



SURFACE VEHICLE RECOMMENDED PRACTICE

J2627™

JUL2022

Issued 2002-09
Revised 2009-08
Stabilized 2022-07

Superseding J2627 AUG2009

Braking System Definitions - Truck and Bus

RATIONALE

This document has been stabilized because it covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

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1. SCOPE

This SAE Recommended Practice identifies and defines terms specifically related to truck and bus braking systems including Antilock Brake Systems (ABS) and Electronically Controlled Braking Systems (ECBS).

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J560	Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable
SAE J592	Sidemarkers Lamps for Use on Road Vehicles Less than 2032 mm in Overall Width
SAE J656	Automotive Brake Definitions and Nomenclature
SAE J1455	Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications
SAE J1587	Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1708	Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1922	Powertrain Control Interface for Electronic Controls Used in Medium- and Heavy-Duty Diesel On-Highway Vehicle Applications

SAE J1939	Recommended Practice for a Serial Control and Communications Vehicle Network
SAE J1939-01	Recommended Practice for Control and Communications Network for On-Highway Equipment
SAE J1939-11	Physical Layer, 250K bits/s, Twisted Shielded Pair
SAE J1939-13	Off-Board Diagnostic Connector
SAE J1939-21	Data Link Layer
SAE J1939-31	Network Layer
SAE J1939-71	Vehicle Application Layer
SAE J1939-73	Application Layer—Diagnostics
SAE J1939-81	Network Management
SAE J2497	Power Line Carrier Communications for Commercial Vehicles

2.1.2 FMVSS Publication

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch>.

Federal Motor Vehicle Safety Standard 121	Air Brake Systems
Federal Motor Vehicle Safety Standard 105	Hydraulic and Electric Brake Systems

2.1.3 ECE Publication

Available from United Nations Economic Commission for Europe, Palais des Nations, CH-1211, Geneva 10, Switzerland, Tel: +41-0-22-917-12-34, www.unece.org.

ECE R13	Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking
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2.1.4 ISO Publications

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 9141	Road vehicles—Diagnostic systems—Requirements for interchange of digital information
ISO 11992-1	Road vehicles—Interchange of digital information on electrical connections between towing and towed vehicles—Part 1: Physical layer and data-link layer—Second edition
ISO 11992-2	Road vehicles—Interchange of digital information on electrical connections between towing and towed vehicles—Part 2: Application layer for brakes and running gear—Second edition
ISO 14230	Road vehicles—Diagnostic systems KWP2000 (Parts 1-4)

3. DEFINITIONS

3.1 1P-1E ECBS Configuration

An Electronically Controlled Braking System in which a single electronic control signal is overlaid onto a single pressure control signal to operate the foundation brakes under normal conditions.

3.2 2P Configuration

A pneumatically controlled braking system in which two isolated pneumatic signals control the service brake system.

3.3 2P-1E ECBS Configuration

An Electronically Controlled Braking System in which a single electronic control signal is overlaid onto the traditional dual pneumatic brake signals to operate the foundation brakes under normal conditions.

3.4 2E ECBS Configuration

An Electronically Controlled Braking System in which two isolated electronic signals control the service brake system.

3.5 2s-1m

An ABS or ECBS control system in which two wheel speed sensors provide the input for control of a single pressure-modulation valve.

3.6 2s-2m

An ABS or ECBS control system in which two wheel speed sensors provide the input for control of two modulation valves.

3.7 4s-2m Axle Control

An ABS or ECBS control system in which four wheel speed sensors provide the input for the control of two pressure-modulation valves that are operated in axle-by-axle mode.

3.8 4s-2m Side Control

An ABS or ECBS control system in which four wheel speed sensors provide the input for the control of two pressure-modulation valves that are operated in side-by-side mode.

3.9 4s-3m

An ABS or ECBS control system in which four wheel speed sensors provide the input for control of three pressure-modulation valves.

3.10 4s-4m

An ABS or ECBS control system in which four wheel speed sensors provide the input for control of four pressure-modulation valves.

3.11 6s-4m

An ABS or ECBS control system in which six wheel speed sensors provide the input for control of four pressure-modulation valves.

3.12 6s-5m

An ABS or ECBS control system in which six wheel speed sensors provide the input for control of five pressure-modulation valves.

3.13 6s-6m

An ABS or ECBS control system in which six wheel speed sensors provide the input for control of six pressure-modulation valves.

3.14 ABS (per FMVSS-121)

Antilock brake system or ABS means a portion of a service brake system that automatically controls the degree of rotational wheel slip during braking by: (1) Sensing the rate of angular rotation of the wheels; (2) Transmitting signals regarding the rate of wheel angular rotation to one or more controlling devices which interpret those signals and generate responsive controlling output signals; and (3) Transmitting those controlling signals to one or more modulators which adjust brake actuating forces in response to those signals.

3.15 ABS (per ECE R13)

An "anti-lock braking system" is a part of a service braking system which automatically controls the degree of slip, in the direction of rotation of the wheel(s), on one or more wheels of the vehicle during braking.

3.16 ACC

Active Cruise Control or Adaptive Cruise Control – A system that uses radar, laser or other sensors in addition to a traditional cruise-control system and ABS or ECBS to monitor traffic ahead of a vehicle, and automatically maintain a preset following interval via engine throttle, auxiliary brakes or the service braking system. ACC typically has three major functions: maintaining a set speed, detecting a vehicle in the travel lane ahead, and maintaining a predefined headway when slower vehicles ahead are detected. Also referred to as Intelligent Cruise Control.

3.17 ADB

Air Disc Brake – A pneumatically actuated disc brake.

3.18 Air Gap

The distance between the face of a wheel speed sensor and tone ring.

3.19 Antilock Malfunction Signal and Circuit (per FMVSS-121, S5.1.6.2)

An indicator lamp, mounted in front of and in clear view of the driver, which is activated whenever there is a malfunction that affects the generation or transmission of response or control signals in the vehicle's antilock brake system. (b)(1) The lamp shall be designed to conform to the performance requirements of SAE International Recommended Practice J592 JUN92, or J592e, July 1972, Clearance, Side Marker, and Identification.

3.20 ALB

Automatic Load-dependent Braking force control – A system that balances the brake force between axles depending on vehicle load distribution. .

3.21 Anti-Compounding

A mechanism that prevents the combined forces of spring brake and service brake from being applied to a foundation brake simultaneously.

3.22 ASR

Automatic Slip Regulation. See ATC.

3.23 ATC

Automatic Traction Control – An electronic control system, based on an ABS or ECBS system with additional software code and electro-pneumatic valving designed to automatically control engine torque levels and modulate drive-axle individual wheel-end brake pressure to a) improve vehicle mobility by utilizing otherwise unavailable tire-road traction and b) improve lateral vehicle stability by maintaining an appropriate slip level of the driven wheels (Also referred to as ASR).

3.24 ATC Deep Snow and Mud Switch

A driver-operated electrical switch used to request a mode of traction control operation that permits greater than usual slip before calling for a reduction in engine torque or brake application. This may enhance vehicle mobility under deep snow and mud conditions. The switch may also completely deactivate ATC as an optional traction aid.

3.25 Automatic Tire Diameter Compensation

A software algorithm that compensates for variability in wheel speed signals caused by tire diameter differences.

3.26 Axle-Load Sensor

A means for determining the load on an axle. Usually by measuring air bag pressure (air suspension systems) or by measuring suspension height (spring suspensions).

3.27 Biased Quick Release Valve

A valve that delivers no pressure until a bias pressure (also referred to as hold off or crack pressure) level has been reached at the inlet.

3.28 Blink Codes

A sequence of blinks of the ABS indicator lamp to communicate information about the ABS system, which allows a technician to troubleshoot ABS problems without special equipment.

3.29 Brake (per SAE J656)

An energy conversion mechanism used to retard, stop or hold a vehicle.

3.30 Brake (per ECE R13)

The part in which the forces opposing the movement of the vehicle develop. It may be a friction brake (when the forces are generated by friction between two parts of the vehicle moving relatively to one another); an electrical brake (when the forces are generated by electro-magnetic action between two parts of the vehicle moving relatively to but not in contact with one another); a fluid brake (when the forces are generated by the action of a fluid situated between two parts of the vehicle moving relatively to one another); or an engine brake (when the forces are derived from an artificial increase in the braking action, transmitted to the wheels, of the engine).

3.31 Brake-by-Wire

Slang term for ECBS.

3.32 Braking System Coefficient of Friction

A parameter that relates the lateral or longitudinal force on a tire to normal or vertical force applied to the tire. Also, a parameter that relates the force of a brake pad or block to its clamping (normal) force.

3.33 CAN Data Link

Controller Area Network – A hardware protocol licensed by Bosch for transmitting data over a multiplex data connection between multiple electronic control units on a vehicle. (SAE J1939 is an implementation of the CAN protocol).

3.34 Clear Codes

A system to erase historical diagnostic trouble codes from the ABS or ECBS ECU using a diagnostic switch or hand held diagnostic tool. Typically only repaired diagnostic codes may be cleared.

3.35 Controller (per ECE R13)

A component designed to evaluate the data transmitted by the sensor(s) and to transmit a signal to the modulator.

3.36 Coupling Force Control (per ECE R13)

A system/function to balance automatically the braking rate of towing vehicle and trailer.

3.37 CMS

Collision Mitigation System – An expansion of the ACC system capable of applying the service brakes to decelerate the vehicle in a collision imminent situation in an effort to reduce collision impact energy.

3.38 DBR

German abbreviation for endurance brakes ie retarder, jake brake, exhaust brake.

3.39 Diagnostic Connector

A receptacle in the vehicle cab for connection of SAE J1587 or SAE J1939 hand held or PC based test equipment.

3.40 Diagnostic Switch

A switch used to activate diagnostic Blink Codes.

3.41 Diagnostic Trouble Code

A code generated by the ECU indicating problems that may affect ABS or ECBS system functionality.

3.42 Differential Braking

A term used to describe part of an ATC event where brake force is applied to a spinning wheel so that drive torque will be transferred to the wheels which have more available traction.

3.43 Directly Controlled Wheel (per FMVSS-121)

A wheel whose braking force is modulated according to data provided at least by its own sensor.

3.44 Driveline Retarder

An energy conversion mechanism mounted between the back of transmission and the drive axle differential used for the purpose of retarding vehicle motion.

3.45 DTC

Drag Torque Control – A system that reduces wheel slip due to driveline inertia drag on a driven axle by increasing engine torque to overcome the inertia. Increases vehicle stability on low traction surfaces during drop throttle conditions, downshifting, or retarder braking.

3.46 EBD

Electronic Brake Force Distribution (see Variable Proportioning Brake System).

3.47 EBS

Electronic Brake System – A term for ECBS commonly used in Europe.

3.48 ECAS

Electronically Controlled Air Suspension. (A related term sometimes used in Europe is ELF).

3.49 ECBS

Electronically Controlled Brake System – The minimum requirement for a service brake system to be designated as an ECBS is that the service brake control is done electronically. The power source (working circuit) is pneumatic or hydraulic. ECBS includes the basic functions and features of ABS. ECBS allows independent control of brake pressures on each axle.

3.50 ECBS Warning Light

A red warning light that may be the same as the low air pressure warning light. This indicator is a signal to the operator that the vehicle should be sidelined as soon as is practicable.

3.51 ECU

An electronic device that monitors a system. The ECU receives data from sensors, analyzes the data, and then transmits correcting instructions as required to a component.

3.52 EDC

Electronic Diesel Control.

3.53 EEPROM

Electrically Erasable Programmable Read Only Memory.

3.54 Electric Control Line (per ECE R13)

The electrical connection between power-driven vehicle and trailer which provides the braking control function to the trailer. It comprises the electrical wiring and connector and includes the parts for data communication and the electrical energy supply for the trailer control transmission.

3.55 EMC

Electromagnetic Compatibility – A term referring to both radiated and conducted electromagnetic susceptibility and emissions.

3.56 Engine Retarder

A method for slowing vehicle motion by using the engine to transfer energy from the vehicle driveline into the engine exhaust. This is accomplished by compressing air in the engine cylinders and exhausting this compressed air at the top of the compression stroke. Also used to synchronize the engine during shifting with an automated manual transmission.

3.57 EOL

End-of-Line, (For example End-of-Line Programming or End-of-Line Test) (See VEPS).

3.58 EPB

Electro-pneumatic brake system – A proprietary term for EBS in Europe (See ECBS).

3.59 ESC

Electronic Stability Control – An active system that automatically intervenes if risk of rollover or yaw instability is detected. An ECU uses wheel speeds, yaw rate, lateral acceleration and steering angle to compare vehicle movement to performance models. If the vehicle shows a tendency to leave an appropriate travel path, or if critical threshold values are approached, the system will intervene to assist the driver. When risk of rollover is detected, the system reacts as described under RSC. When yaw instability is detected the system intervenes and controls the engine torque and auxiliary brake systems as well as selectively applying individual brakes to correct the vehicle's path. ESC may be integrated with ABS- systems or ECBS systems.

3.60 ESP

Electronic Stability Program, (See ESC).

3.61 ETC

Electronic Traction Control, (See ATC).

3.62 Exhaust Brake

A means for slowing vehicle motion by restricting the engine exhaust.

3.63 FBM

Foot Brake Module – A foot actuated device that generates at least two signals for control of the foundation brakes, at least one of which is electrical (For ECBS systems). Also referred to as a Brake Signal transmitter for ECBS.

3.64 FMVSS-121 (per FMVSS-121)

This standard establishes performance and equipment requirements for braking systems on vehicles equipped with air brake systems. The purpose of this standard is to insure safe braking performance under normal and emergency conditions.

3.65 Full-Treadle Brake Application (per FMVSS-121)

A brake application in which the treadle valve pressure in any of the valve's output circuits reaches 586.21 kPa (85 psi) within 0.2 s after the application is initiated, or in which maximum treadle travel is achieved within 0.2 s after the application is initiated.

3.66 Full Brake Application (per FMVSS105)

A brake application in which the force on the brake pedal reaches 150 lb within 0.3 s from the point of application of force to the brake control.

3.67 HIL

Hardware in the Loop – A method of simulation that combines software models interacting with actual vehicle hardware.

3.68 Independent Regulation

A control method in which an individual wheel is controlled at a slip condition representing the best compromise of retardation and stability.

3.69 Independently Controlled Wheel (per FMVSS-121)

A directly controlled wheel for which the modulator does not adjust the brake force actuating forces at any other wheel on the same axle.

3.70 Indirectly Controlled Wheel (per FMVSS-121)

A wheel whose braking force is modulated according to data provided by the sensor(s) of other wheel(s).

3.71 Indirectly Controlled Wheel (per ECE R13)

A wheel at which the degree of rotational wheel slip is not sensed, but at which the modulator of antilock braking system adjusts its brake actuating forces in response to signals from one or more sensed wheel(s).

3.72 Intelligent Cruise Control

See ACC.

3.73 ISO/DIS 11992:2001

Commercial road vehicles – Electrical connections between towing and towed vehicles – Interchange of digital information. Specifies electric control line between towing and towed vehicle.

3.74 ISO 14230

Road vehicles – Diagnostic systems – Keyword protocol 2000. Mainly used in Europe as well as in imported US vehicles.

3.75 ISO 9141

Road vehicles – Diagnostic systems. A diagnostic data link popular in Europe.

3.76 Jennite

Trade name for coal tar emulsion pavement sealer commonly used on test tracks to produce a low coefficient-of-friction road surface when wet.

3.77 KWP2000

Key Word Protocol 2000 – European diagnostic protocol used in ISO 14230.

3.78 Lining Wear-Out Sensor

A sensor that indicates that a brake lining is at or near its service limit and should be replaced.

3.79 Lining Wear Sensor

A sensor used to provide a continuous signal indicating brake lining wear.

3.80 Maximum Drive-Through Speed (per FMVSS-121)

The highest possible constant speed at which the vehicle can be driven through 60.96 m (200 ft) of a 152.4 m (500 ft) radius curve arc without leaving the 3.6576 m (12 ft) lane.

3.81 Modified Individual Regulation

Used in ABS systems with 2 channels dedicated to the front axle (4S4M and higher). A method of controlling the steer axle during ABS operation so that torque steer is minimized. At the beginning of an ABS event on a split-coefficient surface, the front modulators are controlled based on the slip characteristics of the low friction surface. Later in the event, when the vehicle driver has had time to recognize torque-steer steering-wheel inputs, the modulators are controlled more independently, introducing more torque-steer into the driver's control efforts. Also referred to as Modified Individual Control

3.82 MSR

Modified Side Regulation – A method of ABS control in which two wheels on one side of the vehicle are controlled by a single pressure modulating valve, while the control is similar to an enhanced select low control. Also known as MAR for two wheels of the same axle.

3.83 Modulator (per ECE R13)

A component designed to vary the braking force in accordance with the signal received from the controller.

3.84 Off-Highway Mode

A mode of ECBS/ABS control intended for off-highway use. This mode of operation allows deeper wheel cycling and/or early ABS drop out. The object is to allow road materials such as sand, gravel or snow to wedge in front of wheels without resulting in ABS release.

3.85 PCM

Pressure Control Module – An ECBS brake modulation valve.

3.86 PLC

Power Line Carrier – A method of multiplexing used to communicate between combination vehicle trucks, tractors and trailers. PLC transmits data as a series of electronic “chirps” over existing vehicle wiring. Specified in SAE J2497.

3.87 PMV

Pressure Modulation Valve – an electro pneumatic ABS modulation valve.

3.88 Pressure Sensor

A sensor providing a continuous signal representing the measured pressure. Often used in stability control and ACC systems to determine driver demand.

3.89 RAM

Random Access Memory – A term generally used to refer to volatile memory used to store temporary parameters.

3.90 Regenerative Braking

A method to recoup and store energy during vehicle braking via electrical or hydraulic means. Also referred to as regen and regen braking.