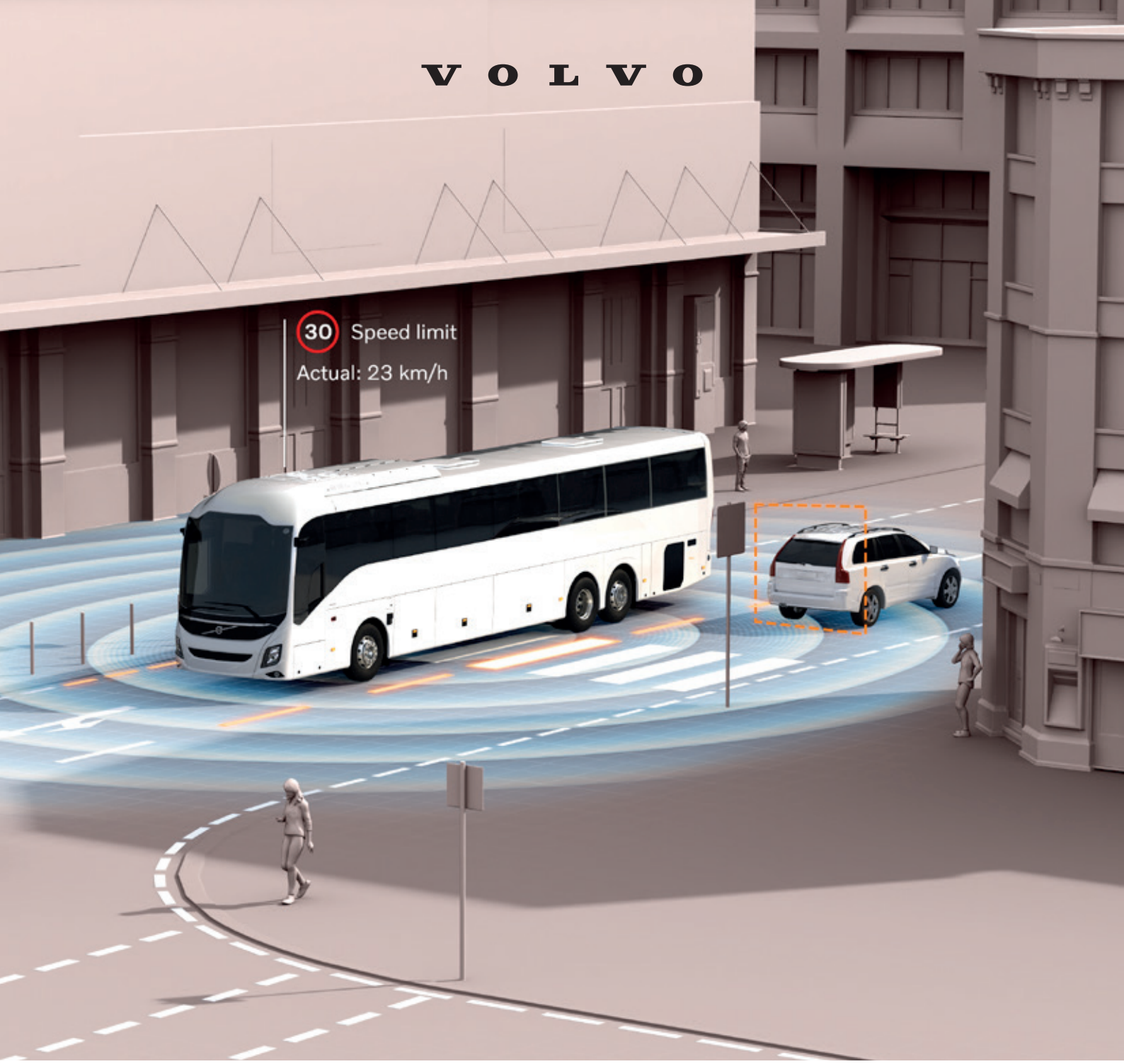

Volvo Buses active safety systems

ADVANCED DRIVER ASSISTANCE SYSTEMS

Volvo Buses

VOLVO

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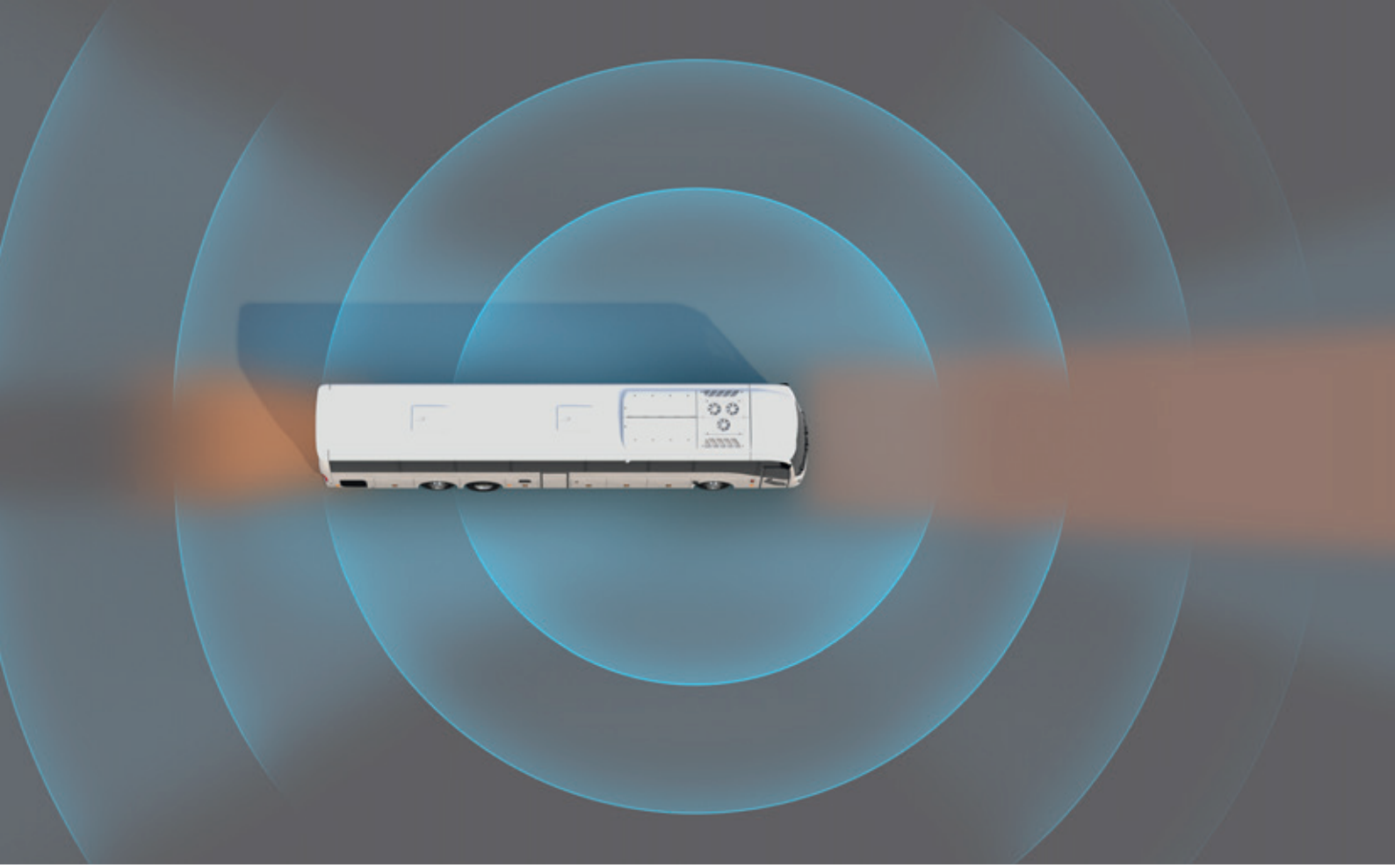


Volvo Buses active safety systems

Third generation of active driver assistance

Volvo offers an array of intelligent features that help drivers to drive more safely, in order to avoid incidents, injuries and damage. Smart sensors and advanced software detect events that could lead to dangerous situations, and warn the driver.

What active safety systems do
The driver's eyes are the best sensors we have. But because the human field of vision is limited, we add sensors for collecting useful information from all around the vehicle. Radars and different types of cameras in sensor fusion configurations provide vital information about the traffic situation.

A fully integrated solution
Safety is not just about technology and systems, it's also about human perception. This is why safety information and alerts are shown directly on the dashboard, instead of via various single-function displays, which can easily disturb the driver's field of vision, or distract the driver. In everything we do, we work upstream to keep the driver aware of potentially hazardous situations before they occur.

Based on the driver's reality
With our active safety systems, all information to the driver is integrated in the instrument cluster, right in front of the driver. The absence of multiple external display units reduces distractions and help the driver stay focused.

Collision Warning with Emergency Brake

Collision Warning with Emergency Brake, CW-EB, is an active safety function developed for buses and coaches with only seated passengers. When detecting a risk for collision, the driver is alerted and unless immediate action is taken, the brakes are activated.

What it does

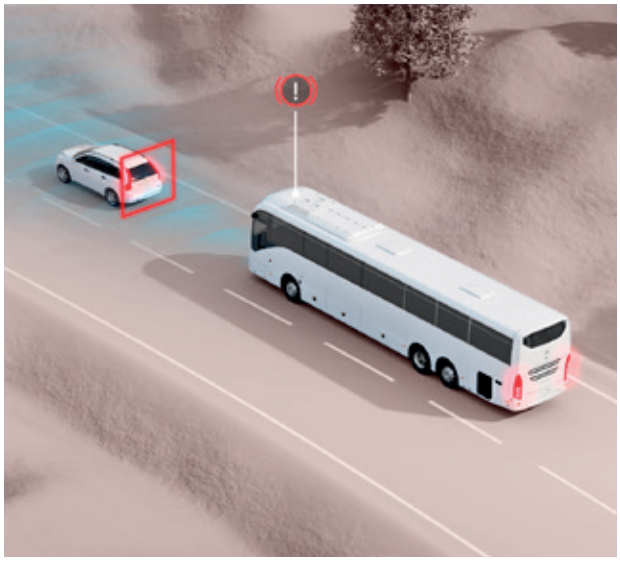
Collision Warning with Emergency Brake, CW-EB, is a system that can detect objects further ahead and initiate an emergency braking. The objects can be other vehicles but also other road users such as cyclists and pedestrians. When an object is detected, the system reacts as follows:

- A visual symbol on the display of the instrument cluster, together with a red light beam at the upper edge of the display. If the function is installed, a head-up alert (HUA) is reflected in the windscreen.
- If the driver does not react, an audio signal is heard, and the red light beam increases in intensity.
- If the driver still has not reacted, pre-braking is applied.
- If the change in distance indicates hazard, full emergency braking is applied and the braking lights flash, a function called Emergency Stop Signal, ESS.

How it works

CW-EB uses both camera and radar to obtain higher precision and performance. The function is active at speeds above 10 km/h. Radar determines the presence of, and distance to, objects ahead of the bus, while image processing provides additional data.

When an object is detected, the sensors collect data on its longitudinal and lateral movements. The system then calculates the distance to a possible impact, based on the speed of the bus, and the velocity and trajectory of the detected object. If the probability of a collision is high enough, the warning and braking sequence is activated. The sequence includes a pre-brake, which reduces the speed but also serves as a haptic alert signal to the driver. If there is still no driver action, the brake force is increased to a full emergency brake.



At low speed, typical for city traffic, the calculated time to impact is short which means that the pre-brake phase is barely noticeable, while at higher speeds the two phases are clearly different. Braking continues until standstill or until the collision threat is gone. Braking can be overridden by the driver through kick-down on the accelerator.

BENEFITS

- Increased safety margins in city and highway traffic.
- Crash avoidance. Adding braking to the warning gives improved protection of passengers, drivers and other road users.
- Cost reduction. Impacts, even at very low speed causes downtime and considerable cost.

For more information, contact your Volvo Buses dealer.

Collision Warning with City Brake

Collision Warning with City Brake, CW-CB, is an active safety function developed for buses allowing standing passengers. When detecting a risk for collision, the driver is alerted and unless immediate action is taken, the brakes are activated.

What it does

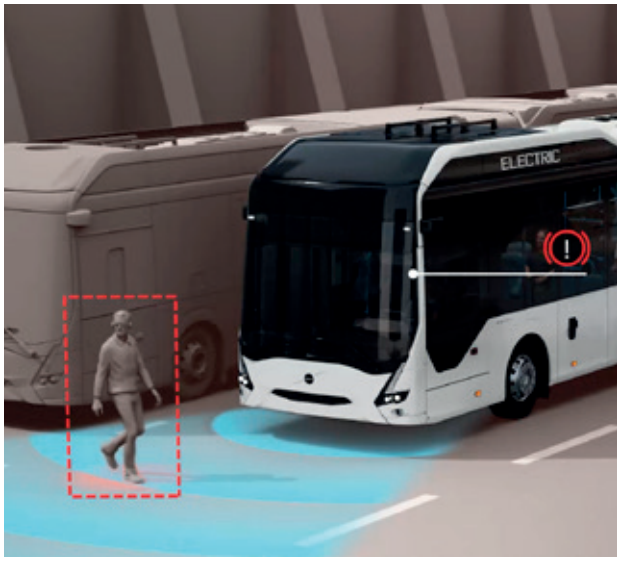
Collision Warning with City Brake, is a system that detects object in front of the bus. If there is a risk for collision, the system reacts with a driver alert followed by an automated braking:

- A visual symbol on the display of the instrument cluster, together with a red light beam at the upper edge of the display. If the function is installed, a head-up alert (HUA) is reflected in the windscreen.
- If the driver does not react, an audio signal is heard, and the red light beam increases in intensity.
- If the driver still has not reacted, braking is applied at a force aimed to mitigate the collision risk while reducing the inconvenience for standing passengers.

How it works

CW-CB uses both camera and radar to obtain higher precision and performance. The function is active at speeds above 10 km/h. Radar determines the presence of, and distance to, objects ahead of the bus, while image processing provides additional data.

When an object is detected, the sensors collect data on its longitudinal and lateral movements. The system then calculates the distance to a possible impact, based on the speed of the bus, and the velocity and trajectory of the detected object. If the probability of a collision is high enough, the warning and braking sequence is activated. The sequence includes a pre-brake, which reduces the speed but also serves as a haptic alert signal to the driver. If there is still no driver action, the brake force is increased to a retardation aimed to minimize the collision risk while still keeping the risk and inconvenience for standing passengers low.



At low speed, typical for city traffic, the calculated time to impact is short which means that the pre-brake phase is barely noticeable, while at higher speeds the two phases are clearly different. Braking continues until standstill or until the collision threat is gone. Braking can be overridden by the driver through kick-down on the accelerator.

BENEFITS

- Increased safety margins in city and highway traffic.
- Crash avoidance. Adding braking to the warning gives improved protection of passengers, drivers and other road users.
- Cost reduction. Impacts, even at very low speed causes downtime and considerable cost.

For more information, contact your Volvo Buses dealer.

Forward Collision Warning

Forward Collision Warning, FCW, is an active safety function developed to assist the driver to drive safely in city and highway traffic. When detecting a risk for collision, the driver is alerted and can take action at an earlier stage. FCW serves as the detection and driver warning part of the Collision Warning with City Brake and Collision Warning with Emergency Brake.

What it does

Forward Collision Warning, FCW, detects object in front of the bus. If there is a risk for collision, the system reacts with two levels of driver alert:

- A symbol on the display of the instrument cluster, together with a red light beam at the upper edge of the display. If the function is installed, a head-up alert (HUA) is reflected in the windscreen.
- If the driver does not react within, an audio signal is heard, and the red light beam increases in intensity. The initial alert to the driver is only visual, to avoid disturbance and unnecessarily alarming the passengers.

How it works

FCW uses both camera and radar to obtain higher precision and performance also in curves and on multi-lane roads. The function is active at speeds above 10 km/h. Radar determines the presence of, and distance to, objects ahead of the bus, while image processing provides additional data.

When an object is detected, the sensors collect data on its longitudinal and lateral movements. The system then calculates the distance to a possible impact, based on the speed of the bus, and the velocity and trajectory of the detected object. If the probability of a collision is high enough, the warning sequence is activated.

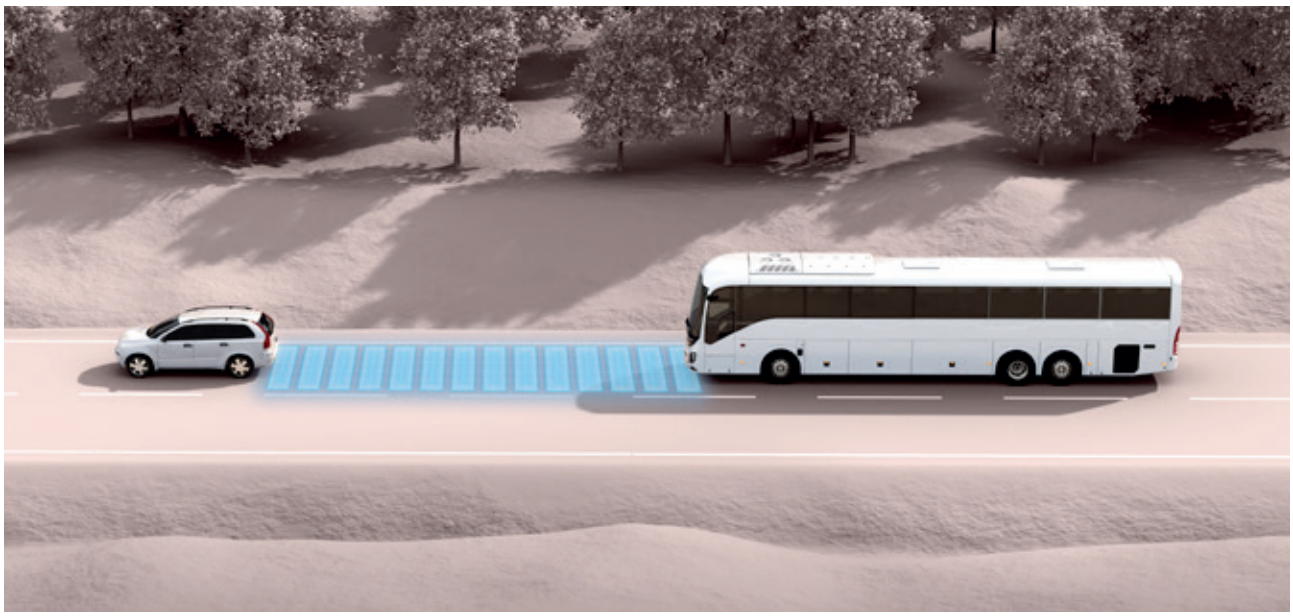
BENEFITS

- Increased safety margins in city and highway traffic.
- Crash avoidance. Additional protection of passengers, driver and other road users, including pedestrians and cyclists.
- Cost reduction. Impacts, even at very low speed causes downtime and considerable cost.

For more information, contact your Volvo Buses dealer.

Adaptive Cruise Control

In today's busy traffic, keeping a suitable distance is a key factor in safe driving. Cruise control is often associated with higher speeds, but Adaptive Cruise Control, ACC, has a wider range of applications.



What it does

With Adaptive Cruise Control, ACC, your vehicle keeps a safe distance to the vehicle ahead in the same lane. ACC has proved to be a very helpful feature for driver assistance on the highway, but also in other traffic scenarios. When approaching a slower vehicle, ACC overrides the target speed. The speed is then adjusted to maintain a safe and speed-dependant distance to the vehicle in front.

How it works

Adaptive Cruise Control uses radar to determine the distance to vehicles in front. It controls accelerator and brakes, to maintain the preset distance to vehicles ahead in the same lane, while ignoring adjacent lanes. When activated, the system works at all speeds above 30 km/h. If the traffic ahead slows to below 30 km/h, ACC is disengaged, and the driver gets a notification.

BENEFITS

- Passenger satisfaction through smoother progress.
- Reduces the risk of harsh braking or collision with vehicles ahead.
- Improves fuel economy.

For more information, contact your Volvo Buses dealer.

Front Short Range Assist

At bus stops, terminals and crossings, various kinds of road users are moving in and out of the bus driver's field of vision, often in a very unpredictable way. A hazardous situation can emerge in split seconds when the driver needs to look the other way.

What it does

Volvo Buses Front Short Range Assist scans the area immediately in front of the bus for the presence of vulnerable road users (VRUs), to avoid accidents when starting to drive. If an object is detected within the pre-defined area, the driver is notified. This information is a visual signal on the display in the instrument cluster or a head-up alert (HUA). The driver can then adjust to avoid interacting with the trajectory of the VRU. If continued progress would make a collision unavoidable, the information is escalated to a warning by adding an audible alert from a transducer in the instrument cluster.

How it works

Radar and camera information is processed to identify objects, primarily VRUs, in front of the bus. The detection area starts 0.8 meters from the bus and covers an area of 3.7×3.5 meters. The system actively detects VRUs in the area at standstill and at speeds up to 10 km/h, such as a cyclist in front of the bus, or a pedestrian making a hasty move onto the street.

BENEFITS

- Reduces the risk of accidents at terminals, bus stops and crossings.
- Constant and active monitoring of the area in front of the bus.
- An extra pair of eyes, helping the driver in complex traffic environments.

For more information, contact your Volvo Buses dealer.

Lane Change Support

Driving on multi-lane roads comes with a constant risk of something happening in a blind spot, outside the driver's field of vision. Starting a lane change without noticing a vehicle in the adjacent lane can result in a serious accident.

What it does

Lane Change Support, LCS, detects vehicles in adjacent lanes along both sides of the bus. LCS helps the driver avoid collision with other vehicles in lane change scenarios. The driver is informed about vehicles present in the blind spots by an LED indicator on the A-pillar on the corresponding side, showing a steady light. If the driver activates the turn indicator, and initiates a lane change with a vehicle present in the detection area, the LED indicator flashes and a warning sound is heard.

How it works

The system uses two radars on each side of the bus. These collect information about distance to objects, motion of the objects, motion of the subject vehicle, driver commands and driver actions. Detection is done in a static zone starting 2 meters in front of the bus and ending 5 meters behind. In the dynamic zone both faster and slower vehicles are detected from 2 meters ahead of the front and up to 50+ meters behind for faster vehicles, but less than 5 meters for slower vehicles. These distances apply for straight road conditions. They may be shorter in curves, but the system functions the same way. The feature is active at all speeds.

BENEFITS

- Reduces the risk of collisions with vehicles in adjacent lanes.
- Early warnings help the driver plan for smooth lane changes.
- Reduces the driver's exposure to stress in dense traffic.

For more information, contact your Volvo Buses dealer.

Lane Keeping Support

Lane Keeping Support, LKS, is a function that alerts the driver when the vehicle unintentionally leaves its intended lane. It helps the driver keep a steady and safe progress in both single- and multi-lane roads.

What it does

Lane Keeping Support, LKS, detects and calculates the distance to the lane markings on the road. If the vehicle gets close to the lane marking, the driver is alerted by a warning from the vehicle. If this move is intentional, the warning is suppressed by the system. LKS is functional at speeds above 60 km/h and is activated/deactivated by the driver using the LKS switch on the dashboard.

How it works

A camera at the front of the bus detects the lane markings. The system's video processing determines the variations in distance to the lane markings, and alerts the driver if there is an indication of a lane departure. The driver is warned by a visual signal on the dashboard, by audio and by a haptic, directional seat vibrator.

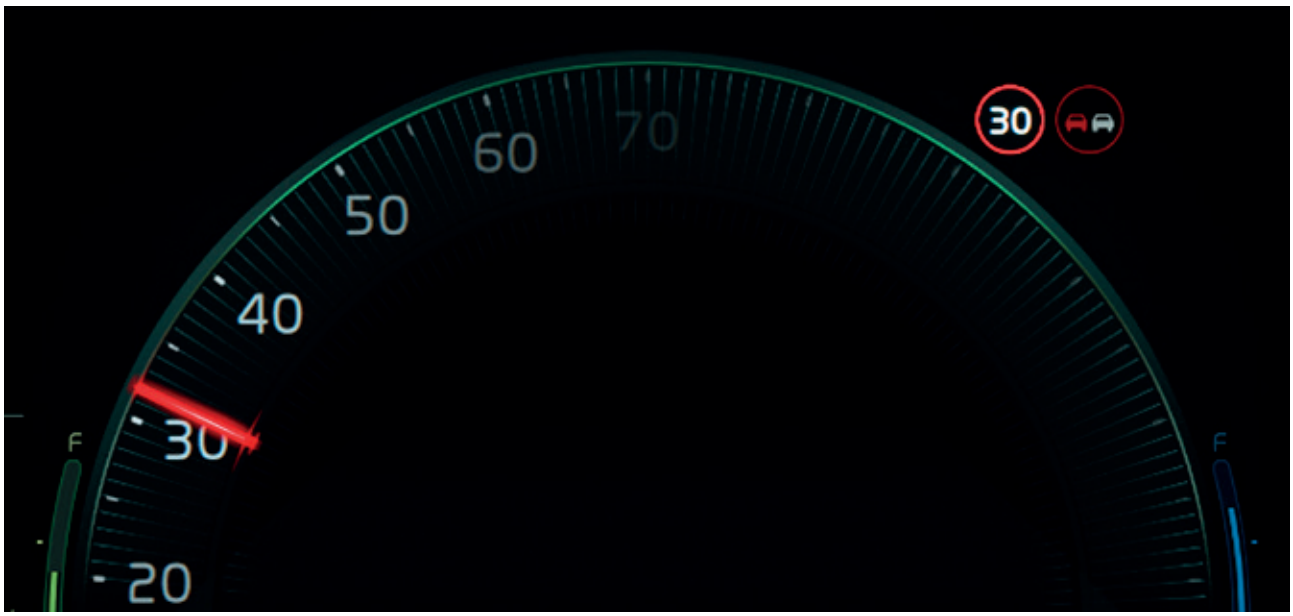
BENEFITS

- Creates safety margins and avoids hazardous situations.
- Supports driver focus.
- Serves as an indication of drowsiness.

For more information, contact your Volvo Buses dealer.

Intelligent Speed Assist

Intelligent Speed Assist, ISA, helps the driver follow rules and restrictions while on the road. By scanning road signs the driver can, at any time update on current conditions, related to speed and other restrictions.



What it does

Intelligent Speed Assist, ISA, is set up to recognize and display a range of road signs as a support to the driver when passing them. In busy traffic, road signs can build a substantial flow of information, and it can be very difficult to register and remember everything. ISA recognizes not only speed limits but also other restrictions and warnings. Should the driver exceed a registered speed limit, the driver receives an audible warning and the symbol on the dashboard flashes.

How it works

The ISA system uses video camera and real-time image processing. Its algorithms determine whether an object is likely to be a road sign, and compares the identified image with a stored graphic library. When there is a match, the sign symbol is displayed on the display of the instrument cluster. When a speed limit is changed, an audio alert indicates this. In addition to sign recognition, ISA can receive cloud-based speed limit information. Contact your Volvo representative for further information.

Disclaimer: ISA will only cover signs in markets where GSR demand is legal. Other markets can benefit from the system if their local signs look the same as signs in supported markets.

BENEFITS

- Helps to avoid risks related to overspeeding.
- Reduces the risk of violating restrictions and traffic rules.
- Reduces the risk of fines and remarks on the operator's track record.

For more information, contact your Volvo Buses dealer.

Volvo Buses active safety systems

Driver Alert Support

Driving a bus is a considerable responsibility, and one that requires focus and concentration. Driver Alert Support, DAS, identifies signs of drowsiness or declining focus, and the driver is requested to take action.

What it does

Driver Alert Support, DAS, monitors the vehicle's position within the lane. If it senses that the driver is losing focus, the system alerts the driver by illuminating a symbol on the dashboard. The alert has two levels of urgency: the first gives a discreet sound alert and the message "Focus on driving", and the second adds an increased sound alert.

How it works

DAS uses camera and image processing to establish the driving pattern within the lane. If frequency and amplitude of corrections indicate extended reaction times, the system will present either of the two alerts on the dashboard. In addition, the system monitors the movements of the steering wheel. There are known patterns that indicate drowsiness, and the detection of this is part of the evaluation of the driving.

BENEFITS

- Prevents hazardous situations caused by distraction, drowsiness and fatigue.
- Reminds the driver of the importance of being focused.

For more information, contact your Volvo Buses dealer.

Side Collision Avoidance Support

In city traffic, several types of vehicles share road space, advancing at various speeds and in different directions. Cyclists and e-scooters overtaking on the inside is a frequent risk when a bus is about to turn at an intersection. With Side Collision Avoidance Support, SCAS, the driver gets a warning when there is a collision risk.

What it does

Side Collision Avoidance Support, SCAS, detects moving vulnerable road users, VRUs, along the sides of the bus. It serves as a blind spot information system, warning the driver of, for instance, cyclists and e-scooters on both sides of the bus. The system detects objects when the bus is in motion, but also when standing still. When an object is detected, an LED on the A-pillar lights up, and if a collision is imminent, the LED flashes and an audible signal is heard.

How it works

This feature uses side radars to gather information about objects along the sides of the bus. This information includes the movement of the objects, and of the vehicle, and driver commands and actions. It is used to determine the risk of intercepting trajectories. The detection range is 7 meters in front of the bus and 30 meters to the rear, and laterally up to 4.25 meters. The system is active at speeds up to 30 km/h.

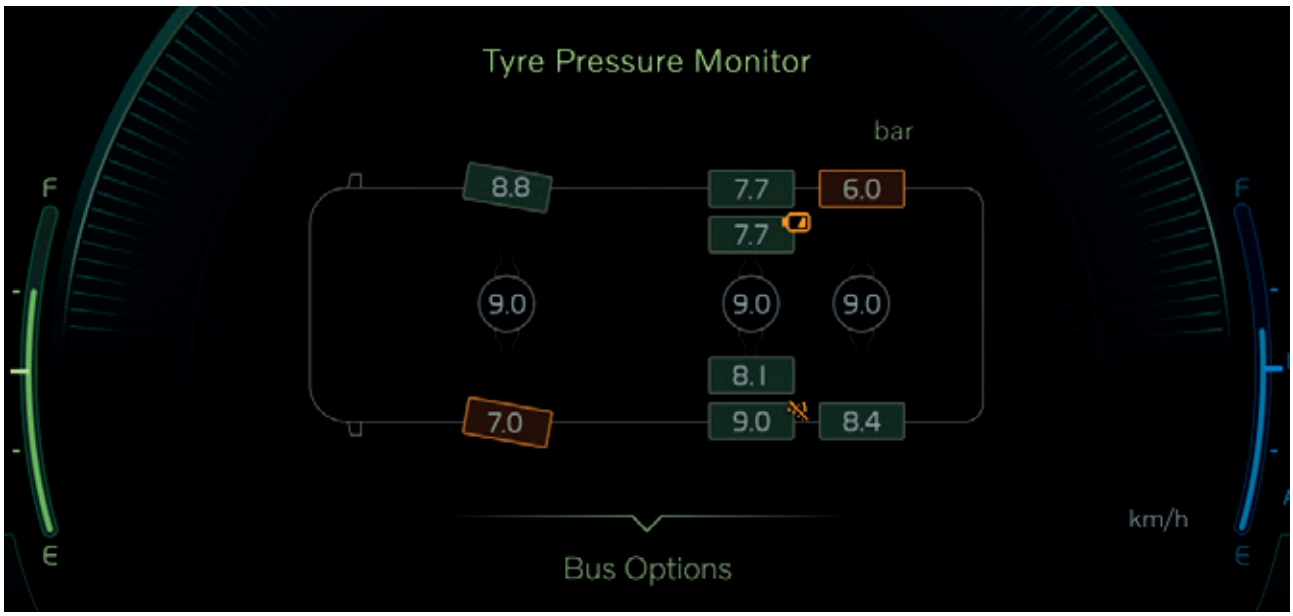
BENEFITS

- Prevents collisions with VRUs and vehicles.
- Reduces the risk of sudden emergency braking in city traffic.
- Monitors both sides of the bus.

For more information, contact your Volvo Buses dealer.

Tire Pressure Monitoring System

Incorrect tire pressure can lead to risk for accidents. In addition, tires make up a substantial expense for bus operators. The Tire Pressure Monitoring System, TPMS, will not only cut tire maintenance costs, but also improve drivability and your fleet's energy efficiency.



What it does

Tire Pressure Monitoring System, TPMS, alerts the driver via the instrument cluster if a tire's air pressure drops below safe levels. At start-up, the pressure is read within a few minutes and then monitored continuously. TPMS gives a visual warning if tire pressure is insufficient, and each tire is monitored individually. The driver gets a graphic presentation on the dashboard, with the latest readings for each tire.

How it works

The TPMS consists of battery-operated wireless pressure sensors attached to each tire's inlet valve, and a processing unit connected to the dashboard display. The sensors transmit the pressure value to the central unit, and if the pressure of any of the tires is outside the recommended pressure range, a warning is displayed on the dashboard.

BENEFITS

- Avoids risk of incorrect tire pressure causing unexpected road behavior.
- Improves drivability and energy efficiency.
- Helps reduce tire maintenance costs.

For more information, contact your Volvo Buses dealer.

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