vehicles which are not loaded or contain no consumable materials are not required to be fitted with an automatic load sensing device (Annex I, 2.1.1.5.).

11.7.2 Required braking systems for trailers

The table shows required braking systems for Category R + S agricultural vehicles.

CATEGORY	MASS	VELOCITY	NO SYSTEM	INERTIA	SEMI /CONTIN.
R1		< 40 km/h	X		
R2				X	X
R3	< 8000 kg			X	X
	> 8000 kg				X
R4					X
S1			X		
S2	< 8000 kg			X	X
	> 8000 kg				X
R1	< 750 kg	> 40 km/h	X		
	> 750 kg				X
R2		> 40 km/h		X	X
R3					X
R4					X
S1	< 750 kg		X		
	> 750 kg			X	X
S2					X

EU 2015/68 Annex I, Paragraph 2.2.2.3.1., Oct. 2016

All braking systems are minimum requirements. If a vehicle is to be fitted with a braking system of superior performance, the fitted vehicle will comply with the requirements for the superior braking system.

Example: Vehicle S1 is to be fitted with an inertia braking system. The requirements for S2 therefore have to be taken into consideration.

In the case of Category b vehicles (> 40 km/h), the service brake must act on both wheels of at least one axle.

In the case of Category T and C vehicles with a maximum design speed not exceeding 30 km/h, the braking system must act on all wheels of at least one axle.

If the design speed of a Category T and C vehicle exceeds 30 km/h, the service brake must act on all the vehicle's wheels. An engagement of the 4WD clutch for distributing the brake force from the rear brakes to the front axle during the braking action is permitted. For Category C tractors, tracks equate to wheels.

11.7.3 Continuous / semi-continuous

Annex I 2.2.2., Oct. 2016

Both types are permitted for all tractor trailer combinations (if a service brake is required on the trailer)

Fast running agricultural trailers may be towed by commercial trucks and tractors. In such cases, the trailers brake system must conform to UNECE Regulation 13.

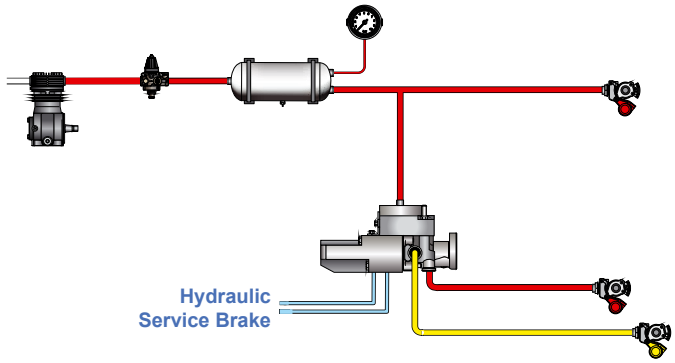
11.8 Types of tractor braking system on towing vehicles for controlling the trailer

The following descriptions of possible braking systems only apply for the tractor's service braking system.

11.8.1 Single or dual line trailer braking system

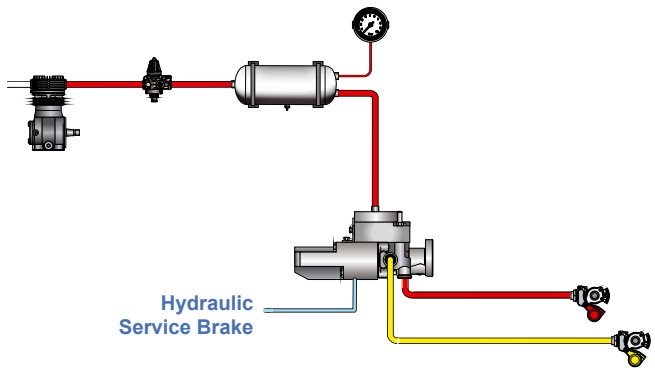
Single line actuation of the trailer by the tractor (hydraulic or pneumatic) will not be permissible in the future: from December 31, 2019, new tractor types (from December 31, 2020, all new tractors) may no longer be fitted with such connections.

11.8.2 Single or dual line trailer control valve actuation



Dual line

Should the service braking system of the tractor fail, and if this system comprises at least two independent sections, the section or sections affected by this failure must be able to fully or partially actuate the towed vehicle brakes. [...]



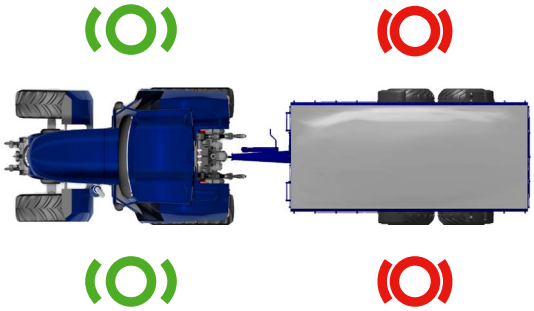
Single line

This requirement does not apply where the two independent sections comprise in one section braking left-hand wheels, and in the other section braking right-hand wheels, where such a design is intended to permit differential braking for cornering on fields. Should in the latter case the service braking system of the tractor fail, the secondary braking system must be able to fully or partially actuate the brakes of the towed vehicle. If this action is effected by means of a valve which is normally at rest, such a valve may only be installed if its correct functioning can easily be checked by the driver, either from in the cab or from outside of the vehicle and without the use of tools. Annex I 2.2.1.16.3., Oct. 2016

11.9 Automatic braking of the trailer (stretch brake)

The service braking system of the trailer or towed vehicle may only be operated during actuation of the service or secondary braking system of the tractor.

The only exception is where the brakes of the towed vehicle are automatically actuated for stabilization purposes. For better driving behaviour, the brakes of the towed vehicle may be automatically actuated for max. 5 seconds without one of the braking systems of the tractor . (Annex I, 2.2.1.19.f, Oct 2016)

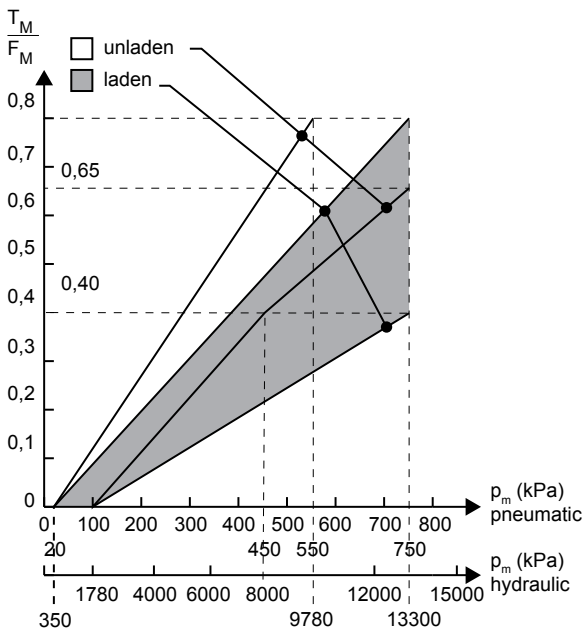


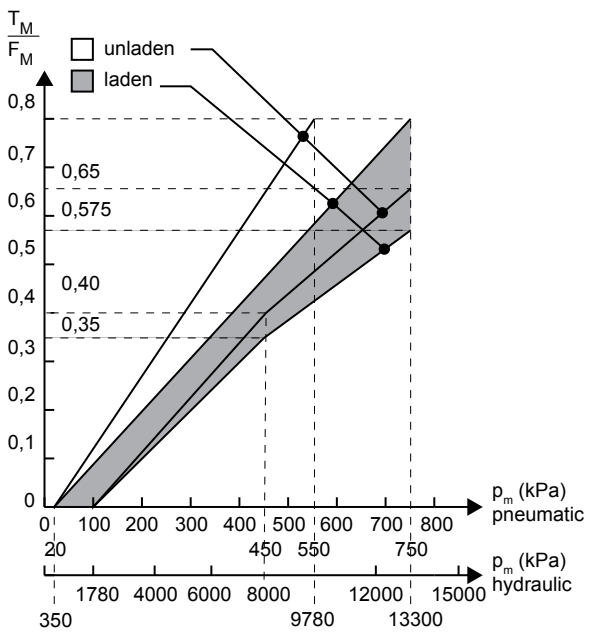
11.10 Additional information

11.10.1 Compatibility between the agricultural tractor and trailer

During a brake application, all the vehicles of a combination should be braked with a similar intensity to enable efficient deceleration without the risk of the combination losing its driving stability. All the vehicles should be able to decelerate their share of the load and avoid high coupling forces between the towing and towed vehicles. Deceleration values for a tractor refer to the pressure values of the control line between the tractor and the towed vehicle. Pressure values for the control line between the tractor and towed vehicle refer to the deceleration values for the towed vehicle.

To this end, EU 2015/68 stipulates that both tractors and trailers with vmax > 30 km/h fulfil the requirements of diagrams 2 and 3, Annex II, Appendix 1.





11.10.2 Wear adjustment

An automatic or at least manual wear adjustment of the service brakes is required for all agricultural vehicles. This will maintain the full efficiency of the friction brakes during the full life time of the brake linings and will reduce response time, fading effects and maintenance costs.

(See EU 2015/68, Annex I, Paragraphs 2.2.1.10. and 2.2.2.8., Oct. 2016)

11.10.3 Differential braking

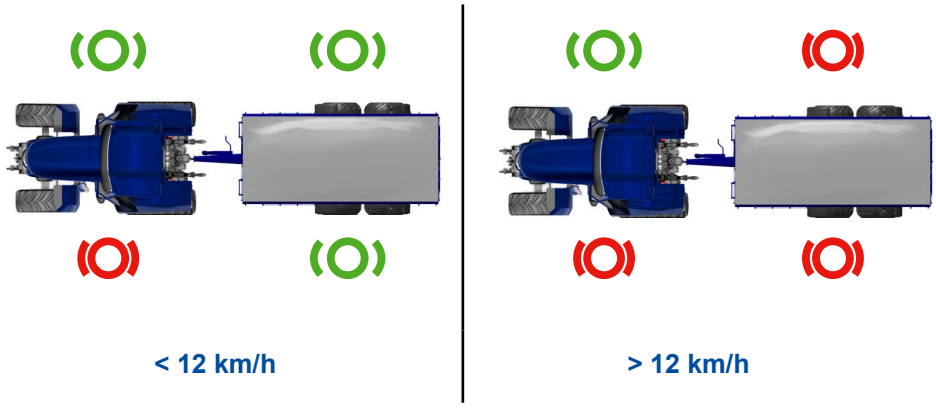
Differential braking describes the capability of a vehicle to apply a braking action on one of the rear wheels without braking any of the other wheels. This functionality assists the driver in steering the vehicle.

A towing vehicle may therefore be fitted with a dual line braking system where each line is connected separately to the left or right-hand wheel brake cylinder and to a left or right-hand foot brake pedal.

During activation of the differential braking mode, it must not be possible for the vehicle to travel at speeds higher than 40 km/h. In deviation from this requirement, the vehicle may travel faster than 40 km/h provided that the differential braking mode is automatically deactivated.

In the case of tractors towing a trailer during an differential braking action, the brakes on the trailer can be deactivated up to a vehicle speed of 12 km/h.

(See EU 2015/68, Annex I, Paragraph 2.2.1.1., Oct. 2016)



The graphical example shown here demonstrates where a vehicle is able to use the steering brake functionality without braking the towed vehicle. The non-application of the brakes on the towed vehicle in this case is just a functional feature of the tractor, and is not a prescribed requirement.

11.11 Trailer control

Among the described requirements in the chapters above, there are four additional requirements for the control of the tractor.

11.11.1 Coupling failure

If the main mechanical coupling between the tractor and trailer separates, the towed vehicle must be automatically braked. Trailers that are not fitted with a service braking system must be fitted with an additional device such as a cable or chain for preventing separation of the tractor and trailer in the event that the main coupling of the combination becomes separated.

In the case of vehicles fitted with an inertia braking system, the additional coupling must automatically apply the brakes of the towed vehicle if the vehicle coupling is separated.

(Annex I 2.2.2.9., Oct. 2016)

In the event of a failure of one of the connecting lines between the tractor and trailer (pneumatic/hydraulic/electric), it must be possible to bring the towed vehicle to a safe standstill by actuating the service/secondary/parking brake system.

This braking action may also be effected by an automatic system. This automatic braking action must attain a minimum force of 13.5% of the maximum stationary wheel load.

In the event of a failure of the supply line, it must be possible to fully or partially actuate the brakes of the vehicle.

In the case of vehicles fitted with a compressed air braking system, the pressure in the supply line must drop to 150 kPa within 2 seconds in the event of a control line failure.

In the case of vehicles fitted with a hydraulic braking system, the pressure in the supply line must drop to 1000 kPa within 2 seconds in the event of a control line failure.

See (EU) Annex I, 2.2.1.17. / Annex II. 3.2.3./ Annex I 2.2.1.17.2.2., Oct. 2016.

11.11.2 Graduated Secondary Brake

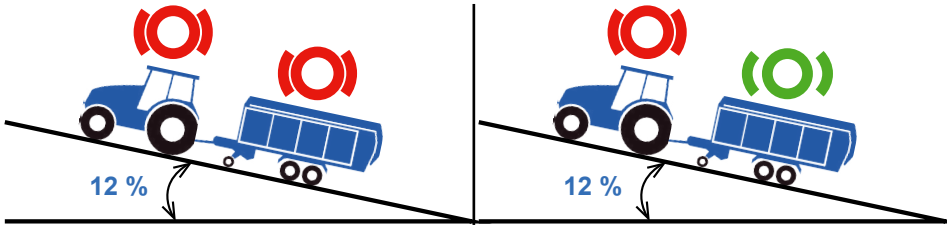
Tractors designed with a maximum speed higher than 40 km/h are required to have a secondary braking system on the tractor with a braking action that gradually brakes the towed vehicle.

(See EU 2015/68 Annex I, paragraph 2.2.1.16.2., Oct. 2016)

11.11.3 Control position

Tractors that are permitted to tow trailers must be fitted with a parking braking system that is capable of holding the tractor/trailer combination on a 12% upward or downward gradient. To check that the tractor has an adequate braking performance, a device is needed that is able to distinguish the secondary and/or parking brake system of the tractor from the braking system of the towed vehicle.

(See EU 2015/68 Annex I, paragraph 2.1.2.3., Oct. 2016)



11.12 Connections between vehicles

Permitted connections between towing and towed vehicles

- One pneumatic supply and one pneumatic control line (and optionally one electric control line)
- One pneumatic supply line and just one electric control line is not permitted
- Hydraulic single line is permitted until 31.12.2019 / 31.12.2020
- Hydraulic dual line system (and optionally one electric control line)

Permitted connections for vehicles with hydraulic connection lines

- Hydraulic control line: male connector on tractor, female connector on trailer, both compliant with ISO 5676:1983
- Hydraulic supply line: male connector on tractor, female connector on trailer, both compliant with ISO 16028:2006
- Electric connector: ISO 7638:2003 for 5 or 7 pin applications

11.13 ABS for agricultural vehicles

An antilock braking system (ABS) is required for vehicles designed with a maximum speed higher than 60 km/h.

In addition, the following tractors designed with a maximum speed higher than 40 km/h are to be equipped with an ABS system:

1) New vehicle types from January 1, 2020
2) New vehicles from January 1, 2021

12 Table of new requirements

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Matrix der Anforderungen der Verordnung

(29.09.2017)

(EU) 167/2013 Fahrzeugklassen				(EU) 2015/68 Anforderungen	Betriebsbremsanlage			Hilfsbremsanlage		
				(EU) 2015/68 Differenzierung		Anhang II 3.1.1.1.	Anh. II Anl. I 1.1.1.1.	Anhang I 2.2.1.16.1.	Anhang I 2.2.1.16.2.	Anhang 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		falls eine Zugmaschine zum Ziehen von R2, R3, R4 oder S2 zugelassen ist: Wenn die Betriebsbremse der Zugmaschine betätigt wird, muss auch eine abgestufte Bremsung am gezogenen Fahrzeug vorhanden sein	Falls eine Hilfsbremsung bei der Zugmaschine aktiv wird, muss auch eine Bremsaktion beim gezogenem Fahrzeug vorhanden sein	d_m = 1,5 m/s² s = 0,15v + v²/39
	T2	UM > 600 kg , GC < 600mm, TW > 1150mm								
	T3	LM < 600kg								
	T4	Zugmaschine für spezielle Anwendung								
	T4.1	Stelzradzugmaschinen								
	T4.2	überbreite Zugmaschinen								
	T4.3	Zugmaschinen mit geringer Bodenfreiheit		> 30 km/h		d_m = 5,00 m/s² s = 0,15v + v²/130	muss EG-Bänder erfüllen			d_m = 2,2 m/s² s = 0,15v + v²/57
	C	Zugmaschine auf Gleisketten								
	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			Falls eine Hilfsbremsung bei der Zugmaschine aktiv wird, muss auch eine Bremsung beim gezogenem Fahrzeug vorhanden sein; dieser Bremsvorgang muss abgestuft sein	d_m = 1,5 m/s² s = 0,15v + v²/39
	T2	UM > 600 kg , GC < 600mm, TW > 1150mm								
	T3	LM < 600kg								
	T4	Zugmaschine für spezielle Anwendung								
	T4.1	Stelzradzugmaschinen								
	T4.2	überbreite Zugmaschinen								
	T4.3	Zugmaschinen mit geringer Bodenfreiheit		> 30 km/h		d_m = 5,00 m/s² s = 0,15v + v²/130	muss EG-Bänder erfüllen			d_m = 2,2 m/s² s = 0,15v + v²/57
	C	Zugmaschine auf Gleisketten								
M = Unladen Mass (Gewicht unbeladen), GC = Ground Clearance Bodenfreiheit), TW = Track Width (Spurbreite)					Anhang I 2.2.2.	Anhang II 3.2.1.	Anh. II Anl. I 1.1.1.1.	Automatische Bremsung Anhang II 3.2.3		
	R1	Summe der Achslast < 1500 kg	„a" < 40 km/h		keine Betriebsbremsanlage erforderlich	falls Fahrzeuge R1 oder S1 mit einer Bremsanlage ausgestattet sind, muss die Leistung den Anforderungen für R2 oder S2 Fahrzeugen entsprechen für durchgehenden / halbdurchgehenden Typ: X % stat. Radlast X = 50 (>30 km/h) X = 35 (<30 km/h)		automatische Bremsleistung bei einem Ausfall (2.2.1.17.1 und 2.2.1.18.5 Anh. I) für beladenes Fahrzeug muss mindestens 13,5 % der maximalen stationären Radlast betragen		
	R2	Summe der Achslast: 1500 - 3500 kg			durchgehend/ halbdurchg./ Auflauf					
	R3	Summe der Achslast: 3500 - 21000 kg		< 8000 kg	durchgehend/ halbdurchg./ Auflauf		muss EG-Bänder erfüllen falls > 30 km/h			
				> 8000 kg	durchgehend/ halbdurchgehend					
	R4	Summe der Achslast > 21000 kg			durchgehend/ halbdurchgehend					
	S1	Summe der Achslast < 3500 kg			keine Betriebsbremsanlage erforderlich					
	S2	Summe der Achslast > 3500 kg		< 8000 kg	durchgehend/ halbdurchg./ Auflauf		muss EG-Bänder erfüllen falls > 30 km/h			
				> 8000 kg	durchgehend/ halbdurchgehend					
	R1	Summe der Achslast < 1500 kg	„b" > 40 km/h	< 750 kg	keine Betriebsbremsanlage erforderlich					
				> 750 kg	durchgehend/ halbdurchg./ Auflauf					
	R2	Summe der Achslast: 1500 - 3500 kg			durchgehend/ halbdurchg./ Auflauf		muss EG-Bänder erfüllen			
	R3	Summe der Achslast: 3500 - 21000 kg			durchgehend/ halbdurchgehend					
	R4	Summe der Achslast > 21000 kg			durchgehend/ halbdurchgehend					
	S1	Summe der Achslast < 3500 kg		< 750 kg	keine Betriebsbremsanlage erforderlich					
				> 750 kg	durchgehend/ halbdurchg./ Auflauf					
	S2	Summe der Achslast > 3500 kg			durchgehend/ halbdurchgehend		muss EG-Bänder erfüllen			

Feststell-brems-anlage		Anzahl der angesteuerten Räder	Differenzial-bremsung	Nachstellung Verschleiß	Zusätzliche Kupplung	Ausfall bei Verbindungs-leitungen	Anschlüsse	ABS	Last-abhängig
Anhang II 3.1.3.1. / 3.1.3.2.	**Anhang II 3.1.3.4.**	**Anhang I 2.2.1.6.**	**Anhang I 2.2.1.1.**	**Anhang I 2.2.1.10.**		**Anhang I 2.2.1.17.1**	**Anhang I 2.1.4.1**	**Anhang I 2.2.1.21.**	
muss Fahrzeug halten bei: 18 % Gefälle/Steigung	bei Zugmaschinen, bei denen Kupplung mit gezogenen Fahrzeugen zulässig ist, muss Feststellbremse des Zugs den gesamten Zug bei 12 % Gefälle/ Steigung halten	Betriebsbremse muss auf alle Räder mindestens einer Achse wirken	falls Differenzial-bremsung aktiviert ist, keine Fahr-geschwindig-keiten > 40 km/h falls Fahr-geschwindig-keit > 40 km/h muss Funktion deaktiviert sein	Verschleiß der Betriebsbremse muss manuell oder automatisch ausgeglichen werden		bei einem Fehler in der pneum. Steuerleitung, muss der Druck innerhalb von 2 Sekunden auf 1,5 bar fallen	zulässig: 1 x pneum. Versorgung 1 x pneum. Ansteuerung oder 1 x pneum. Versorgung 1 x pneum. Ansteuerung 1 x el. Ansteuerung oder hydraulische Doppelleitung oder bis 2019/20 hydraulische Einzelleitung noch nicht zulässig: 1 x pneum. Versorgung 1 x el. Ansteuerung nicht zulässig: 1 x pneum.	kein ABS erforderlich	derzeit kei lastabhäng Vorrichtu nach Verordnu erforderli
0 % Gefälle/Steigung halten		Betriebsbremse muss auf alle Räder des Fahrzeugs wirken							
muss Fahrzeug halten bei: 18 % Gefälle/Steigung		Betriebsbremse muss auf alle Räder mindestens einer Achse wirken		Verschleiß der Betriebsbremse muss automatisch ausgeglichen werden				> 60 km/h ABS Kat. I nach Bestätigung der Bewertung durch die Europäische Kommission auch für >40 km/h neuer Typ: 01.2020 neues Fahrzeug: 01:2021	
0 % Gefälle/Steigung halten		Betriebsbremse muss auf alle Räder des Fahrzeugs wirken							
muss Fahrzeug bei 18 % Gefälle/Steigung halten									
Anhang II 3.2.2.1.	**Anhang I 2.2.2.10.**	**Anhang I 2.2.2.4.**	**Anhang I 2.2.1.1.**	**Anhang I 2.2.2.8.1.**	**Anhang I 2.2.2.9.2.**	**Anhang I 2.2.2.9.**	**Anhang I 2.1.6. + 2.1.7**	**Anhang I 2.2.2.16.**	**Anhang 2.1.1.5**
muss das beladene gezogene Fahrzeug bei abgekoppelter Zugmaschine bei 18 % Gefälle/Steigung halten	wenn Betriebsbrem-sanlage im Fahrzeug vorhanden, muss Feststellbremse sichergestellt werden, auch wenn diese vom gezogenen Fahrzeug getrennt ist	Betriebsbremse muss seine Wirkung angemessen über die Achsen verteilen	< 12 km/h ist keine Betätigung der Betriebs-bremse im Differential-modus erforderlich	manueller Ausgleich von Verschleiß erforderlich; automatische Nachstellung ist optional	bei Auflaufbremse ist eine 2. Kupplung (Seil, Kette) erforderlich, um Anhängerbremsen zu aktivieren, falls Kupplung abreißt	muss automatisch anhalten, wenn Kupplung abreißt	flexible Schläuche und Seile müssen Bestandteil des gezogenen Fahrzeugs sein nicht automatisch betätigte Absperrvor-richtungen sind nicht zulässig	kein ABS erforderlich	muss mit ei automatisc lastabhängi Vorrichtu ausgestatt werden Ausnahm Ra < 30 km und Sa aus technisc Gründen ni möglich 3 gesonde Einstellung zulässig Ra < 30 km und Sa ermög bauartbedi lediglich „bel und „leer“ Bed 2 gesonde Einstellunger zulässig Kategorie S, di andere Last e (bis zu 10 Verbrauch material
				Automatische Nachstellung	2. Kupplung erforderlich				
				manueller Ausgleich von Verschleiß erforderlich; automatische Nachstellung ist optional	bei Auflaufbremse ist eine 2. Kupplung (Seil, Kette) erforderlich, um Anhängerbremsen zu aktivieren, falls Kupplung abreißt				
		Betriebsbremse muss Wirkung entsprechend zwischen den Achsen verteilen und muss auf mindestens zwei Räder je Achse wirken		Automatische Nachstellung	2. Kupplung erforderlich			> 60 km/h ABS erforderlich	
				manuelle Nachstellung; automatische optional	bei fehlenden Bremsen oder Auflaufbremse, ist 2. Kupplung erforderlich			kein ABS erforderlich	
				Automatische Nachstellung	2. Kupplung erforderlich			> 60 km/h ABS erforderlich	

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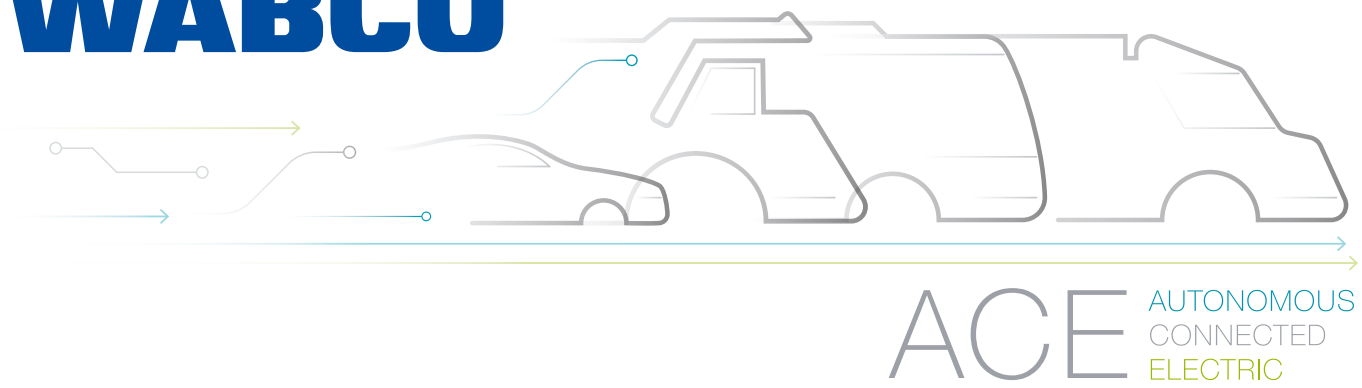

ZF Friedrichshafen AG

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