



TECHNICAL GUIDE

ABS Brake System: How It Works, Warning Light and Faults

Learn how the ABS brake system works on heavy trucks, why the warning light comes on, how to diagnose sensor faults, and the correct replacement steps.

A loaded tractor unit brakes hard on a wet road. The driver turns the steering wheel, but the vehicle doesn't turn — it keeps going straight. The wheels have locked; the tire is no longer rolling, it is sliding, and a sliding tire can neither steer nor stop in the shortest distance. ABS exists to prevent exactly this moment. In the field, though, ABS usually comes up for a completely different reason: a yellow warning lamp lights up on the dashboard and stays on. This guide covers the ABS system on heavy commercial vehicle air brakes from start to finish — what it is, how it works, why that lamp comes on, and how to diagnose it.

This document was prepared by the VADEN technical team for heavy commercial vehicle air brake systems. The values given here are general reference figures; for exact data, the current OE service manual matching the vehicle's engine and chassis code is authoritative. Last updated: September 2026.

What Is ABS? Definition, Function and Operating Principle

ABS, short for Anti-lock Braking System, is the electronic safety system that prevents wheel lockup during braking. ABS continuously measures each wheel's rotational speed with sensors; when a wheel begins to lock, ABS rapidly reduces and reapplies the brake pressure at that wheel several times per second so the tire keeps rolling. This keeps the vehicle steerable under braking and shortens stopping distance on most road surfaces.

ABS's real benefit isn't the shorter stopping distance most drivers assume — it's **keeping steering control under braking**. A locked wheel only slides forward; no matter how far the driver turns the wheel, the vehicle won't change direction. ABS holds the wheel just below the lockup threshold, keeping the tire's lateral grip alive. On a heavy commercial vehicle this difference multiplies on a tractor pulling a trailer: a locked axle sets the stage directly for a tractor jackknife or trailer swing.

On heavy commercial vehicles, ABS operates in a different physical environment than the hydraulic ABS found on passenger cars. In a passenger car the pressure-transmitting fluid is incompressible brake fluid; in trucks, tractors and buses it is compressible **compressed air**. Because air is compressible, the system's response time is longer and pressure modulation is handled through valves. This is why heavy-vehicle ABS isn't simply a scaled-up hydraulic ABS — it is its own separate system with its own component family.

ABS Meaning: Where the Abbreviation Comes From

The abbreviation ABS comes from the German "Antiblockiersystem" and became established in English as "Anti-lock Braking System." In everyday shop language the abbreviation is used almost on its own: "ABS light," "ABS sensor," "ABS valve."

Is ABS Mandatory on Heavy Commercial Vehicles?

On heavy commercial vehicles and trailers, ABS falls under the **ECE R13** regulation and its annexes, which govern commercial vehicle braking; heavy commercial vehicles and trailers with European type approval have long been required to carry an anti-lock braking system. The ABS/EBS power supply and communication link between tractor and trailer is defined by the **ISO 7638** socket standard, while electronic brake communication is defined by **ISO 11992**. Which

category a vehicle falls into and which annex applies is stated in its type-approval documentation; in practice, the vehicle's current OE service documentation is authoritative.

A vehicle with a faulty ABS is **not brakeless** — the service brake continues to work mechanically. But lockup protection is disabled, and the vehicle is classed as defective at inspection. Driving a vehicle with the ABS light on because "the brakes still work anyway" risks a complete loss of directional control on wet or snowy surfaces.

How Does Heavy-Vehicle ABS Work?

Heavy-vehicle ABS performs four core tasks in sequence: it measures, decides, acts, and confirms. Wheel speed sensors continuously measure the rotational speed of the wheel at each axle. The electronic control unit compares these speeds with each other and with the vehicle's estimated road speed. If one wheel is slowing down faster than the others, lockup is beginning. The control unit sends a command to that wheel's modulator valve, which manages the air pressure going to the brake chamber in three modes.

The three operating modes of the ABS modulator valve

Mode	What the valve does	Result
Pressure release (dump)	Exhausts the air in the brake chamber to atmosphere	The locked wheel is released and starts rotating again
Pressure hold	Holds the current pressure steady, neither increasing nor decreasing it	The wheel is kept just below the lockup threshold
Pressure buildup (apply)	Reapplies the pressure coming from the foot brake valve to the chamber	Braking force is restored

This cycle repeats several times per second. During this, the driver feels vibration in the brake pedal and hears a rhythmic air-release sound from the system — **this is not a fault, it is the sign that ABS is working**. In a panic stop, the driver should not lift off the pedal; ABS can only modulate while the pedal stays pressed.

What Are the Components of an ABS System?

- **Wheel speed sensor:** mounted on the axle hub, it generates a speed signal by reading the passing teeth of a toothed ring that rotates with the wheel. On heavy vehicles it is commonly an inductive type that generates its own signal.
- **Tone wheel (exciter ring / pole wheel):** the ring the sensor reads, with evenly spaced teeth around its circumference. A ring with broken or mud-clogged teeth produces a faulty signal even if the sensor itself is sound.
- **ABS electronic control unit:** the brain that processes sensor signals, makes the lockup decision, and drives the modulator valves. It stores fault codes in memory.
- **ABS modulator (solenoid) valve:** the valve that exhausts, holds, or reapplies the air going to the brake chamber on the control unit's command. It is typically positioned per axle or per wheel.

- **Solenoid coil:** the coil that electrically drives the modulator valve; when the coil winding is open-circuit, the valve receives no command.
- **ISO 7638 socket:** the 7-pin standard connector that carries ABS/EBS power and communication between tractor and trailer.
- **Warning lamp:** the dashboard indicator that reports the result of the system's self-diagnosis to the driver.

What Is the Difference Between ABS and EBS?

ABS only prevents lockup, and it only engages once the driver applies the brakes; pressure still arrives through the pneumatic circuit from the foot brake valve. **EBS** (Electronic Braking System), by contrast, carries the brake demand primarily as an electrical signal, with the pneumatic circuit kept as a backup. EBS incorporates ABS and adds functions on top of it, such as brake force distribution, wear compensation, and coordination with the trailer. In practice, on a vehicle equipped with EBS, ABS isn't a separate box — it is one function of the EBS.

Why Does the ABS Light Come On? What the Lamp Means and Possible Causes

The ABS light reports that the system's self-diagnosis has found an inconsistency. It is normal for the ABS lamp to flash briefly when the ignition is switched on — this is a lamp test. If the lamp does not go out once the vehicle reaches a certain speed, or if it comes on while driving, there is a fault stored in the system. Heavy commercial vehicles usually have two separate ABS lamps on the dashboard: one for the tractor, one for the trailer. A lit trailer lamp means the search should start on the trailer side, not the tractor.

Causes of the ABS warning lamp and how to check them

Symptom	Likely cause	Check / verification
Lamp stays on continuously, doesn't go out while driving	Wheel speed sensor disconnected, dirty, or air gap out of spec	Read the fault code with a diagnostic tool; measure sensor resistance and signal, clean the tone wheel
Lamp only comes on at a certain speed or in corners	Sensor air gap borderline; play in the hub bearing	Confirm the sensor is fully seated in its bore; check hub bearing play
Trailer ABS lamp lit, tractor lamp off	ISO 7638 socket, cable, or trailer ABS component	Check socket pins for corrosion and voltage; scan the trailer separately
Comes on at ignition, never goes out, no code stored	Low supply voltage or weak ground connection	Measure battery voltage and the ABS supply fuse; clean the chassis ground
Lamp flashes, rhythmic air sound during braking	Modulator valve may be venting continuously	Test the valve and solenoid coil command with a diagnostic tool; listen for an air leak
Fault returns shortly after being cleared	Chafing or rodent damage in the wiring harness; intermittent open circuit	Trace the harness by hand along the axle, inspect insulation at bend points

Clearing an ABS fault code does not fix the fault. If the vehicle records the same code again within a few kilometers after clearing it, the problem is still present. A lasting fix requires a physical check of the circuit the code points to.

Standards and further reading

This subject is governed by the equipment rules for air-braked commercial vehicles. In the United States the federal air brake standard, **FMVSS 121 (49 CFR 571.121)** defines the reservoirs, protection and timing a compliant system must provide, and Europe applies the equivalent limits of UNECE Regulation No. 13. For further detail, see the illustrated reference guide at airbrakecompressor.com. Always confirm specific figures against the current regulation and the vehicle manufacturer service data.

Outside the United States the equivalent duties sit in national law. In the United Kingdom, **regulation 18 of the Road Vehicles (Construction and Use) Regulations 1986** requires every part of the braking system to be maintained in good working order. In Canada, air brake systems fall under the **Motor Vehicle Safety Regulations, which contain CMVSS 121**.

How Is an ABS Fault Diagnosed? Symptoms and Diagnosis

An ABS fault most often shows up only as the warning lamp; there may be no noticeable change in how the vehicle drives. That's why the lamp is often the system's only visible symptom and should never be ignored. Beyond that, symptoms encountered in the field include:

- **Brake pulls to one side:** if a modulator valve at one axle keeps holding or venting pressure, that side doesn't brake enough.
- **Unnecessary ABS activation at low speed:** a sensor producing a faulty signal misleads the control unit even without real lockup; the driver feels pedal vibration while the vehicle is moving slowly.
- **Continuous air-release sound from the system during braking:** points to a modulator valve that is sticking or leaking.
- **Delayed or harsh trailer braking:** if the ISO 7638 line isn't supplying power, the trailer ABS is disabled and brake distribution is upset.
- **ABS defect at inspection:** periodic inspection checks the warning lamp and system communication; a stored fault is recorded as a defect.

How Do You Check an ABS Sensor?

Checking an ABS sensor starts with the simplest step: remove the sensor from its bore and clean the metal filings, mud, and rust off its tip. Because inductive sensors are magnetic, metal dust tends to build up on the tip, and the accumulated filings throw off the air gap. Next, measure the sensor's resistance with a multimeter; on heavy-vehicle inductive sensors resistance is typically in the kilo-ohm range, and **the exact value is given in the vehicle's OE service manual**. An open-circuit or short-circuit reading means the sensor needs replacing.

The second step is the air gap. The gap between the sensor tip and the tone wheel is generally kept within a narrow range of about a millimeter, depending on the vehicle model; when the sensor isn't fully seated in its bore, or play develops in the hub bearing, this distance grows and the signal weakens. The third step is the tone wheel itself: a broken tooth, a crack, or dirt packed between the teeth produces a faulty reading even if the sensor is sound. The last step is the wiring harness; this area, in constant motion with the axle, is prone to chafing and fatigue damage.

Always clean the tone wheel and trace the wiring harness by hand before replacing a sensor. In a significant share of parts replaced in the field as a "faulty sensor," the real problem is a dirty tone wheel or a chafed cable; the code comes back even after the sensor is replaced.

How Is an ABS Component Replaced? Step by Step

- 1 Park the vehicle on level ground, apply the parking brake, and place wheel chocks. The engine must be off.
- 2 Release the air pressure. If a modulator valve or air line is to be removed, no fitting should ever be loosened before the system pressure is drained.
- 3 Disconnect the battery terminal. This step is required if the electronic control unit or solenoid coil connector will be disconnected.
- 4 Confirm the faulty circuit with a diagnostic tool and record the stored code. Knowing the starting condition is needed to compare after the replacement.
- 5 Disconnect the connector. Don't force the locking tab; if the pins bend, the intermittent connection persists even with the new part fitted.
- 6 Remove the component. On a sensor, clean the corrosion around the bore; on a modulator valve, mark the fitting connections in order.
- 7 Clean the bore and mounting face. Use a suitable mounting grease on the sensor bore; grease prevents the sensor from seizing and keeps corrosion away.
- 8 Fit the new part. Push the sensor in until it contacts the tone wheel — the wheel itself sets the working air gap on the first brake application. Tighten the bolts in a crossing pattern and in stages; **torque values must be taken from the vehicle's current service manual.**
- 9 Seat the connector until it clicks audibly and clip the cable along its original routing. A cable left loose will chafe and break in a short time.
- 10 Reconnect the battery, switch on the ignition, clear the fault memory, and rescan the system. Then run a low-speed brake test in a safe area; the lamp should go out.

Things to Watch For: Common Mistakes

- **Clearing the code and driving off:** a code cleared without a physical check comes back within a few kilometers if the fault persists, and ABS protection is absent in the meantime.
- **Replacing only the sensor:** replacing a sensor without checking the tone wheel and wiring harness is the most common unnecessary expense.
- **Seating a sensor with a hammer:** impact permanently damages the sensor body and the tone wheel; a sensor should always be pushed in by hand.
- **Skipping the ISO 7638 socket:** a large share of trailer ABS faults come from corrosion on the socket pins; the socket should be measured before any part is replaced.
- **Loosening a fitting without releasing pressure:** loosening a fitting under air pressure can cause serious injury.
- **Aiming a high-pressure washer directly at a sensor:** water gets into the connector and causes intermittent contact loss that surfaces days later.
- **Choosing a part by brand:** the right part is selected by the vehicle's engine and chassis code and the OE reference number, not by brand name.

Technical Values and Check Points

The table below summarizes the main points checked in the field on an ABS system and the general reference ranges. Values vary by vehicle manufacturer and system supplier; **the exact value must always be taken from the vehicle's current OE service manual.**

ABS system check points (general reference)

Check point	General reference	What a deviation indicates
Warning lamp behavior	Lights at ignition, goes out once the vehicle reaches a low speed	If it doesn't go out, a fault is stored
Inductive sensor resistance	Kilo-ohm range (OE value is authoritative)	Open or short circuit: sensor faulty
Sensor air gap	Narrow, sub-millimeter range (OE value is authoritative)	If too large, signal weakens; may indicate hub bearing play
Tone wheel teeth	Full count, unbroken, clean	Broken or dirty teeth: intermittent faulty signal
ISO 7638 supply voltage	Close to the vehicle's system voltage	If low, socket corrosion or cable resistance
Modulator valve response	Audible command click during diagnostic test	No sound: coil or valve faulty
Brake circuit air leak	Within the acceptance limit on a leak-down test	If leaking, pressure modulation is disrupted

ABS components are part of the brake safety chain. When selecting a modulator valve, control unit, or sensor, exact match to the vehicle manufacturer's OE reference must be required. A tone

wheel with a different tooth count, or a sensor with different characteristics, throws off the speed reading even if the system still runs electrically.

ABS System Maintenance and Service Life

The strongest factor determining the service life of an ABS system is the cleanliness of the electrical connections and the sensor area. During periodic maintenance, metal filings should be cleaned off the sensor tips, the tone wheel should be visually inspected, and the wiring harness should be checked along the axle for chafing marks. On vehicles operating in salty, damp winter road conditions, applying a suitable electrical contact protector to the socket areas noticeably reduces faults caused by intermittent contact loss.

Air quality also directly affects ABS. Moist, oily air gradually degrades the internal sealing elements of the modulator valves and causes the valve to stick. For this reason, replacing the air dryer cartridge at the manufacturer-specified interval, monitoring the compressor for oil carryover, and keeping the drain valves working are all inseparable parts of ABS maintenance. Supplying the brake system with dry, clean air is the cheapest measure for extending the service life of ABS components.

For fleet operations, it's recommended to add ABS fault-memory readout to the periodic maintenance plan. Even when the warning lamp isn't on, a past (inactive) code may be stored in memory; these codes are early warning of an intermittent fault and allow it to be caught before a breakdown on the road. This check interval can be shortened based on the vehicle's age and duty cycle.

Beyond keeping the sensor area clean, it helps to know the fault causes; the main causes of signal loss and the symptom picture are collected in our [ABS sensor failure symptoms and checks](#) guide.

VADEN ABS and Air Brake Components

VADEN ORIGINAL manufactures ABS solenoid modulator valves (ABS relay valves), ABS sensor rings and sensor holders, plus repair kits for the ABS solenoid modulator valve, the ABS double relay valve and the ABS electronic control unit, for heavy commercial vehicle air brake systems to OE dimensions. The range covers the connector and pin configurations commonly used in truck, tractor, bus, and trailer applications. To find the right part, using your vehicle's **engine and chassis code together with the OE reference number printed on the existing part** — rather than the vehicle's make and model — eliminates the risk of a mismatch.

ABS is not a component that works on its own within the air brake system; it is the last link in a chain that starts with drying the air from the compressor, splitting it into circuits through the four-circuit protection valve, delivering it quickly through relay valves, and converting it into force at the brake chamber. A problem anywhere in this chain shows up in ABS performance. The VADEN technical guide library has separate fault, replacement, and maintenance guides for the air compressor, air dryer, four-circuit protection valve, relay valve, ABS sensor, EBS modulator, brake chamber, and brake caliper.

This document is for information only; in practice the vehicle manufacturer's current service manual and safety instructions apply. Values are general references for common heavy-duty systems; use the relevant OE service document for model-specific figures. © VADEN Otomotiv San. Tic. A.Ş. · vadenoriginal.com