Systems for Commercial Vehicles

Product Manual

System and Installation Instructions for KB4TA-G2

- 24 Volt Multi-Channel Trailer-ABS
- With integrated anti-compounding

KNORR-BREMSE

Disclaimer

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Content

Safety Checks

Before working on or around air braking systems and devices, the following precautions should be observed:

- Stop the engine before working under a vehicle.
- Park the vehicle on a level surface, apply the parking brakes, and always chock the wheels as depleting vehicle air system pressure may cause the vehicle to roll.
- Always wear safety glasses when working with air pressure.
- Never exceed manufacturer's recommended air pressures.
- Never look into air jets or direct them at anyone.
- When working under or around the vehicle, and particularly when working in the engine compartment, the engine should be shut off and the ignition key removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components. Additionally, it is advisable to place a clear sign on or near the steering wheel advising that there is work in progress on the vehicle.
- If the work is being performed on the vehicle's air braking system, or any auxiliary pressurized air systems, if it is necessary to drain the air pressure from reservoirs etc. keep clear of brake actuator push rods and levers since they may apply as system pressure drops. Be aware that if the vehicle is equipped with an air dryer system, it can also contain air pressure along with its purge reservoir if fitted.
- Never connect or disconnect a hose or line containing pressure; it may whip as air escapes. Never remove a device or pipe plug unless you are certain all system pressure has been depleted.
- Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- Examine all pipework for signs of kinks, dents, abrasion, drying out or overheating. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems. Check the attachment of all pipework; it should be supported so that it cannot abrade or be subjected to excessive heat.
- Use only genuine Knorr-Bremse replacement parts, components and kits.
- Never attempt to install, remove, disassemble or assemble a device until you have read and thoroughly understand the recommended procedures. Some units contain powerful springs and injury can result if not properly dismantled. Use only the proper tools and observe all precautions pertaining to use of those tools.
- Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle or component manufacturer.
- Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

Welding

To avoid damage to the EBS-module when carrying out electrical welding, the following precautions should be observed:

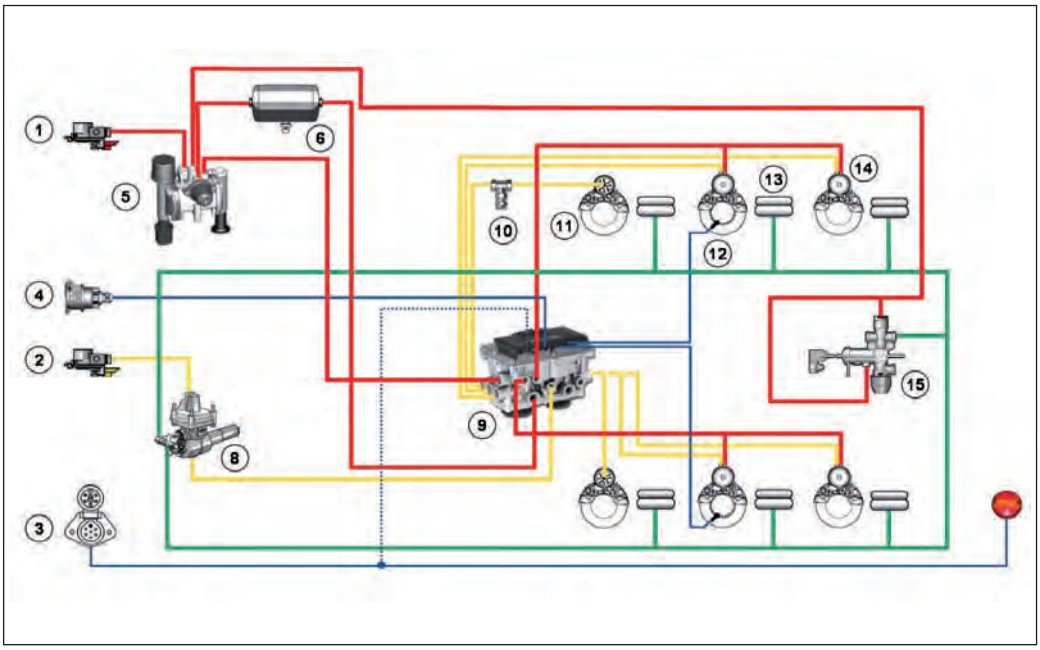
- In all cases before starting any electrical welding, first remove all connections.
- Note: When reinserting the sensor plugs (in reverse order) it is essential that they are fitted to their correct assigned position - if necessary this must be checked by PC-diagnostics.

1
Introduction

The Knorr-Bremse KB4TA-G2 module is an integrated trailer ABS controller and modulator for air-braked heavy-duty trailers, semi-trailers and full trailers. The module acts as two relay valves during normal braking, but during ABS events, it will intervene to help improve stability. All modules include an Electronic Control Unit (ECU) and two Modulator Relay Valves (MRV).

2 Main System Layouts

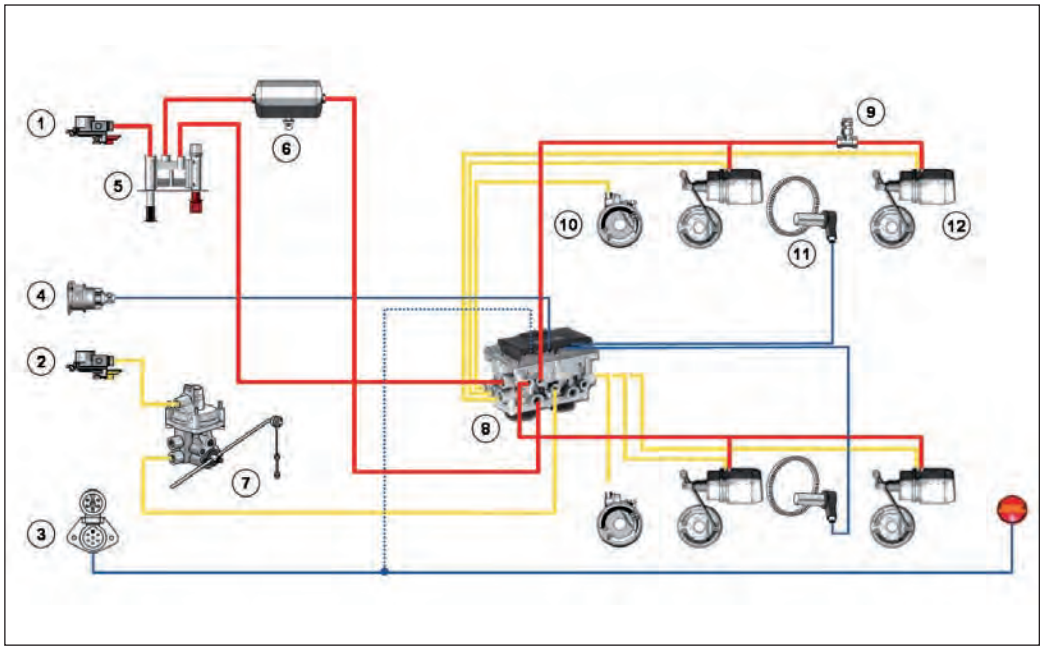
2.1 System Layout for air suspended semi-trailer



Legend:

(1) Coupling Head with Filter "Supply"
(2) Coupling Head with Filter "Control"
(3) Electrical Connection "Lighting" acc. to ISO1185
(4) ABS-Connector ISO7638
(5) Park-/Shunt Valve AE4311 with Emergency Function and Charging Valve
(6) Air Reservoir [e.g. 100 litre]
(7) Overflow-Valve
(8) Load-Sensing Valve BR5522 (e.g.)
(9) ABS-Module with 6 Ports
(10) Test Connector
(11) Brake Chamber
(12) Sensing Ring and Speed Sensor
(13) Air Spring Bellow
(14) Spring Brake
(15) Leveling Valve

2.2 System Layout for mechanical suspended semi-trailer



Legend:

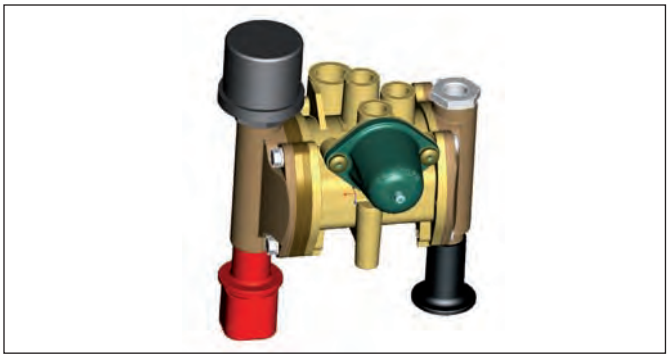
(1) Coupling Head with Filter "Supply"
(2) Coupling Head with Filter "Control"
(3) Electrical Connection "Lighting" acc. to ISO1185
(4) ABS-Connector ISO7638
(5) Park-/Shunt Valve AE4311 with Emergency Function
(6) Air Reservoir [e.g. 100 litre]
(7) Load-Sensing Valve BR4370 (e.g.)
(8) ABS-Module with 6 Ports
(9) Test Connector
(10) Brake Chamber
(11) Sensing Ring and Speed Sensor
(12) Spring Brake

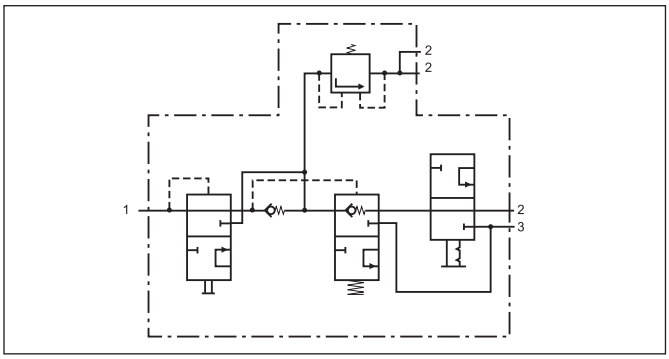
3. Component Description

3.1 Park-/Shunt Valve with integrated Overflow-Valve

Features:

- Priority to service braking system during charging
- Spring brakes held off during energy consumption test
- Spring brakes fully applied when reservoir pressure < 3.0 bar

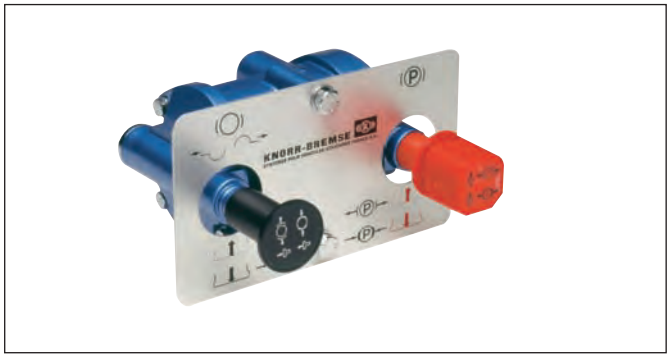


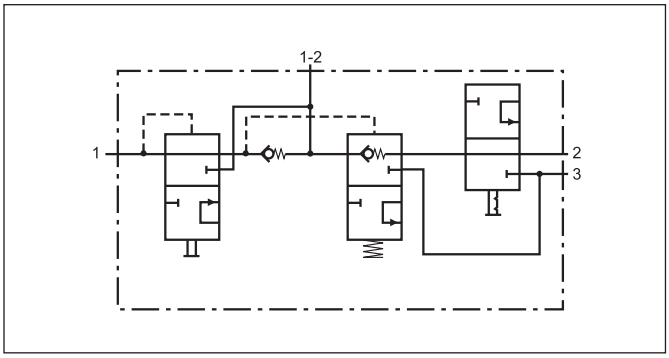


3.2 Park-/Shunt Valve without integrated Overflow-Valve (for mechanical suspended trailers)

Features:

- Priority to service braking system during charging
- Spring brakes held off during energy consumption test
- Spring brakes fully applied when reservoir pressure < 3.0 bar





3.3 Load Sensing Valve - Air suspension

Function:

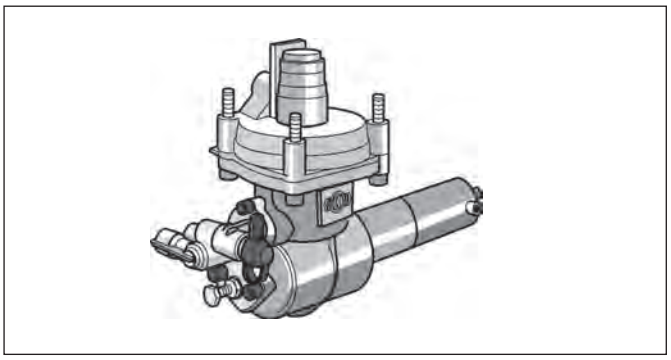
The load sensing valve is used to modify the applied service brake pressure in relation to the load imposed on the vehicle's axles. The air suspension load sensing valve uses the pressure in the suspension air bags to „sense" the load imposed on the axles and determine the valve's braking ratio.

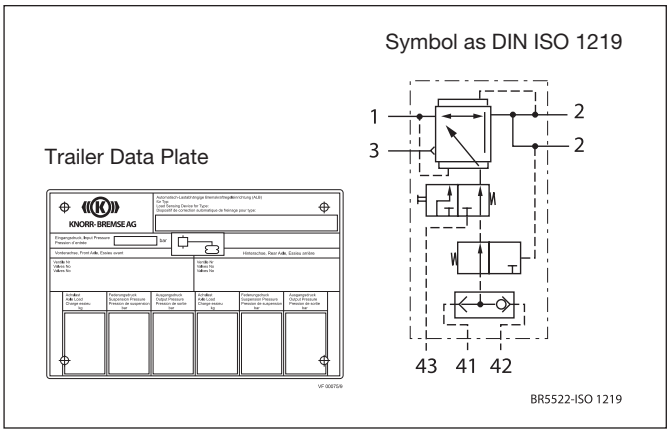
Versions of the valve are available with or without relay and emergency features, and with static or dynamic operation. A static valve uses the braking ratio at commencement of braking application, a dynamic valve adjusts the braking ratio throughout the brake application to help counteract the effect of load transfer.

A trailer data plate, showing the settings of the load sensing valve is required by law.

Technical Features:

- Maximum operation pressure: . . . . . 8,5 bar
- Operating temperature range: . . . -40 °C to +80 °C





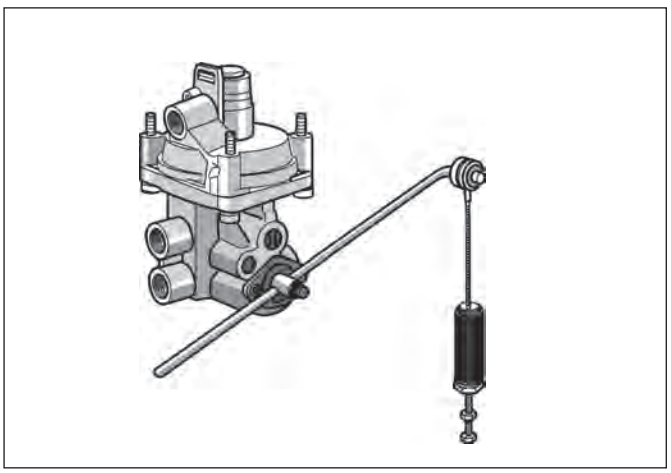
3.4 Load Sensing Valve - Mechanical suspension

Function:

The load sensing valve is used to adjust the applied service brake pressure in relation to the load imposed on the vehicle's axles. The mechanical suspension load sensing valve uses the movement between the vehicle's chassis and axles to „sense" the load imposed on the axles.

The valve is installed on the chassis and a linkage is required to connect the control arm of the valve to the axle(s). Any movement of the chassis changes the position of the valve's control arm which, in turn, alters the ratio of input pressure to output pressure.

Versions of the valve are available with or without relay and emergency features, and with static or dynamic operation.

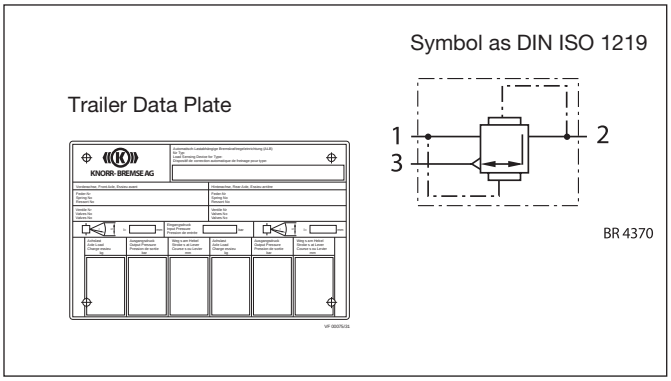


A static valve uses the braking ratio at commencement of braking application, a dynamic valve adjusts the braking ratio throughout the brake application to counteract the effect of axle load change due to load transfer.

A Trailer Data Plate, showing the settings of the Load Sensing Valve is required by law.

Technical Features:

- Maximum operation pressure: . . . . . 8,5 bar
- Operating temperature range: . . . -40 °C to +80 °C
- Working Angle: . . . . . 20°



3.5 Levelling Valve

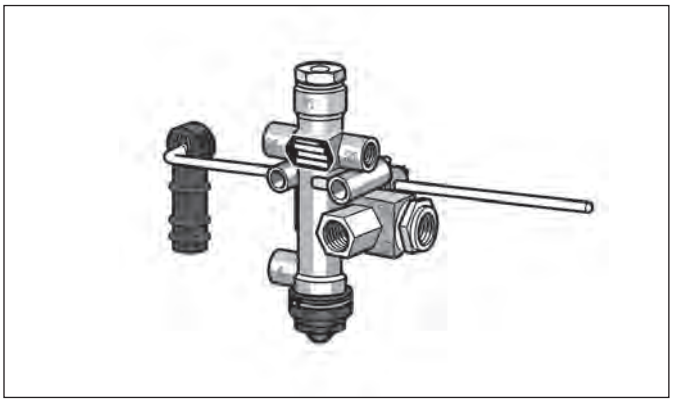
Function:

On vehicles fitted with air suspension, the leveling valve ensures that the axle Suspension air bags maintain a constant chassis height irrespective of the vehicle load

Versions with the „Height Limitation“ feature prevent the chassis height being manually raised above a set limit.

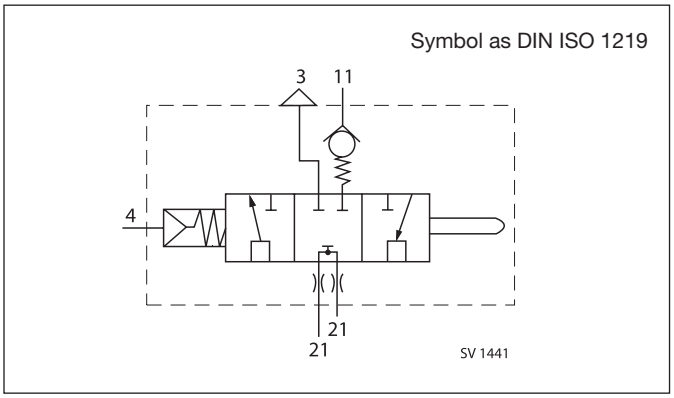
Versions with the „Second Ride Height“ feature allow the driver to pneumatically signal the valve and raise the chassis to an alternative ride height.

Transverse throttling prevents the rapid flow of air between the two outlet ports **21** (left and right side of the vehicle).



Technical Features:

- Maximum operation pressure: . . . . . 12 bar
- Operating temperature range: . . . -40 °C to +80 °C



3.6 Coupling Heads

Function:

Coupling heads are used to connect the braking system of the towing vehicle and trailer. An integral filter protects the air brake system and the auxiliary system of the trailer from contamination.

To prevent a blocked filter trapping air pressure in the supply or control lines, a by-pass feature allows air to flow back through the valve.

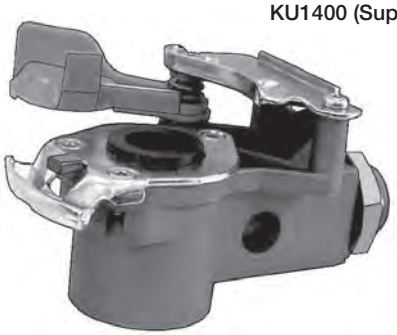
Coupling heads are colour coded to indicate the control (yellow) and supply (red) air line connections and are designed as defined in DIN ISO 1728 to prevent wrong connection.

The versions for semi-trailers are designed to prevent the rotation of the coupling head when connecting or disconnecting the air line.

Technical Features:

- Maximum operation pressure: . . . . . 8,5 bar
- Operating temperature range: . . . -40 °C to +80 °C
- Medium: . . . . . Compressed air
- Filter: . . . . . .Integrated
- Approximate weight: . . . . . 0.3 kg
- Yellow and red coupling heads are not interchangeable

KU1400 (Supply - Red)



VF 00199_161

KU1410 (Control - Yellow)

VF 00199_162

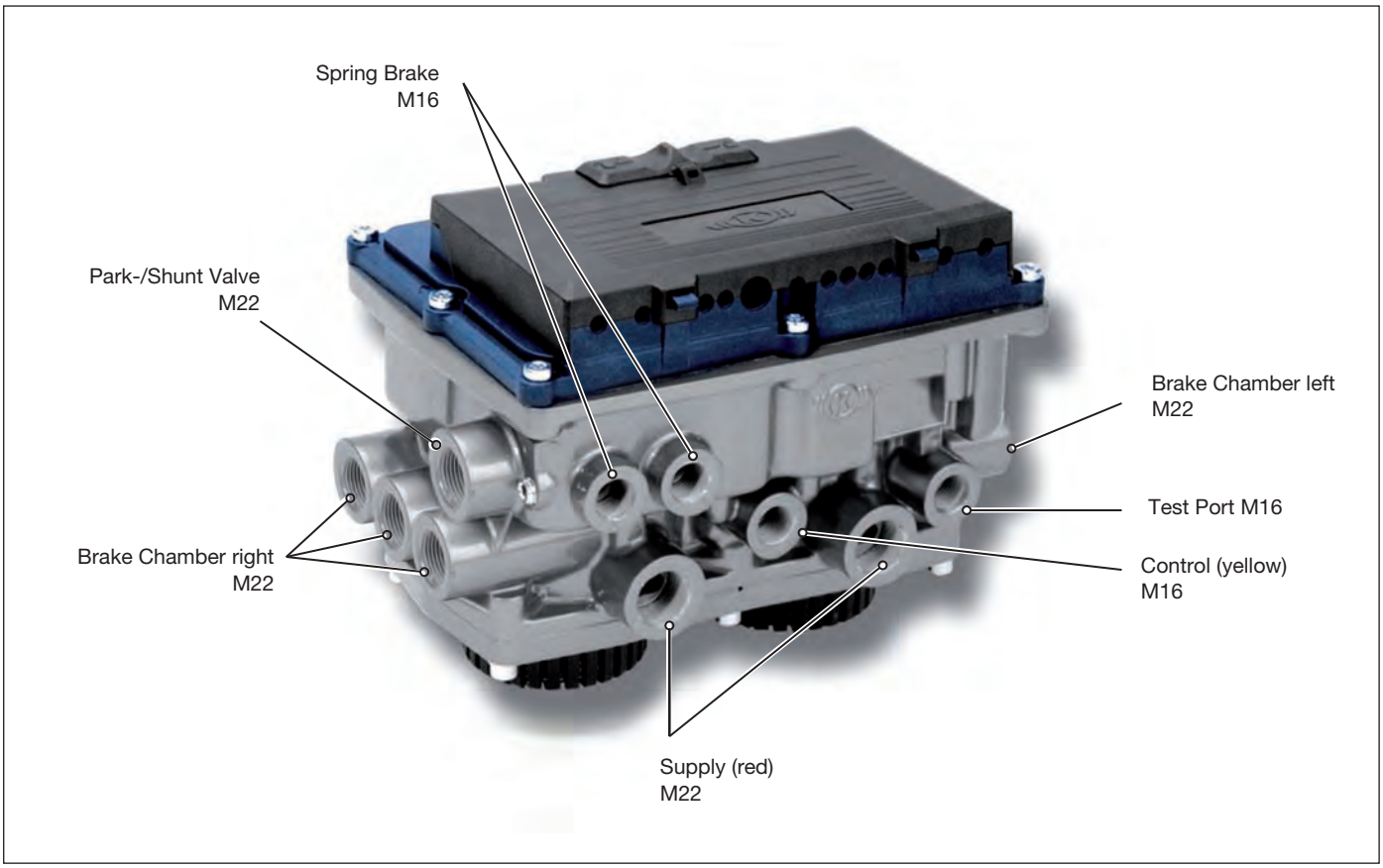
Symbol as DIN ISO 1219

VF 00199_162

3.7 Trailer ABS Module

3.7.1 Pneumatic Connections

KB4TA-G2: 24 Volt Trailer Anti-lock System: Pneumatic connections



Features:

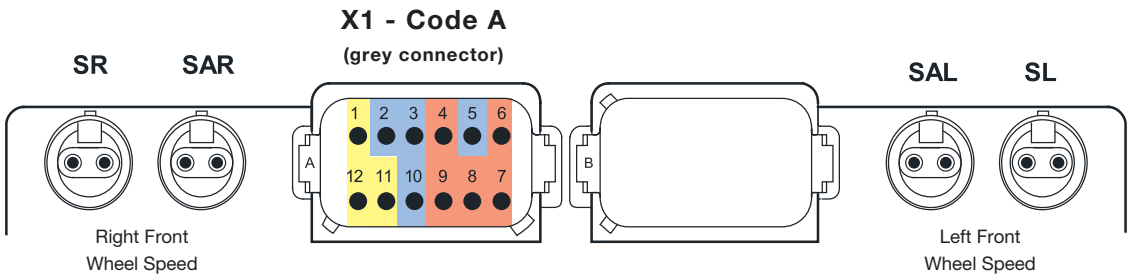
- Mechatronic Module for multi-channel
  - application
  - System configurations
  - 2S/2M - 4S/2M - 4S/3M
- Applications:
  - Semi-trailer
  - Centre-axle trailer
  - Full trailer
- Auxiliary functions:
  - *Speed pulse
  - *Programmable speed switch
  - Brake wear monitoring
  - Stop lamp powering
  - Headboard warning lamp
  - 24V Supply

* Only available with special Part Numbers

- Automatic System Configuration up to 4S/2M
- Blink-Code activation via Stop light

3.7.2 ECU Connectors

The Knorr-Bremse KB4TA-G2 module ECU connectors use a 12-pin Deutsch DT series connector for ISO 7638 power supply, diagnostics and auxiliary I/Os like ISO 1185 stop light power supply, additional 3rd modulator and 1 additional Input/Output. The module also utilizes up to 4 wheel speed sensor-inputs



Pin.	Signal	Description
X1-1	AUXI01	Auxiliary Input/Output (4S/3M: Valve 3rd Modulator)
X1-2	AUXRET23	Return Line for AUXI02 and AUXI03 (Diagnosis Ground)
X1-3	TI_CANL	5V-CAN Low for Diagnosis
X1-4	GND_M	System Ground (ISO 7638 - ABS connector - Pin 4)
X1-5	TI_CANH	5V-CAN High for Diagnosis
X1-6	BAT	Valve Supply Voltage (ISO 7638 - ABS connector - Pin 1)

Pin.	Signal	Description
X1-7	GND_H	Warning Lamp Ground (ISO 7638 - ABS connector - Pin 3)
X1-8	WL	Warning Lamp (ISO 7638 - ABS connector - Pin 5)
X1-9	IGN	ECU Supply Voltage
X1-10	AUXI03 (DIA)	Auxiliary Input/Output (Diagnosis Supply Voltage)
X1-11	AUXI02/ GND_BL	Auxiliary Input/Output (Brake Light ground)
X1-12	AUXRET1/BL	Return Line for AUXI01 (Brake Light Supply) (4S/3M: Return Line 3rd Modulator)

ISO 7638 Connection (5 Pins)

X1.4 = ISO 7638 Pin 3 valve-ground

X1.6 = ISO 7638 Pin 1 valve supply

X1.7 = ISO 7638 Pin 4 Ignition / warning lamp Ground

X1.8 = ISO 7638 Pin 5 warning lamp

X1.9 = ISO 7638 Pin 2 ignition

Diagnostic Connector

KB4TA-G2 harnesses provide a 4-pin 5 Volt J1939 CAN diagnostic connection for a diagnostic tool. Remote diagnostic cables are available from Knorr-Bremse to provide a J1939 diagnostic port at the side of the trailer.

X1.2 = Diagnosis ground

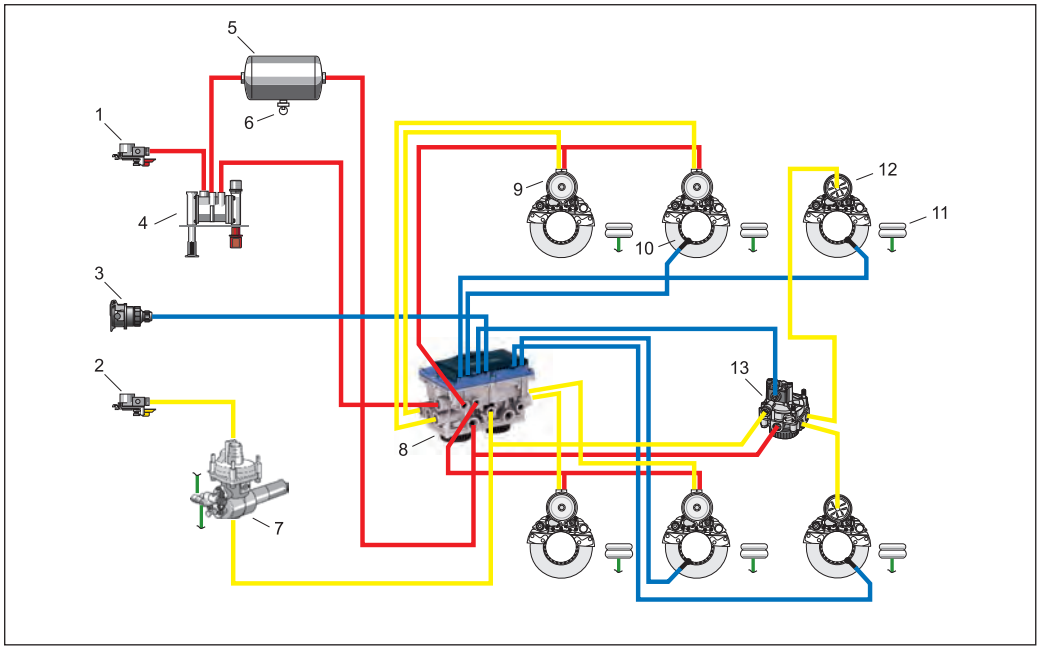
X1.3 = 5 Volt CAN low

X1.5 = 5 Volt CAN high

X1.10 = 24 Volt diagnosis supply

4. Layout “3M-System”

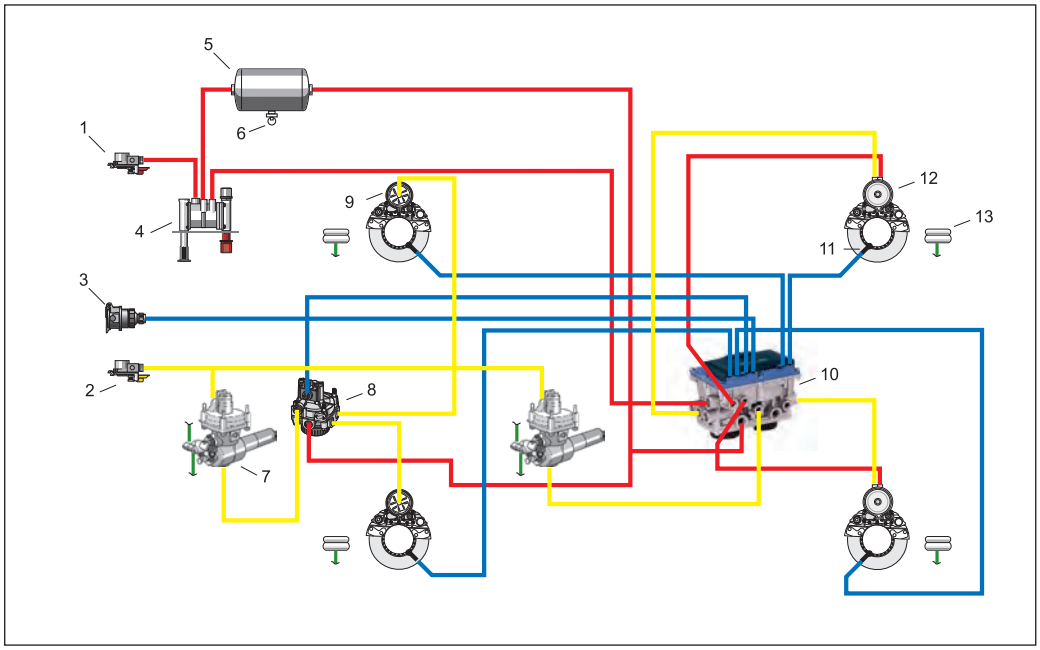
4.1 System layout for air-suspended semi-trailer



Legend:

(1) Coupling Head with Filter “Supply”
(2) Coupling Head with Filter “Control”
(3) ABS-Connector ISO7638
(4) Park-/Shunt Valve AE4311 with Emergency Function and Charging Valve
(5) Air Reservoir [e.g. 100 litre]
(6) Overflow-Valve
(7) Load-Sensing Valve BR5522 (e.g.)
(8) ABS-Module with 6 Ports
(9) Spring Brake
(10) Sensing Ring and Speed Sensor
(11) Air Spring Bellow
(12) Brake Chamber
(13) Levelling Valve

4.2 System layout for air-suspended full-trailer



Legend:

(1) Coupling Head with Filter “Supply”
(2) Coupling Head with Filter “Brake”
(3) ABS-Connector ISO7638
(4) Park-/Shunt-Valve AE4311 with Emergency Function and Charging Valve
(5) Air Reservoir [e.g. 100 litre]
(6) Overflow-Valve
(7) Load-Sensing-Valve BR5522 (e.g.)
(8) Levelling Valve
(9) Brake Chamber
(10) ABS-Module with 6 Ports
(11) Sensing Ring and Speed Sensor
(12) Spring Brake
(13) Air Spring Bellow

4.3 Knorr-Bremse BR9234 ABS Modulator Relay Valve

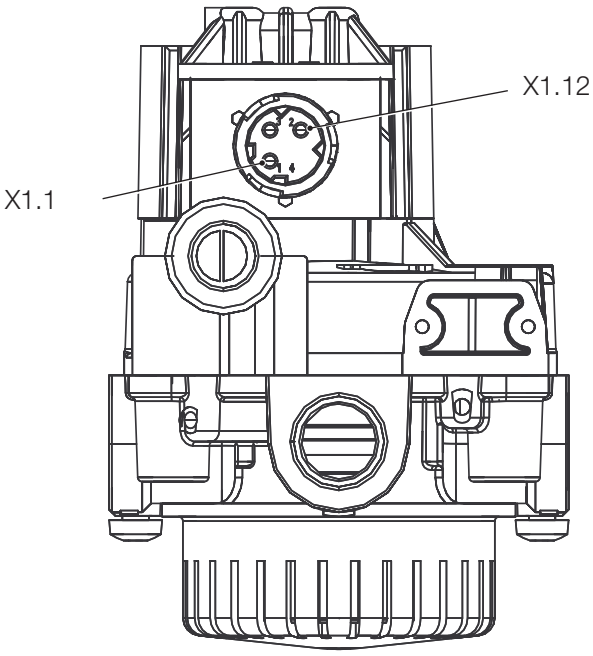
Knorr-Bremse BR9234 modulator relay valves (MRV) is required for “3M” Antilock-applications. The MRV is an electro-pneumatic control valve and is the last valve that air passes through on the way to the brake chambers. The normally-closed exhaust solenoid is activated to precisely modify the brake pressure on command. During normal braking, the BR9234 MRV functions as a standard relay valve. As brakes are applied or released by the driver, the control signal from the tractor foot brake causes the BR9234 MRV to apply proportional pressure to the trailer brake chambers.

4.4 3rd ABS Modulator Connection

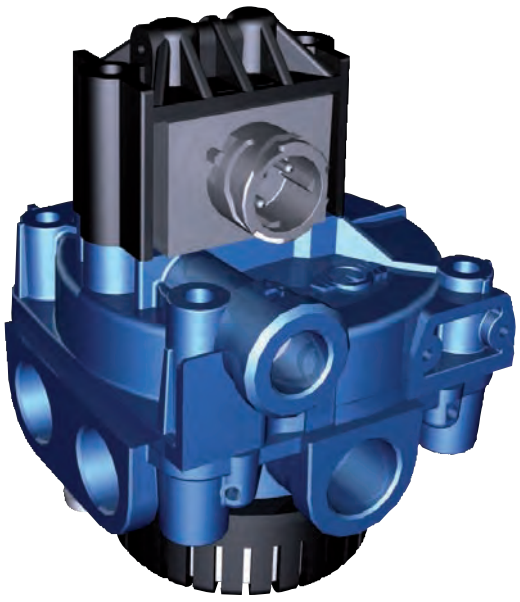
X1.1 Connection to exhaust coil of BR9234 MRV

X1.12 Connection to Common (GND)

Relay Valve



Front view showing pin connection

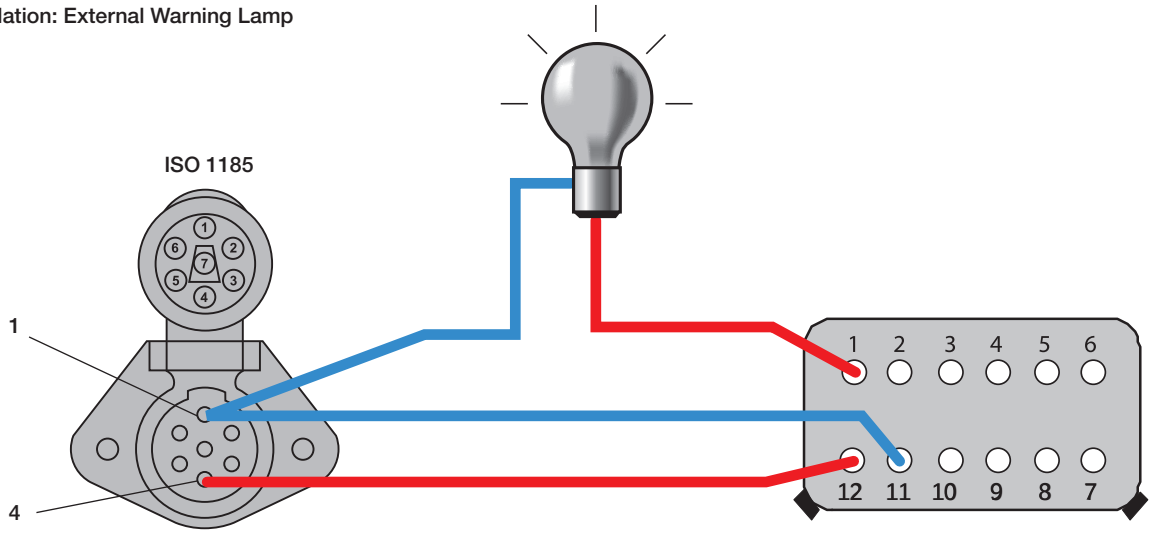


Perspective view

4.5 Auxiliary I/O Connector

The KB4TA-G2 module provides an option for a single auxiliary Input/Output on pin X1.1 e.g. external warning lamp

Installation: External Warning Lamp



Pin	ISO 1185 Connector
1	Common return
2	Left-hand rear position and end outline marker light and rear registration plate illuminating device
3	Left-hand direction-indicator light
4	Stop light
5	Right-hand direction-indicator light
6	Right-hand rear position and end outline marker light and rear registration plate illuminating device
7	Braking control for trailers

5 Wiring / Harness

Several wiring harnesses are available to connect the KB4TA-G2 module and other trailer system components. Harnesses are weather sealed at the connector interface and are clearly labelled for proper installation.

Because of the over-moulded design of the KB4TA-G2 module wiring harnesses, Knorr-Bremse recommends that a complete harness be replaced if damage or corrosion occurs.

The following connector options may be present:

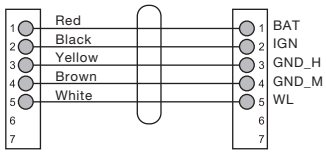
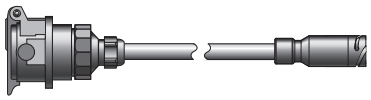
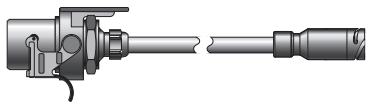
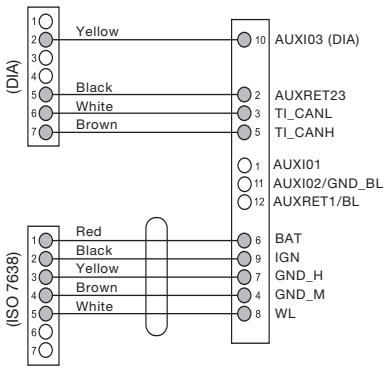
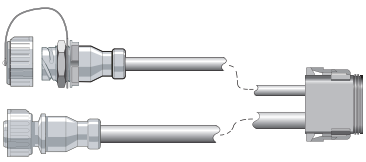
- ext. Modulator (M2)
- auxiliary
- diagnostic
- additional axle wheel speed sensors.

Note: All KB4TA-G2 modules include the four wheel speed sensor connections.

Four 2-pin connectors are provided for additional wheel speed sensors for 4S ABS applications:

- SL & SR are foreseen for 2S/2M applications
- SAL & SAR are additional connections for 4S/XM-Application (X=2 or 3). Additional Sensor Left (SAL), and Additional Sensor Right (SAR) can be installed at certain configurations on lift axles.

Table of power supply cables available from Knorr-Bremse.

Part No.	Description	Cable Length (m)	Wiring Diagram	Picture
2264462396 2264462397 2264462398	Power supply cable with socket (for Semi-trailers)	8.0 12.0 14.0		
2264462399 2264462400	Power supply cable with plug (for drawbar trailers and centre axle trailers)	8.0 10.0		
K010838	Power supply + Diagnostics	6.0 (DIA) 0.5 (ISO 7638)		

continued on following page.....

Table of power supply cables continued...

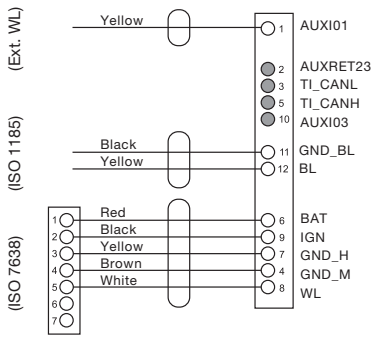
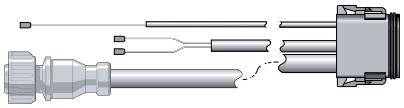
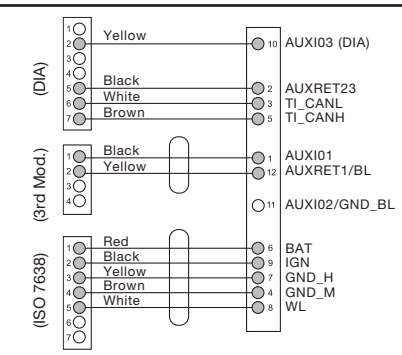
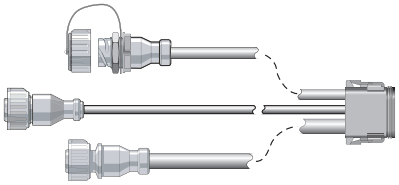
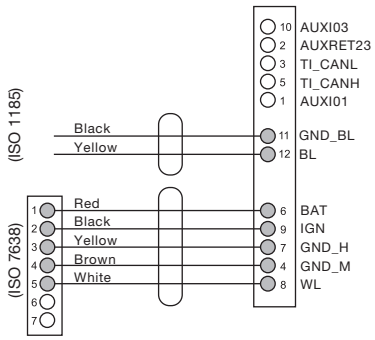
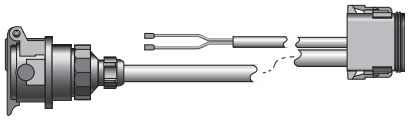
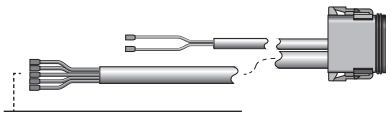
Part No.	Description	Cable Length (m)	Wiring Diagram	Picture
K016660	Power supply + External warning lamp	15.0 (Ext. WL) 15.0 (ISO 1185) 0.5 (ISO 7638)		
K016991*) *)available from Qu. 4/2006	Power supply + Diagnostics + 3rd ABS Modulator	6.0 (DIA) 10.0 (3rd Mod.) 0.5 (ISO 7638)		
K015313	Power supply cable with socket - Direct to X1 Connector	12.0 (ISO 1185) 12.0 (ISO 7638)		
K015468	Power supply cable without socket or plug - Direct to X1 Connector.	12.0 (ISO 1185) 12.0 (ISO 7638)		 possible connection for: - Socket K002290 - Plug K002291

Table of extension cables available from Knorr-Bremse.

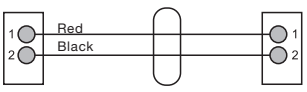
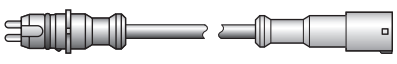
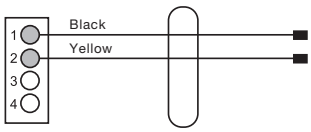
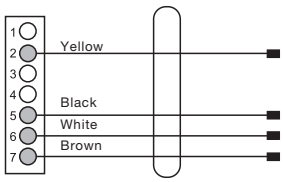
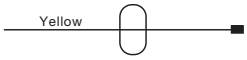
Part No.	Description	Cable Length (m)	Wiring Diagram	Picture
II36756...	Extension cable for speed sensor	2.0 3.0 4.0 5.0 6.0 8.0 10.0 12.0 15.0		

Table of modular system cables available from Knorr-Bremse.

Part No.	Description	Cable Length (m)	Wiring Diagram	Picture
K002274* K002275* K002276* K017003*	Connecting cable for 3rd ABS Modulator	2.0 6.5 10.0 15.0		
K013194	Diagnostic cable	4.0		
K016629 K016630	External Warning Lamp	7.0 15.0		

* Starting from production date (ww/yy): 27/06 (Cable imprint)

5.1 Laying of extension cable speed sensor and connection cable modulator

The rotation angle of the fifth wheel and the suspension travel must be taken into account when calculating cable length and during installation.

To reduce the risk of faults in the system we recommend the following:

1) To lay the modulator cable and the sensor cables separately on the vehicle frame. The sensor cable should have a minimum distance to other cables ofapproximately 5 –10 cm. If it is possible the cabling should not run parallel to the main cabling harness.

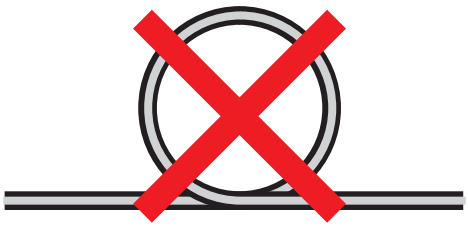
2) Cables installed in conduit must be protected with cable grommets as well as consider maximum of spring travel.

3) It is not permitted to 'lose' any excessive length of the extension and connection cables in circular loops or ring form. Excess cable should be detoured or folded (see diagram).

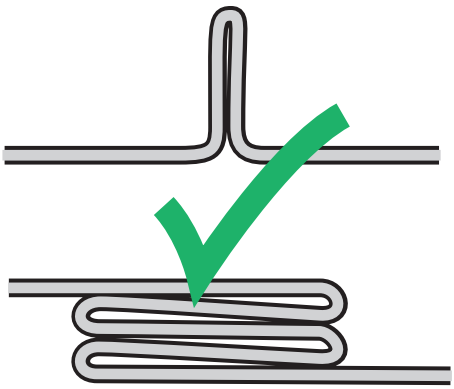
Wire cross section

- Modulator cable: . . . . . 1.0 mm²
- Sensor cable: . . . . . 0.75 mm²

Correct laying of excessive cable length



Circular looping is **not** permissible



Permissible methods

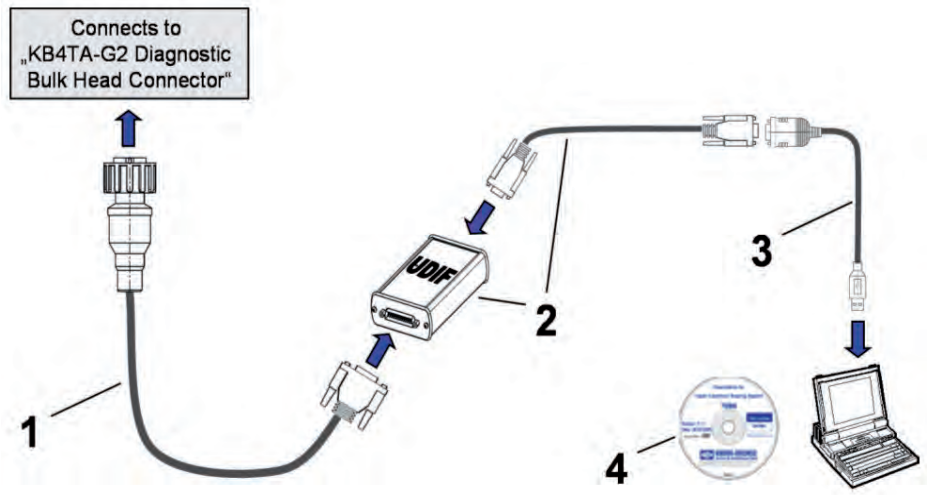
6 Diagnostic Tools

In order to configure the KB4TA-G2, carry out End Of Line testing and system checks, special hardware and software is required. The required parts are listed below:

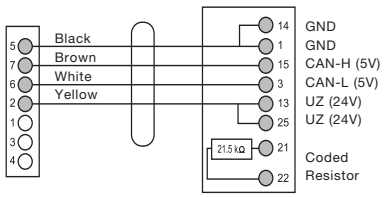
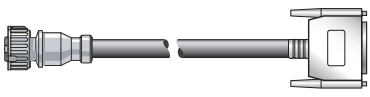
Pos	Name	Type-No.	Part-No.	Description
1	Diagnostic cable	EZ1037	K010837	length = 3m
2	Diagnostic Set UDIF[1)]	EZ1031	II39809F	included connection cable **Z005474** (9-pin sub-D-plug and 9-pin sub D-socket)
3	Connection cable		Z007887	optional for USB-connection to PC
4	Diagnostic software		K015844	CD-ROM “ECUTalk”

1) UDIF = Universal Diagnostic Interface

Diagram showing the diagnostic connection set-up



Adapter cable available from Knorr-Bremse.

Type No. + Description	Part No.	Cable Length (m)	Wiring Diagram	Picture
EZ1037 Adapter cable for UDIF (for 5V CAN Diagnostics)	K010837	3		

7 Wheel Speed Sensor

Wheel speed data is provided to the KB4TA-G2 module from the DF4 wheel speed sensors. Vehicles have an exciter ring (or “tone ring”) as part of the wheel assembly, and as the wheel turns, the teeth of the exciter ring pass the wheel speed sensor, generating an AC signal. The KB4TA-G2 module receives the AC signal, which varies in voltage and frequency as the wheel speed changes. (The default setting expects a 100-tooth tone ring to be used.) Vehicle axle and ABS control configurations determine if two or four wheel speed sensors are required.

A proper sensor installation is critical for correct ABS operation.

1) For increased corrosion protection we recommend that a high-temperature rated silicon- or lithium-based grease be applied to the interior of the mounting block, the sensor, and to the new clamping sleeve.
2) Install the new clamping sleeve fully into the block, with the retaining tabs toward the inside of the vehicle. Please note that DF4 wheel speed sensors must use the correct clamping sleeve to avoid problems associated with reduced retention force, such as sensor movement, and resulting ABS trouble codes.
3) Gently push (DO NOT STRIKE) the sensor into the mounting block hole until it contacts the face of the tone ring. Secure the cable lead wire to the knuckle/ axle housing 10-15 cm from the sensor.
4) Apply a moderate amount of dielectric non-conductive grease to both the sensor connector and harness connector.
5) Engage the connectors, and push together until the lock tab snaps into place.

NOTE: It is important for the wheel bearings to be adjusted per the manufacturer‘s recommendations

The friction fit allows the DF4 sensor to slide back and forth under force but to retain its position when the force is removed. When the DF4 sensor is inserted all the way into the mounting block and the wheel is installed on the axle, the hub exciter contacts the sensor, which pushes the sensor back. Also, normal bearing play will “bump” the sensor away from the exciter. The combination of these two actions will establish a running clearance or air gap between the sensor and exciter.

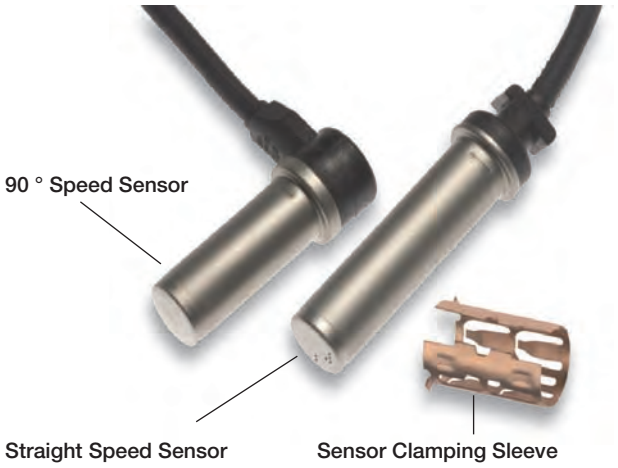
Excessive wheel end play can result in diagnostic trouble codes in cases where the sensor is pushed too far away from the tone ring.

Let us start from the assumption that the pole wheel and the speed sensor are available. Before installation you should grease the location bore and the outer diameter of the clamping sleeve II16774.

Order number: I90693 (25g tube)

The clamping sleeve should be pushed in the bore by hand until it reaches the stop Ø18 H11, never use excessive force

Typically, the DF4 sensor is installed in mounting blocks that are welded to the axle housing. DF4 wheel speed sensors are protected by a stainless steel sheath. They are designed to be used with a beryllium copper clamping sleeve (sometimes referred to as a “retainer bushing”, “friction sleeve” or “clip”). The clamping sleeve provides a friction fit between the mounting block bore and the DF4 sensor.



(e.g. by hitting it with a hammer), as this may damage the sensor, sensor sleeve or surrounding area.

Next insert the DF4 until it makes contact with the pole wheel. The necessary air gap between the pole wheel and speed sensor is obtained automatically after a few wheel turns (assuming the wheel-bearings are performing correctly).

If the air gap is >1 mm or, the signal is too low, the speed sensor has to be adjust.

Attention:

Never use excessive force when fitting the speed sensor (e.g. using a hammer or similar tool) as the speed sensor heads could be damaged.

In such cases when the DF4 is replaced, it is recommended the clamping sleeve also be replaced (Part No. II16774).

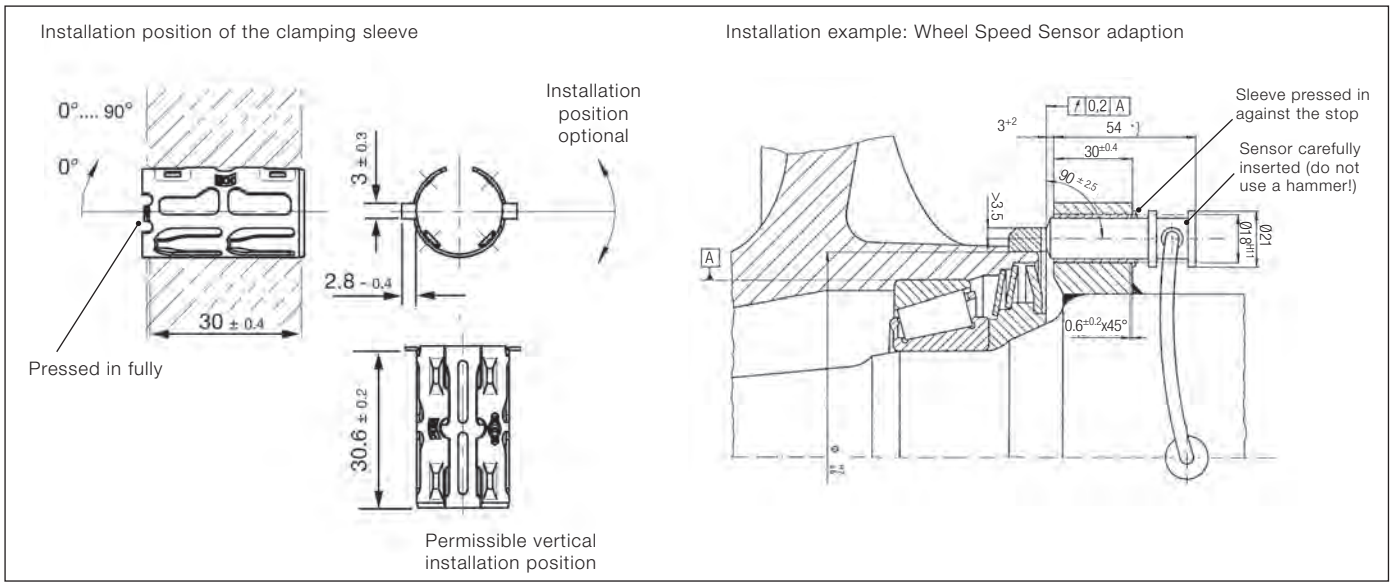
The DF4 cable should be fixed at a short distance of approx. 50 mm behind the DF4, to avoid possible damage and limit vibration at the axle tube. A longitudinal displacement may not be hindered.

Next fix the cable at the brake hose. By the cable installation it is important that maximum distance from the heat radiation components (wheel brake) is achieved.

The plug connection between sensor and extension cable should be fixed at both sides.

Fasten cables using cable clips (not available by KB), individual suspension travel should be taken into account to avoid possible damage. If necessary the cable should be secured at the cover sheet of the wheel brake with a cable grommet!

Diagram showing mounting position of sleeve and sensor



8 Module Main function

8.1 Customer Scratch Pad

The KB4TA-G2 module has a customer scratch pad feature which allows the customer, or end-user, to store up to 756 bytes of information. This information can then be read using the Knorr-Bremse KB4TA-G2 Diagnostic Software.

8.2 Power-up Sequence

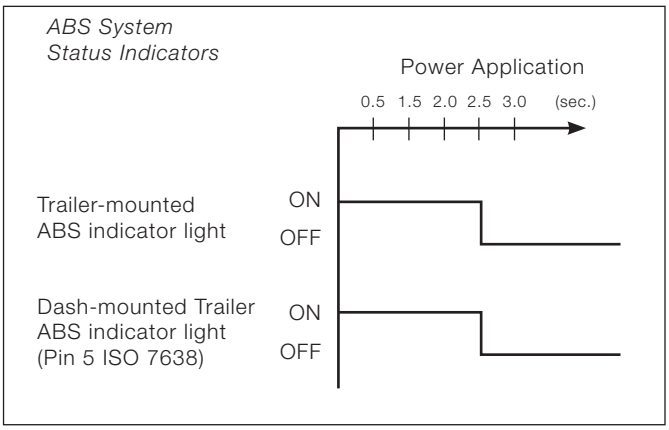
At power-up, the KB4TA-G2 module performs a series of self-checks that can assist a technician to determine the ABS system status and configuration.

8.3 Trailer ABS Indicator Lamp

At power-up (when no faults are detected) the trailer ABS indicator lamp will turn on for 2.5 seconds as a bulb check and then turn off. If a fault has been detected the bulb will remain on.

8.4 Modulator Chuff Test at Power-up

At power-up, the KB4TA-G2 module activates a modulator chuff test. This electrical and pneumatic ABS modulator test can help the technician identify problems with modulator installations and/or wiring. With brake pressure applied, a properly installed modulator will cause five rapid audible chuffs of air pressure. If additional modulators are installed, the KB4TA-G2 module activates 5 chuffs at the internal modulators then for the additional modulator (MOD3). The chuff sequence is then repeated. If the modulator is wired incorrectly, the modulator will only produce one chuff, or no chuffs at all. If a fault is detected during the modulator chuff test, compare the modulator wiring and plumbing to the KB4TA-G2 module's electrical system schematic and make any necessary repairs.



8.5 ABS Operation

The KB4TA-G2 module uses wheel speed sensors, modulator relay valves and an ECU to control trailer wheels either distributed by axle or vehicle side. By monitoring individual wheel turning motion during braking, and adjusting or pulsing the brake pressure at each wheel, the KB4TA-G2 module is able to optimize slip between the tyres and the road surface. When excessive wheel slip, or wheel lock-up, is detected, the ECU will activate the pressure modulator valves to modulate braking pressure at the wheel ends. The ECU is able to pump the brakes on individual wheels (or pairs of wheels), independently, and with greater speed and accuracy than a driver.

8.5.1 Normal Braking

During normal braking, the KB4TA-G2 module functions as two standard relay valves in parallel. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and the vehicle stops with normal braking.

8.6 Odometer Function

8.6.1 Odometer

The KB4TA-G2 includes an odometer function to provide a means of storing the accumulated mileage of the vehicle. The mileage is computed by utilizing information calculated from the vehicle wheel speeds. This feature is accurate to within 0.62 km per power-up and will typically store mileage up to 1,000,000 km The mileage can be displayed using PC diagnostics or through blink codes.

8.6.2 Trip Counter

The module provides a counter to record the trip mileage. The feature is accessed through PC.

8.6.3 Service Interval

The KB4TA-G2 module provides a feature that can be used to indicate a service interval for the trailer. The service

interval can be accessed via PC. If configured, the KB4TA-G2 module can flash the indicator lamp when the vehicle is at standstill to indicate when the service interval has been exceeded.

8.7 Non-standard Tyre Size

The module allows for tyre rolling radius and tone ring tooth count parameters to be set for each axle using a diagnostic tool. These adjustments may be necessary for the module to accurately calculate the vehicle velocity and odometer mileage. Wheels of the same axle must be set to the same rolling radius and tone ring tooth count. In most cases, these parameters are set by the trailer OEM and do not need to be adjusted.

In the case of a service replacement unit, always check that these parameters are set to match the vehicle. Refer to the manufacturer's tyre specification for correct values. Tone ring tooth count is defaulted to 100 teeth and can be set to 60 to 140 teeth.

8.8 Diagnostic Trouble Code Detection

The KB4TA-G2 module contains self-testing diagnostic circuitry that monitors the ABS components and wiring. When the module senses an erroneous system condition, it activates the trailer-ABS indicator lamp, disables all or part of the affected ABS functions, and it stores the fault code in memory.

For some trouble codes, the KB4TA-G2 module will automatically reset ("self-heal") the active diagnostic trouble code when the error is corrected. However, repeated occurrences of a given trouble code can cause the code to "latch" - that is, be retained as active, even if the condition is only intermittent.

Once the code is latched, a manual reset will be necessary. Technicians can use these latched codes to assist them in troubleshooting intermittent errors. After the problem is repaired, trouble codes can be reset using blink code diagnostics or with a diagnostic tool. When a trouble code self-heals or is manually reset, the code remains stored in the ECU memory. This trouble code history can be retrieved using blink code diagnostics or with a diagnostic tool.

8.8.1 Auto-configuration

The KB4TA-G2 module is by default configured in the 2S/2M ABS configuration . At power-up, if the KB4TA-G2 detects additional sensors, it will perform an auto-configuration. An Auto-configuration only adjusts upward (from 2S/2M Side to a 4S/2M Side configuration only). Additional detected components that do not conform to a legitimate configuration will generate the appropriate faults. If the vehicle begins moving before the new configuration has been accepted, the reconfiguration will not take place at this time.

8.8.2 Partial ABS Shutdown

Depending on the trouble code detected, the ABS ECU partly or completely disables the ABS functionality. The trailer ABS system, on vehicles that only have two modulators, is disabled by any single fault. In the case of vehicles with more than two sensors or more than two modulators, depending on the trouble code, the trailer ABS system may still provide some level of ABS function on axles that are not affected by the fault, but the ABS indicator lamp will remain on. In cases where the ABS is completely disabled, the vehicle reverts to normal braking (without ABS interventions). Always repair ABS shutdowns at the earliest opportunity.

8.8.3 ECU Diagnostic Trouble Codes

All ABS functions are completely disabled. The system reverts to normal braking.

8.8.4 Voltage Diagnostic Trouble Code

While voltage is out of range, the ABS functionality is disabled and the system reverts to normal braking. When the correct voltage level is restored, full ABS is typically available again. The operating voltage range is 18.0 to 32.0 VDC.

9 Blink Code Diagnostics

The KB4TA-G2 module provides diagnostic and configuration functions through blink code diagnostics. This means that the technician, even without diagnostic tools, can read a series of ABS indicator lamp(s) blinks to diagnose the trouble codes being generated.

The blink code diagnostics mode is entered by providing constant power to the ignition circuit and toggling the brake light power input three times. With a parked towing vehicle attached, this is done by applying ignition power and after the power up sequence is complete, depressing and releasing the brake pedal three or more times. Depending on the blink code mode activated, the KB4TA-G2 module will blink the trailer ABS indicator lamp(s) to display:

- active fault codes
- fault code history
- ABS configurations
- Odometer mileage.

Blink code diagnostics can also be used to reset active fault codes. Wait until after the modulator chuff test before activating the brake light power. Following a single display of all available messages, the trailer ABS indicator lamp(s) will remain on for five seconds and then return to normal operating mode.

Blink code diagnostics can only be activated following a power-up, where wheel speeds have not been detected. If the vehicle moves during blink code diagnostics mode, the module will cancel the blink code diagnostics and return to normal operating mode. Blink code diagnostics must be activated within the first 15 seconds of ignition power being applied.

If brake light power is continuously applied for greater than five seconds, blink code diagnostics will be disabled until the next time the ignition power is cycled.

9.1 Display Active Diagnostic Trouble Codes

To display active codes, apply ignition power and depress /release the brake pedal 3 times within 15 seconds. Following activation, there will be a 5 second delay followed by a blink code display of all active fault codes.

9.2 Display Diagnostic Trouble Code History

To display trouble code history, apply ignition power and depress/release the brake pedal 4 times within 15 seconds. Following activation, there will be a 5 second delay followed by a blink code display of all history fault codes.

9.3 Reset Active Diagnostic Trouble Codes

To reset active codes, apply ignition power and depress /release the brake pedal 5 times within 15 seconds. Following activation, there will be a 5 second delay followed by a blink code message of: 1-1, (System Fully Operational - No Codes Detected) or a blink code display of all remaining active fault codes. The ABS indicator lamp will stay on if active DTCs are still present. Resetting active fault codes with blink code diagnostics does not clear information from trouble code history. Both blink code diagnostics or diagnostic tools can retrieve trouble code history, but only diagnostic tools can erase this information.

9.4 Display Odometer Mileage

To display the trailer odometer mileage, apply ignition power and depress/release the brake pedal 7 times within 15 seconds. Following activation, there will be a 5-second delay followed by a blink code display of the odometer information (x1000). Example: 152,431 km will be displayed as: 152 (x1000) or 1 blink (pause), 5 blinks (pause), 2 blinks. Zeros will be displayed by the ABS indicator lamp flashing twice. Odometer mileage cannot be altered with blink code diagnostics. Complete odometer information can be retrieved using a diagnostic tool.

9.5 Diagnostic Trouble Codes (DTCs)

ALB sign attached to the vehicle showing the DTCs

1st Blink Code		2nd Blink Code	
Code	Location	Code	Description
1	All	1	No faults
2	Sensor SL	1	Sensor signal valid - large air gap
3	Sensor SR	2	Sensor signal valid - loss of signal
4	Sensor SAL	3	Sensor signal valid - noisy
5	Sensor SAR	4	Sensor shorted or open
		5	Tire diameter out of range
		6	Sensor Configuration error
6	Power	1	Over-voltage
		2	Low-voltage
		3	Excessive Resistance ISO7638 pin 1
7	Valve M22 (Int)	2	Exhaust solenoid shorted or open
8	Valve M21 (Int)	3	ABS modulator dynamic error
9	AUXIO1 / M2	4	Valve configuration error
10	Common	1	Internal low-side switch shorted to ground
		2	AUXIO1 (M2) low-side switch shorted to ground
		3	ABS modulator dynamic error - all valves
		4	Excessive ABS activity
		5	AUXIO1 (M2) low-side switch shorted to battery
11	ECU	1	ECU internal error
		2	ECU configuration error
12	AUXIO2	1	Shorted or open
13	AUXIO3		
14	System	2	Service Interval Exceeded

KNORR-BREMSE

Bendix®

Trailer-ABS KB4TA-G2

To Read/Clear Diagnostic Troubleshooting Codes (DTC's):

1. Apply constant power to the trailer (ignition switch).
2. Within 15 seconds, apply/release the brake pedal at 1 second intervals:
   a) 3 times for Active DTC's.
   b) 4 times for Inactive DTC's.
   c) 5 times for clearing Active DTC's.
3. After a 5 second delay, the blink codes will be activated.
4. Observe the Trailer-ABS indicator lamp and record blink code(s).
5. Refer to blink code chart for description.
6. After making repairs and clearing DTC's, verify lamp is no longer illuminated.

Note: Blink Code is only working with Stop light supply configured and only for ABS systems 2S/2M and 4S/2M!

10 Diagnostic Trouble-shooting Flowcharts

Diagnostic trouble code information can be retrieved from the KB4TA-G2 module by using blink code diagnostics, or a diagnostic tool. The following troubleshooting flow charts will help the technician isolate the cause of the fault and confirm whether the fault resides in the component, wiring or connectors.

Troubleshooting should always begin by observing the dash or trailer-mounted ABS indicator lamp during the KB4TA-G2 module‘s power-up sequence.

If it is necessary to make electrical measurements, always begin by taking voltage and resistance measurements at the 12-pin ECU pigtail harness connector.

Once the circuit fault is found, isolate the area needing repair by repeating the measurements at all connections in the affected circuit towards the modulator, wheel speed sensor, etc.

No voltage or resistance measurements are to be made on the bulkhead connector pins of the module.

The following pages contain detailed information on:

Section A: (Diagnostic Trouble Code)

Blink Code Quick Reference

Section B: (Power-Up-Sequence)

Dash-Mounted ABS Indicator Lamp

Section C: (Power-Up-Sequence)

Trailer-Mounted ABS Indicator Lamp

Section D:

Troubleshooting the Trailer-Mounted ABS Indicator Lamp Circuitry

Section E:

Troubleshooting the ISO 7638 (and ISO 1185 if connected) Power-Supply

Section F:

Troubleshooting the Wheel-Speed-Sensors

Section G:

Troubleshooting the Modulator Relay Valve (BR9234)

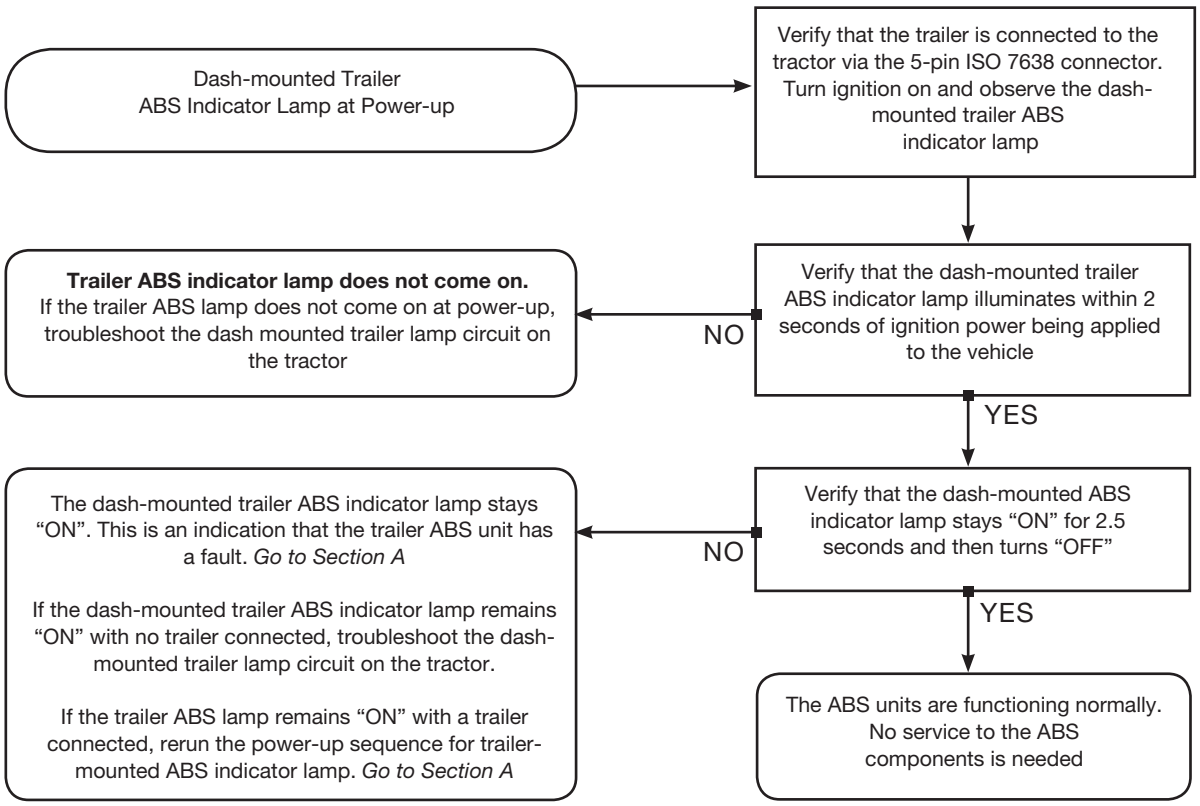
Section A: (Diagnostic Trouble Code) Blink Code Quick Reference

1st Blink Code		2nd Blink Code		Repair Information
Code	Location	Code	Description	
1	All	1	No Faults	System fully operational - no faults detected
2 3 4 5	Sensor SL Sensor SR Sensor SAL Sensor SAR	1	Sensor signal valid - large air gap	Go to Section F - Dynamic WSS DTCs
		2	Sensor signal valid - loss of signal	Go to Section F - Dynamic WSS DTCs
		3	Sensor signal valid - noisy	Go to Section F - Dynamic WSS DTCs
		4	Sensor shorted or open	Go to Section F - Static WSS DTCs
		5	Tyre diameter out of range	Verify correct tyre size, proper tyre inflation & correct number of exciter ring teeth. Verify that the ECU has the proper tyre size settings.
		6	Sensor configuration error	Verify correct ABS configuration. If needed, reset to the default ABS configuration and power-up to initiate auto-configuration.
6	Power	1	Over-voltage	Go to Section E - Power Supply
		2	Low-voltage	Go to Section E - Power Supply
		3	Excessive resistance ISO 7638 pin 1	Go to Section E - Power Supply
7 8 9	Valve M22 (Int) Valve M21 (Int) AUXIO1 / M2	2	Exhaust solenoid shorted or open	Go to Section G - ABS Modulator DTCs
		3	ABS modulator dynamic error	Go to Section G - ABS Modulator DTCs
		4	Valve configuration error	Verify correct ABS configuration. If needed, reset to the default ABS configuration and power-up to initiate auto-configuration.
10	Common	1	Internal low-side switch shorted to ground	Go to Section G - ABS Modulator DTCs
		2	AUXIO1 (M2) low-side switch shorted to ground	Go to Section G - ABS Modulator DTCs
		3	ABS modulator dynamic error - all valves	Go to Section G - ABS Modulator DTC
		4	Excessive ABS activity	Go to Section F - Dynamic WSS DTCs
		5	AUXIO1 (M2) low-side switch shorted to battery	Go to Section G - ABS Modulator DTCs
11	ECU	1	ECU internal error	Check for damaged or corroded connectors. Check for damaged wiring. After repairs or if no issues found, then clear faults. If faults return, replace the module.
		2	ECU configuration error	Verify correct ABS configuration. If needed, reset to the default ABS configuration and power-up to initiate auto-configuration.
12	AUXIO2	1	Shorted or open	Check for corroded/damaged wiring or connectors
13	AUXIO3	1	J1939 diagnostics shorted or open	Check for corroded/damaged wiring or connectors between the ECU and J1939 Diagnostics. Replace/repair J1939 diagnostic wiring or components as required.
14	System	2	Service Interval Exceeded	...

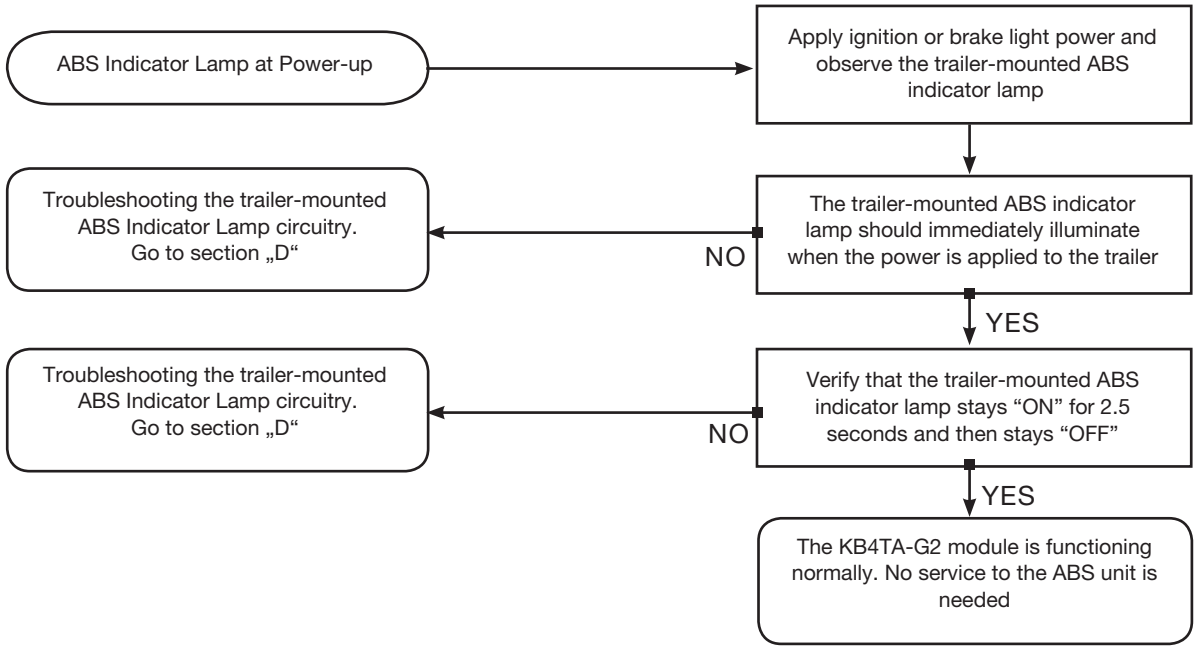
To Read/Clear Diagnostic Troubleshooting Codes (DTCs):

1) Apply constant power to the trailer (ignition switch).
2) Within 15 seconds, apply/release the brake pedal at 1 second intervals:
   (a) 3 times for displaying Active DTCs.
   (b) 4 times for displaying Inactive DTCs.
   (c) 5 times for clearing Active DTCs.After 5 seconds delay, the blink codes will be displayed.
3) Observe the trailer-mounted ABS indicator lamp and record blink code(s).
4) Refer to blink code chart for description.
5) After making repairs and clearing Active DTCs, verify lamp is no longer illuminated.

Section B: (Power-up Sequence) Dash-Mounted ABS Indicator Lamp



Section C: (Power-up Sequence) Trailer-Mounted ABS Indicator Lamp



Section D: Troubleshooting the Trailer-Mounted ABS-Indicator Lamp Circuitry

Trailer-mounted ABS indicator lamp did not illuminate during the power-up sequence

Troubleshoot the power supply to the module. *Go to Section E*
Verify stoplight-supply at the ISO 1185 connector.
Verify the correct installation of the Trailer-Mounted Warning lamp.
Continue if power (ISO1185 - pin 4) and ground (ISO1185 - pin 1) wiring are OK.

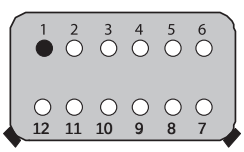
Turn off the power to the module. Inspect the condition of the ABS indicator lamp, connector and ground. Using a volt/ohm meter, verify continuity across the bulb. Verify continuity from the ISO 1185 ground (pin 1) to the ABS indicator lamp ground pin.

If repairs are made, rerun the power-up sequence.
Continue if the indicator lamp and ground wire check out OK.

With power off to the module, disconnect the 12-pin ECU connector.

Verify continuity from external ABS WL pin (pin 1) of the ECU connector and the ABS indicator lamp connector.

if repairs are made, rerun the power-up sequence.



Looking into KB4TA-G2-Module
Wire Harness (Pin 1 - ABS Indicator Lamp)

Trailer-mounted ABS indicator remains “ON” during the power-up sequence

Determine if a module Diagnostic Troubleshooting Code (DTC) exists using any of the following methods:

- KB4TA-G2 Blink Code Diagnostic. *Got to Section A*
- PC-diagnostic tools

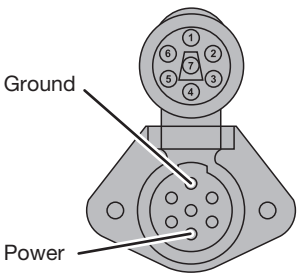
If DTC(s) exist and repairs are made are made, rerun the power-up sequence.

Continue if no DTCs are found and the ABS module appears to be functioning normally.

With power off to the module, disconnect the 12-pin ECU connector.

Using a volt meter, verify that there is no a short to Vbat between the external ABS WL pin (pin 1) of the ECU connector and the ABS indicator lamp connector.

if repairs are made, rerun the power-up sequence.



Looking into ISO1185-connector
(Pin 1 - ground / Pin 4 - power)

Section E: Troubleshooting the ISO 7638 (and ISO 1185 if connected) Power-Supply

Turn off power to module, disconnect the 12-pin-connector.

with ignition-power, battery-power & stoplight-power to the trailer

measure voltage between the ignition pin and it‘s corresponding gnd, measure voltage between the battery pin and it‘s corresponding gnd, measure voltage between the stoplight-supply and stoplight-gnd

the operating range is between 18 - 32 vdc

YES

Check for high resistance (corrosion, wire-connector-damage or improper termination of the power lines, resulting in high voltage drop across the lines

measure the voltage under load by placing a load such as brake light bulb with ignition-power, battery-power & stoplight-power to the trailer

measure voltage between the ignition pin and it‘s corresponding gnd, measure voltage between the battery pin and it‘s corresponding gnd, measure voltage between the stoplight-supply and stoplight-gnd

the operating range is between 18 - 32 vdc.

verify that the voltage drop measurements are no less than 1 vdc at the vehicle voltages (ignition, battery, stoplight)

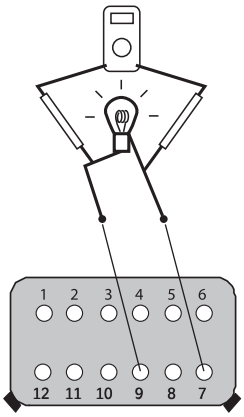
NO

With a voltmeter check power- and gnd-wires. look for corroded or damaged wires or pins

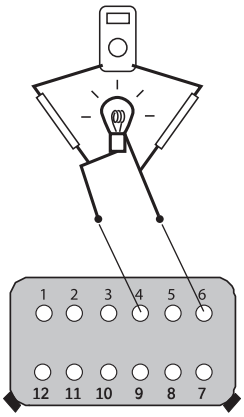
if repairs are made, rerun the power-up sequence.

With the voltage meter, check the power and gnd wires, look for corroded or damaged wires or pins

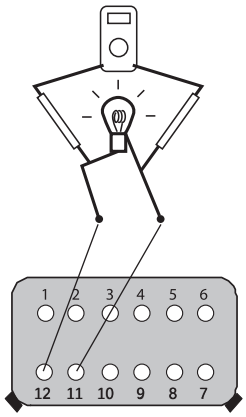
if repairs are made, rerun the power-up sequence.



KB4TA-G2-Module Wire Harness,
ECU Connector Measure:
Pin 9 (Ignition Power) to Pin 7 (ground)



KB4TA-G2-Module Wire Harness,
ECU Connector Measure:
Pin 6 (Battery Power) to Pin 4 (ground)



KB4TA-G2-Module Wire Harness,
ECU Connector Measure:
Pin 12 (Brake Light Power) to Pin 11 (ground)

Section F: Troubleshooting the Wheel-Speed Sensors

Turn off power to module, disconnect the 12-pin-connector.

If Dynamic WSS DTCs are present:

Rotate the effected wheel and verify a minimum of 0,25 VAC sensor output @ 0,5 RPS across the wheel speed sensor pins. A properly positioned sensor can output more than 2,0 VAC @ 1 RPS.

Verify/Inspect the following:

- Speed sensors property contact tone ring.
- Condition and retention force of sensor clips.
- Proper sensor lead routing and clamping.
- Condition of tone ring mounting and teeth.
- Proper number of tone ring teeth per sensed wheel.
- Proper adjustment of wheel bearings.
- Condition of foundation brakes.

Make repairs as needed (replace wiring and/or ABS components). Reconnect all connectors to the module.

Reset active DTCs by using any of the following methods:

- Blink Code Diagnostics.
- PC-diagnostic tools

Then rerun the power-up sequence.

If Static WSS DTCs are present:

Using a volt/ohm meter to measure the connector pins of the faulted sensor, verify 950-1950 OHMS across sensor connector pins.

Verify/Inspect the following:

- No continuity from sensor connector pins to ground.
- Vbat no measured at either sensor connector pins.
- Sensor/ECU wiring and connectors are not damaged or corroded.
- Proper sensor lead routing and clamping.

If an issue with the wiring is found isolate the area needing repair by repeating the measurements at all connections.

Make repairs as needed (replace wiring and/or ABS components). Reconnect all connectors to the module.

Reset active DTCs by using any of the following methods:

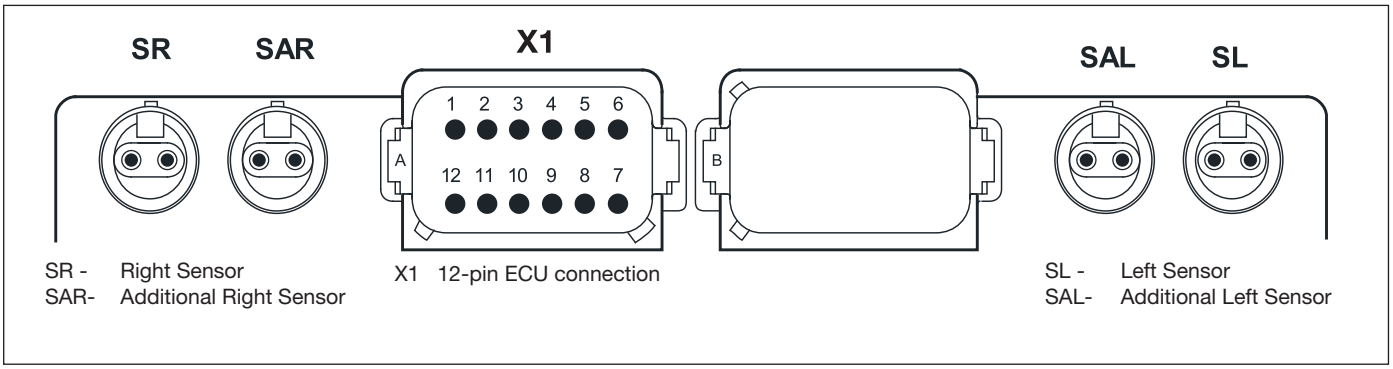
- Blink Code Diagnostics.
- PC-diagnostic tools

Then check for Dynamic WSS DTCs, see left column.

Then rerun the power-up sequence.

Note: Both Static and Dynamic WSS DTCs may be present

KB4TA-G2-Module Pinning



Section G: Troubleshooting the Modulator Relay Valve (BR9234)

Remote ABS-Modulator (M2) DTCs:

Turn off the power to the module, disconnect the 12-pin ECU connector

Static ABS Modulator DTCs:

Verify/Inspect the following:
- 13 to 17 OHMS across Exhaust/ Common connector pins.
- No continuity from modulator connector pins to ground.
- Vbat is not measured at any modulator connector pins.
- Modulator/ECU wiring and connectors are not damaged or corroded.

If an issue with the wiring is found, isolate the area needing repair by repeating the measurements at all connections.

Issue with modulator relay valve circuit identified?

NO

YES

Dynamic ABS Modulator DTCs:

Verify/Inspect the following:

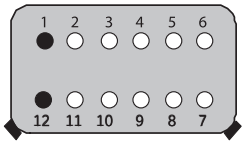
Verify proper modulator-valve activation with brake pressure applied, at power-up (Chuff Test) and/or using diagnostic tool. The wiring to the modulator may be reversed.

Check for:
- dragging brakes
- dry bearings
- faulty return springs
- parking brake system faults
- restricted brake air lines
- over adjusted slacks
- out-of-round drums
- damaged/loose tone rings

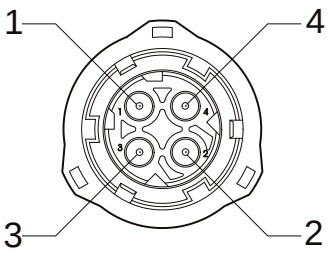
Make repairs as needed (replace wiring and/or ABS components). Reconnect all connectors to the module.

Reset active DTCs by using any of the following methods:
- Blink Code Diagnostics.
- PC-diagnostic tools

Then rerun the power-up sequence .



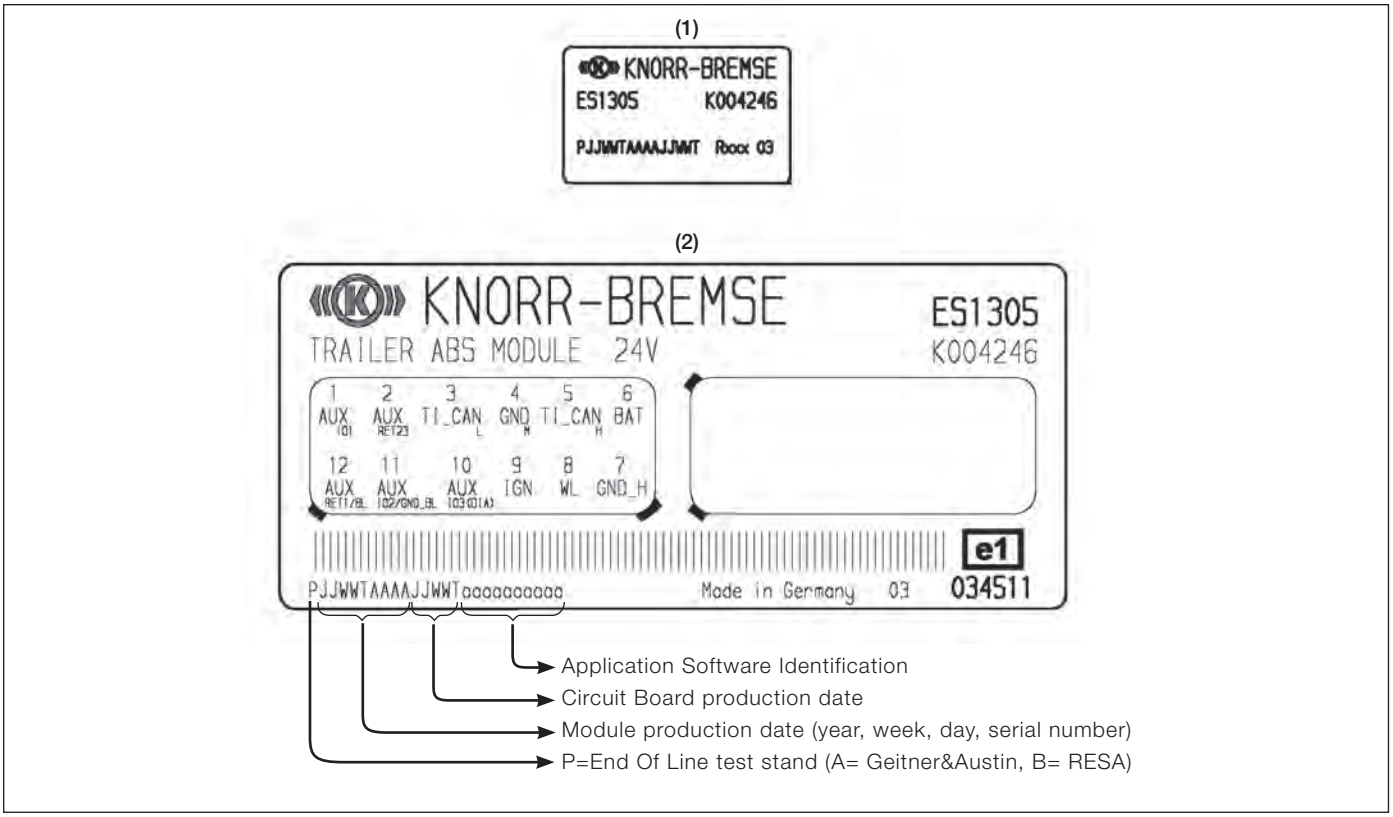
Looking into KB4TA-G2-Module
Pin 1 AUXI01 (Valve 3rd Modulator)
Pin 12 AUXRET1 (Return Line 3rd Modulator)



Looking into Modulator Connector Pins
Pin 1 AUXI01 (Release)
Pin 2 AUXRET1 (Common)

11 Label information

The small identification label (1) is located on the top of the module. A further label (2) containing additional information is located under the removable cover of the KB4TA-G2 module. If the part number label is not readable or is painted over, the ECU part number and revision can be read using a diagnostic tool. The number of the initial software loaded on the ECU is also indicated. The module part number, and pin-out information is shown on the label beneath the removable cover.



Software Revision Level

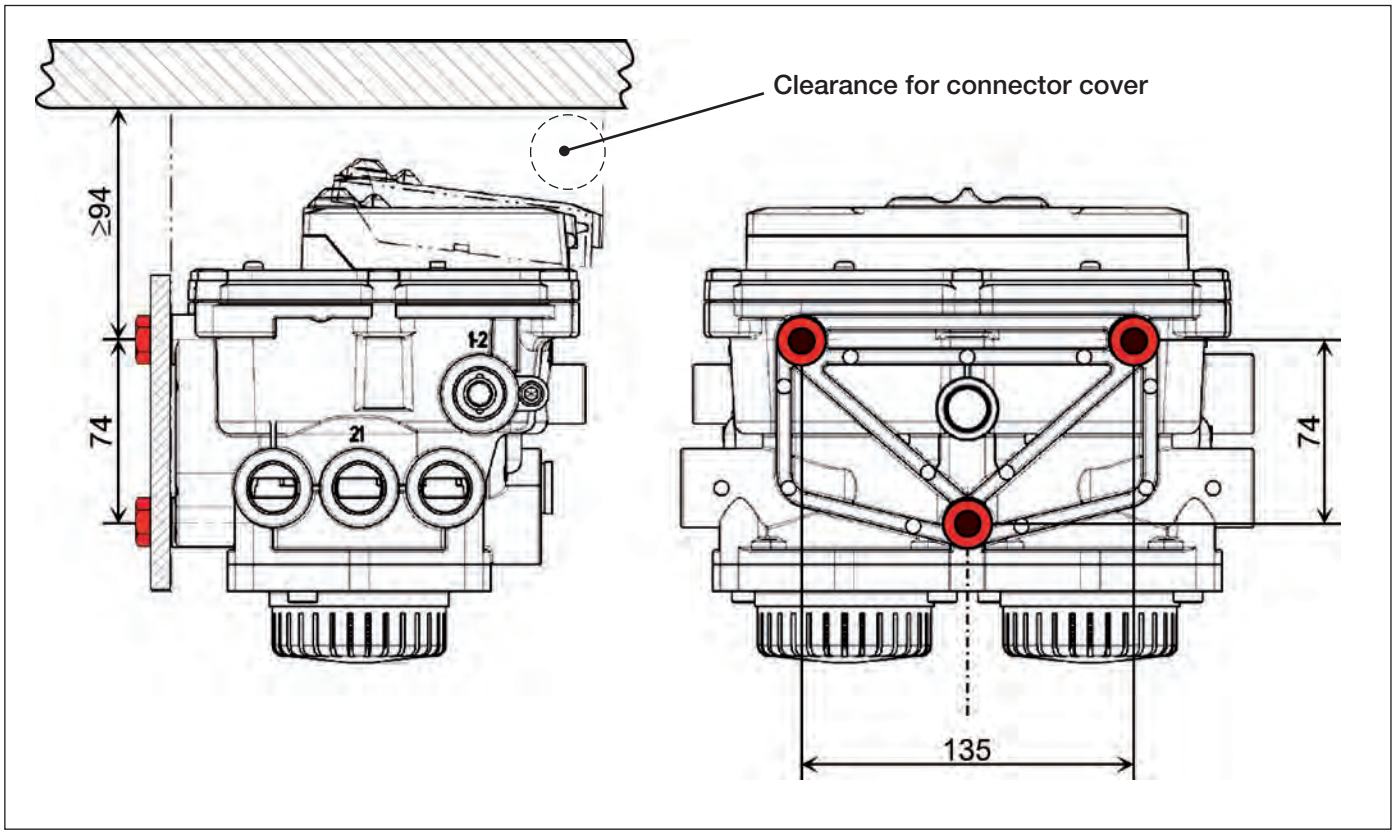
The current software revision number can be read using a diagnostic tool.

Document Revision Level

Please visit www.knorr-bremseSfN.com to ensure you have the latest version of this document.

12 Fixing Points

Diagram showing fixing points of the KB4TA-G2 Module



13 Service Replacement of the KB4TA-G2

The KB4TA-G2 module is designed to be used as the service replacement part for the Knorr-Bremse KB3TA, A9 & A18 trailer ABS controllers.

For more information, contact Knorr-Bremse.

13.1 Required Checks after replacement

1. Before performing leak tests, block the wheels.
2. Fully charge air brake system and verify proper brake adjustment.
3. Make several trailer brake applications and check for prompt application and release at each wheel.
4. Check the module, modulator valve(s) and all air hose fittings for leakage using a soap solution

   Check the ABS solenoid body with the trailer service brakes fully applied. If leakage is excessive, more than a single 1“ bubble within 1 minute, replace the module.

   Check the relay exhaust port with the trailer service brakes released to be sure that leakage is less than a single 1“ bubble within 3 seconds. If excessive leakage is detected at the relay exhaust port, perform the following test before replacing the module:

   • Apply the trailer spring brakes. Recheck for leakage around the relay exhaust port. If the exhaust port stops leaking, this indicates a leak between the emergency and service sides of the spring brake chamber. However, if the relay exhaust port continues to leak excessively, replace the KB4TA-G2 module.
5. Apply power and monitor the power-up sequence to verify proper system operation.
6. Determine the current ABS configuration by activating blink code diagnostics or using a diagnostic tool. If necessary, reset the ABS configuration and allow the module to auto-configure. See section 8.8.1
7. Calibrate and set odometer parameters if necessary using a diagnostic tool. Refer to the Odometer Function section 8. 6
8. Where a safe location (e.g. restricted access area or test track) is available, it is possible to road test the ABS function by making an abrupt stop from a vehicle speed of about 30 km/h. The wheels should not enter a prolonged lock condition and ABS function should be audible. It is the responsibility of the technician to perform this test in a safe location.

13.2 Wiring

All connector leads of the KB4TA-G2 module harness are weather sealed at the connector interface and are clearly labelled for proper installation.

Knorr-Bremse provides over-moulded versions of the KB4TA-G2 wiring harness and recommends that the complete harness be replaced if corrosion or damage occurs.

When troubleshooting ABS wiring, some general rules should be followed where applicable.

1. Check all wiring and connectors to ensure they are secure and free from visible damage (e.g. cuts, abrasions, etc.).
2. Check for evidence of wire chafing due to poor routing, or poor securing of wires.
3. Check connectors for proper insertion and locking.
4. Verify that the connector pins are properly greased with a non-conductive electrical grease compound.
5. Connector terminals must not show signs of corrosion or exposure to the environment.
6. Never pierce wire insulation when checking for continuity.
7. Do not deform individual pins or sockets during probing with a volt/ohm meter.
8. It is strongly recommended to properly secure all wiring harness and sensor leads at least every 45 cm.
9. Apply a moderate amount of non-conductive electrical grease to each connector pin before reconnecting.

14 Additional Documentation

Link to other KB4TA-G2-Documents:

- Type-Approval Statement (RDW-00050205)
- Information document “Alternative Procedure for Testing of Trailer-Anti-Lock Braking Systems” (Y023866)
- Information document “Safety Aspects of Complex Electronic Vehicle Control Systems” (Y023867)
- *Installation Instructions “Wiring/Harness, Modular System” (Y011788)

* Download version available from the Knorr-Bremse website: www.knorr-bremseSfN.com

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