

You will find on the next pages a description of the entire pneumatic braking system operation in different vehicle types. The braking systems chosen are:

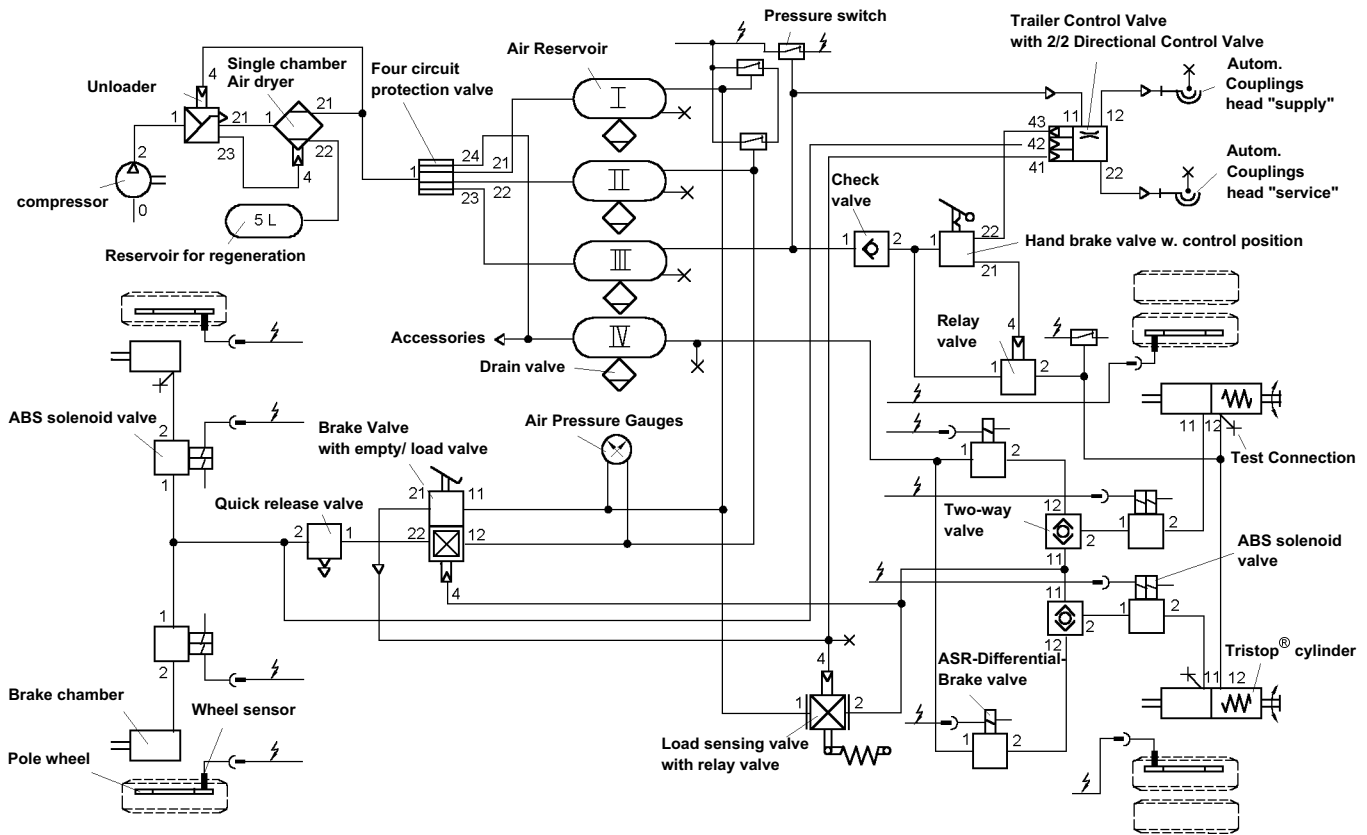
- **Motor vehicle braking system** Page 2
(Example: two-axle drawbar / SZM with ABS / ASR)
- **Trailer braking system** Page 5
(Example: two-axle drawbar trailer or three-axle semi-trailer, each with ABS and spring braking system)
- **Motor coach braking system** Page 7
(Example: two-axle standard line bus with ABS / ASR)
- **Motor coach braking system** Page 9
(Example: standard articulated bus with ABS / ASR)

Behind the descriptions, you will find, for use as work sheet or exercise sheet, the respective schematic representation of the braking system presented again in a full page.

In addition to the afore-mentioned trailer braking systems, schematic representations of two older drawbar-trailer and semi-trailer braking systems are also attached as exercise sheet for information.

Wiring diagram

two-line/dual-circuit/pneumatic braking system in accordance with the EC regulation on braking systems (example: 2-axle drawbar)



Driving position service braking system

Compressed air from the compressor flows into the four-circuit protection valve via the unloader and the air dryers. Depending on the variant of this valve, compressed air is immediately supplied to the connected air circuits, or air supply only starts after reaching the opening pressure which is the same as the secured pressure in the four-circuit protection valve.

While compressed air is being supplied to the valve in **circuits 1 and 2**, the pressure from port **23** of the four-circuit protection valve flows to the 2/2 directional control valve flanged to the trailer control valve. Since this device is normally switched to through flow, the pressure from port **11** is channelled to the coupling head via port **12**.

Driving position auxiliary and parking braking system

Pressure is also supplied to the auxiliary and parking braking system from port **23** of the four-circuit protection valve. Compressed air flows into the check valve, hand brake valve, and relay valve via the air reservoir of **circuit 3**. The hand brake valve set to through flow transfers the incoming supply pressure on its connection **1** immediately as pilot pulse via ports **22** and **21** to the trailer control valve (port **43**) and to the relay valve (port **4**).

If a trailer is coupled, air is thus evacuated from the trailer control line via the trailer control valve. At the same time, the relay valve can reverse and push the supply pressure in port **1** via port **2** to the spring brake part of the tristop brake actuator. The auxiliary and parking braking system is ready for use after the release pressure has been attained.

Braking position
service braking system

When the brake valve is actuated, compressed air flows via the automatic load-regulating brake-power regulator to the front and rear axle brake cylinders. At the same time, trailer control valve ports **41** and **42** receive the same pressure as pilot pulse through which the trailer control valve supplies air to the trailer control line.

Release position

After the brake valve has been released, air is evacuated from the two braking circuits and from ports **41** and **42** of the trailer control valve. The trailer control valve then evacuates the trailer control line.

Braking position
auxiliary braking system

When the hand brake valve is actuated, air is gradually evacuated from the pilot line leading to the trailer control valve (port **43**) and to the relay valve (port **4**). This causes the relay valve to reverse accordingly and to evacuate air from the spring brake part of the tristop brake actuator. After the pressure has dropped by about 2.0 bar, the spring brake actuator transfers its mechanical energy to the wheel brake via the brake chamber. At the same time, air is supplied to the trailer control line via the trailer control valve, and the trailer is braked via the trailer emergency valve.

Braking position
Parking Braking System

If air is completely evacuated from the spring brake actuator, you can turn the hand lever further on the hand brake valve to lock it. The device complies with the specifications on parking braking systems through this locking. The coupled trailer remains braked.

Control position

The control position is actuated by turning the hand brake lever further again. In this position, the hand brake valve channels the entire pressure via port **22** to port **43** of the trailer control valve. Air is evacuated from the trailer control line, and the braking effect cancelled in the trailer, through this forced reversal of the trailer control valve (if the parking braking system has been activated). In accordance with the EC regulation, the driver can thus determine whether the vehicle's parking braking system alone can stop the entire vehicle combination. The trailer braking system is actuated again when the hand lever is returned to the locked position.

Functions for line break
to the trailer

Circuit 3 fails if the trailer breaks away. The spring braking system is first secured completely by the check valve, while **circuits 1 and 2** drop out below the opening pressure. If the compressor is actuated, the pressure in both service braking circuits rises up to the opening pressure of the 3rd circuit. The trailer control valve no longer receives any supply pressure.

Function when the trailer control
line breaks

Nothing happens at first if the trailer control line breaks. It is only when the driver brakes that compressed air flows from the trailer control line into the atmosphere via the faulty part. Since the flanged 2/2 directional control valve no longer receives pressure from port **22** of the trailer control valve, this valve block the passage to port **12**, leaving only a small cross-section.

Air is thus quickly evacuated from the trailer supply line so that the trailer is automatically braked almost as quickly as when the trailer breaks away. If the driver releases the braking system, the 2/2 directional control valve reverses again, and compressed air can again flow freely via the trailer supply line to the trailer which is now being released again.

Function after Failure of 1st or 2nd circuit

If the first or second circuit fails, the four circuit protection valve reverses and back-feeds the intact circuit only up to the opening pressure level. Since the trailer control valve has a dual circuit control structure, it is actuated via the working circuit. Pressure is supplied to the trailer control line as usual from **circuit 3**. If the opening pressure on the faulty circuit is exceeded, the higher pressure coming from the compressor escapes into the atmosphere via the faulty point.

Function after failure of 3rd or 4th circuit

In case of third-circuit or fourth-circuit failure, the service braking system pressure falls down to the level of both circuits' closing pressure. The supply to the service braking system also takes place up to the level of the third-circuit or fourth-circuit opening pressure

Please note

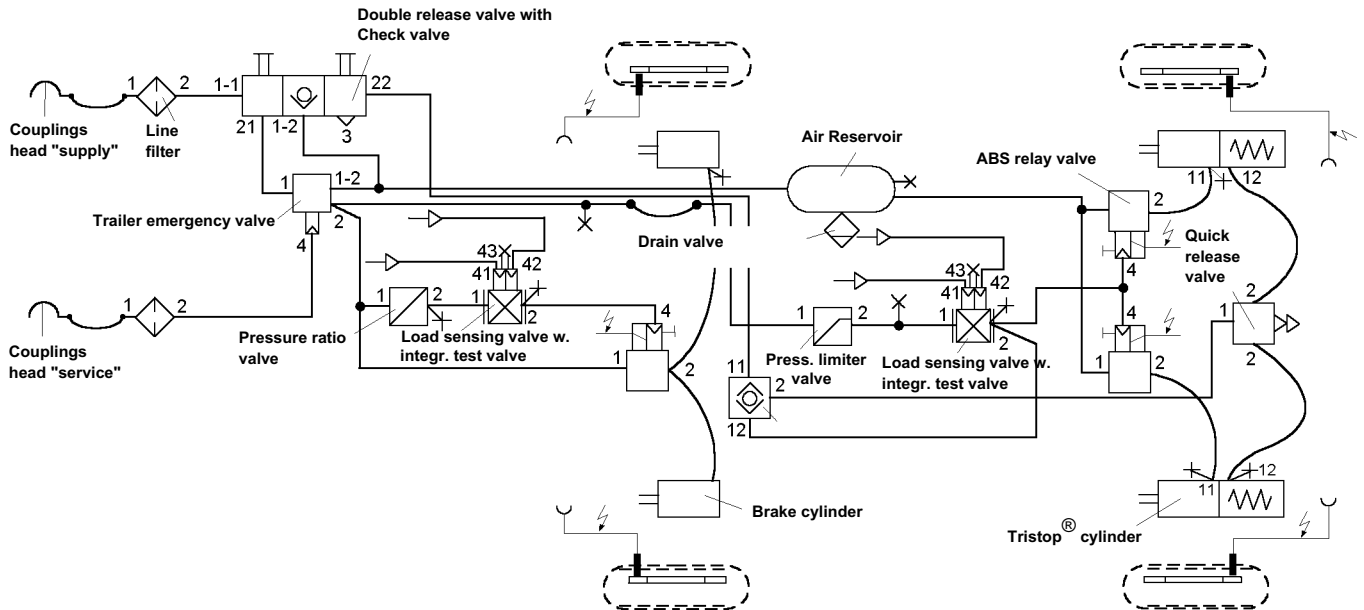
If the pressure in the spring braking system behind the check valve fails, the pressure in **circuit 3** reservoir also fails. Pressure is then supplied to the working circuits up to the opening pressure level of the third circuit. At the same time, the spring brake actuator responds automatically. If the vehicle has to be moved, the spring brake actuator must be released mechanically.

Function of the auxiliary braking system in case of service braking system failure

In case of total dual-circuit service braking system failure, the auxiliary braking system pressure is secured completely or up to the closing pressure level of **circuits 1 and 2** (depending on the design of the four-circuit protection valve). The auxiliary braking system can still be actuated several times, depending on the size and design of the **circuit 3** air reservoir .

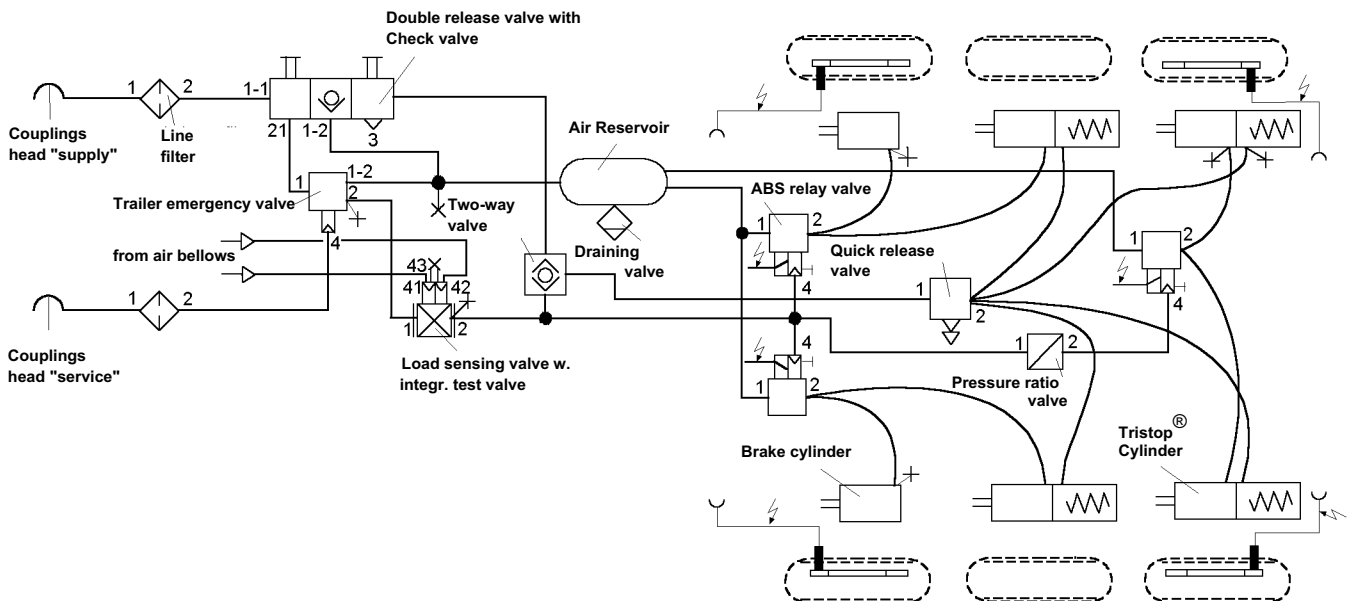
Wiring diagram

Two-line/single-circuit/pneumatic braking system in drawbar trailers in accordance with the EC regulation on braking systems.



Wiring diagram

Two-line/single-circuit/pneumatic braking system in semi-trailers in accordance with the EC regulation on braking systems.



Driving position

Compressed air from the motor vehicle flows into the trailer emergency valve via the supply line coupling head, pipe filter, and dual release valve. Pressure flows via ports 1 and 1 – 2 of the trailer emergency valve to the air reservoir, and from there to ports 1 of the semi-trailer's ABS relay valve respectively the ABS relay valve of the drawbar trailer rear axle, and back to ports 1 – 2 of the dual release valve.

Braking position BBA

When the brake valve is actuated in the tractor vehicle, air is gradually supplied via the trailer control valve to the trailer control line and trailer emergency valve (port **4**). This leads to a reversal of the valve, and compressed air flows via port **2** to the load sensing valve(s). Depending on the load carried by the vehicle, the regulated pressure is channelled by the load sensing valve(s) to the brake cylinders.

The adaptor valve on the drawbar trailer front axle blocks the pressure in the lower part. A pressure limiting valve on the drawbar trailer rear axle prevents rear axle over-braking in case of dynamic axle-load transfers due to strong brake application.

Release position

When air is evacuated from the trailer control line, the trailer emergency valve reverses and evacuates air from downstream devices. Air is evacuated from the brake cylinders in the process, via the ABS relay valve.

Function when the trailer breaks away or is unhitched

When air is evacuated from the trailer supply line, the trailer emergency valve reverses (just like in the single line braking system), and the trailer is braked automatically.

Function of BBA release valve

To be able to manually move the unhitched trailer, you must actuate the BBA release valve. You can do this by pushing in the (black) actuating knob. This can cause the trailer emergency valve to reverse and evacuate air from the brake cylinder.

When the trailer is coupled again, the actuating knob springs out and the BBA release valve automatically returns to the original position. This restores the trailer braking function.

Braking position of the spring braking system

If the spring braking system of the unhitched trailer is to be actuated, actuate the (red) actuating knob of the FBA release valve. This evacuates air from the line leading from port **22** of the dual release valve to the two-way valve, and the spring brake part of the tristop brake actuator can become active. Nevertheless, so long as the automatic braking of the unhitched trailer still creates braking pressure in the diaphragm part of the tristop brake actuator (BBA release valve not actuated), the two-way valve prevents an addition of braking force to the axles equipped with tristop brake actuators.

Function of FBA release valve

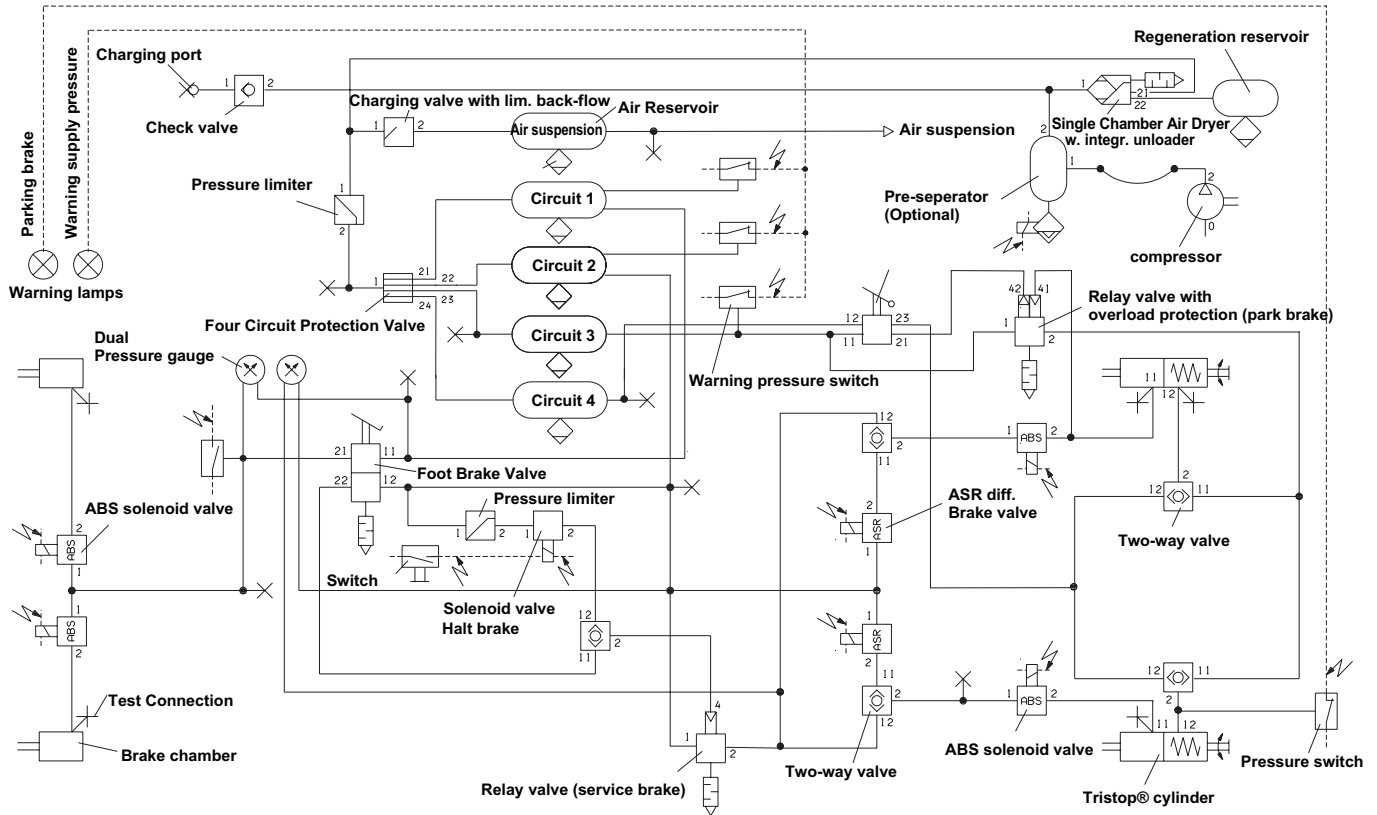
To be able to manually move the unhitched trailer, you must actuate the BBA release valve (black actuating knob) and the FBA release valve (red actuating knob). You can do this by pushing down the actuating knobs. Air is thus supplied again via the air reservoir to the spring brake part of the tristop brake actuators, which are also released, whereas the brake chambers remain in the release position.

Please note

In older trailers without spring brake actuators, the spring brake is still mechanically actuated via the spindle crank and arrester wire.

Wiring diagram

Dual-circuit pneumatic braking system in motor coaches with ABS and ASR.



Braking position
(service braking system)

Compressed air from the compressor flows into the four-circuit protection valve via the air dryer with unloader. When the opening pressure is attained, the connected air circuits are filled up to the pressure level fixed by pressure limiting valve. Compressed air is thus supplied to the brake valve and to the low pressure indicator for the service braking system (air reservoir for **circuits 1 and 2**).

Driving position
(auxiliary and parking braking system)

The hand brake valve with automatic emergency release function (pipe rupture safeguard) receives compressed air from the air reservoirs of **circuits 3 and 4**. Compressed air is supplied from the air reservoir of **circuit 3** to the relay valve with or without anti-compound function. Due to the hand brake and relay valve function, pressure build-up in the tristop brake actuators cancels the effect of the auxiliary and parking braking system in the “**driving position**”.

Driving position
(service braking system)

When the brake valve is actuated, air is supplied to the front axle brake cylinders via port **21**. Air is supplied to the rear axle from port **22**. In this process, the two-way valve switched in between closes port **12** to the solenoid valve. If a relay valve with anti-compound function is installed, air is also supplied to port **41** of the valve. This activates the relay valve's blocking function.

Release position

When the brake valve is released, air is evacuated from the pipes and valves to which air had been supplied before. The braking effect is cancelled again through the pressure drop.

Braking position
(auxiliary braking system)

Air is first evacuated rapidly from port **23** when the hand brake valve is actuated. This merely reverses the two-way valve in the tristop brake actuator. Thereafter air evacuation from port **21** starts, with the inherent relay valve reversal. Due to the pressure drop in port **42**, the relay valve is in a position to evacuate air from the tristop brake actuator and thus brake the rear axle.

Braking position
(parking braking system)

If air is completely evacuated from the tristop brake actuator, the hand lever can be engaged by being actuated further.

Release position

Air is again supplied to the connected lines, valves and the tristop brake actuators, and the brake thus released, by resetting the hand lever.

Braking position
(halt brake)

The solenoid valve is actuated via the hand brake pressure switch. Through the reversal of this latter, incoming and reduced pressure from the pressure limiting unit is transferred via the two-way valve to port **11**, and the rear axle is braked.

Release position

If the halt brake is deactivated, air is evacuated via the solenoid valve.

The anti-compound function

When the brake valve and the hand brake valve are actuated one after the other, the actual effect is reversed in the relay valve with anti-compound function. This means that despite the evacuation of air from port **42**, air continues to be supplied to port **2**, and the spring brake actuator in the tristop brake actuators are not activated.

Function in case of circuit failure

If a circuit fails, the four circuit protection valve reverses and back-feeds the intact circuit only up to the secured pressure level. If the secured pressure on the faulty circuit is exceeded, the higher pressure coming from the compressor escapes into the atmosphere via the faulty point.

Function of the auxiliary and parking braking system in case of 3rd circuit failure (emergency release function / pipe rupture safeguard)

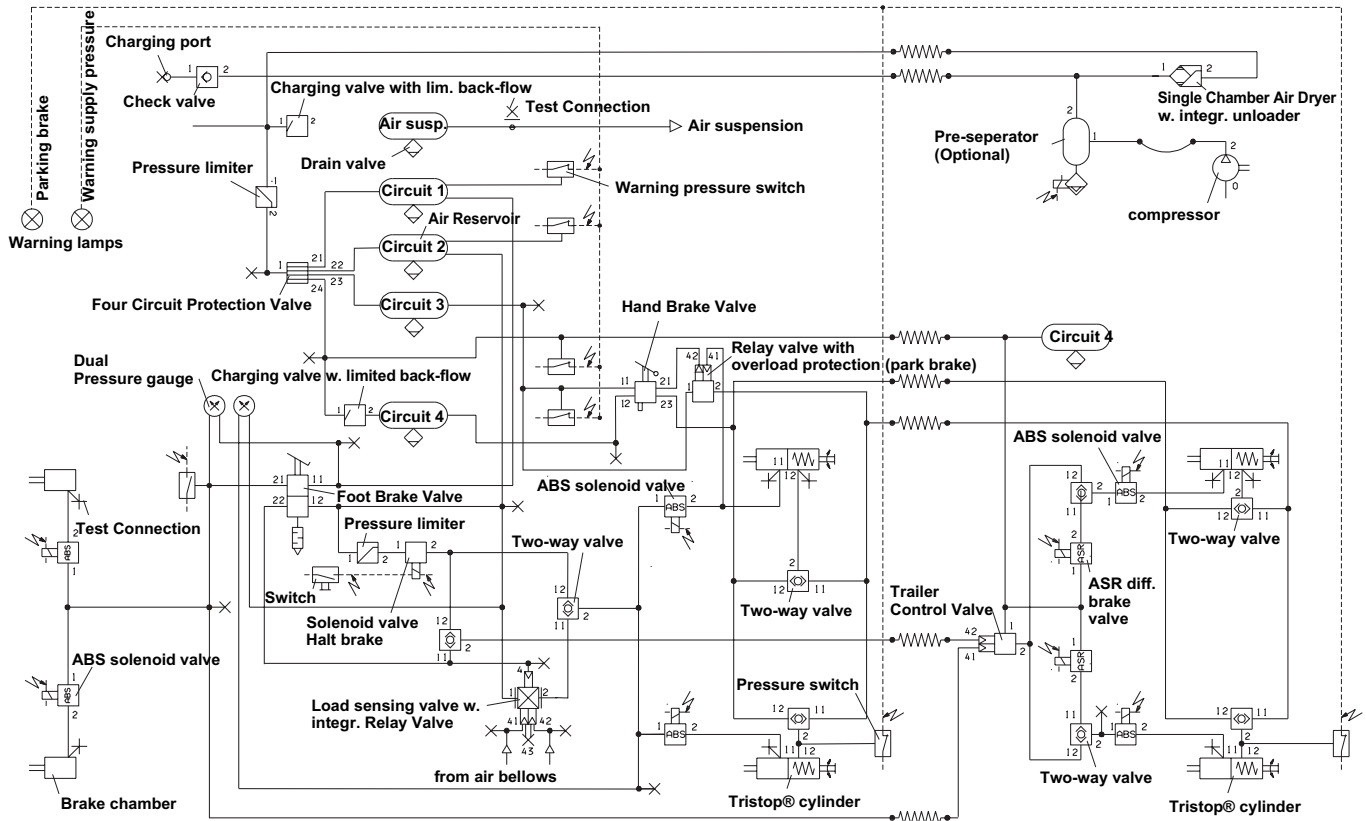
Since the hand brake valve is dual-circuit controlled, the tristop brake actuators cannot respond automatically, because pressure is maintained via **circuit 4**. If the hand brake valve is actuated in this situation, only the graduation (auxiliary brake system failure) is cancelled. The effect of the parking braking system is maintained.

Function in case of service or parking braking system failure

In case of total failure of the service or auxiliary and parking braking system, each of the working braking systems can continue to be actuated up to the secured pressure level. This ensures maximum security. Nevertheless, the vehicle no longer complies with the regulations on the service braking system's minimum braking rate.

Wiring diagram

Dual-circuit pneumatic braking system in articulated tramway set with ABS and ASR.



Please note

The description of the operation only concerns rear axle control. The middle axle is regulated via a load sensing valve.

Driving position

Air is supplied to the air reservoir of **circuit 4** via port **24** of the four-circuit protection valve. The trailer control valve thus receives supply pressure on connection 1.

Braking position
(service braking system)

When the brake valve is actuated, air is supplied to the trailer control valve's ports **41** and **42**. This reverses the device and it supplies air to port **11** of the tristop brake actuator. In case of circuit failure (**41** or **42**), the circuit that is still intact takes control of the trailer control valve.

Release position

If air is evacuated from control ports **41** and **42**, the valve reverses and evacuates air from port **11** of the tristop brake actuator.

Braking position
(parking braking system)

When the hand brake valve is actuated, the two-way valve controls and evacuates air from port **1** of the quick release valve. Air is evacuated thereafter from port **12** of the tristop brake actuator via the quick release valve.

Release position

Due to the air supply to the hand brake valve (port **21**), air is supplied the tristop brake actuators (port **12**) via the two-way valve and the quick release valve, and thus released.

