AUSTRALIAN TRUCKING ASSOCIATION

INDUSTRY TECHNICAL COUNCIL

TECHNICAL ADVISORY PROCEDURE

STABILITY CONTROL FOR TRUCKS AND TRAILERS

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ATA Technical Advisory Procedure

Stability Control for Trucks and Trailers

Edition 3

Australian Trucking Association
25 National Circuit
Forrest
ACT 2603
T - 02 6253 900
E - ata@truck.net.au

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This Technical Advisory Procedure (TAP) is published by the Australian Trucking Association Ltd (ATA) to assist the road transport industry in improving heavy vehicle safety.

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Contents

Figures

Tables

Introduction

This Technical Advisory Procedure (TAP) is published by the Australian Trucking Association Ltd (ATA) to assist the road transport industry to improve the technical understanding and key information about the fitment and operation of stability control systems for improved vehicle safety.

It is not, nor is it intended to be, complete or without exceptions.

Two fundamentally different braking platforms exist in the Australian heavy vehicle market, ABS platform and EBS platform.

1. The Antilock Braking System (ABS) platform emerged more than 30 years ago and uses pneumatic valving to generate a braking pressure as demanded by the driver. The ABS platform is typically found on North American vehicles and generally operates at 12V, while Japanese trucks that are not fitted with EBS will be fitted with a 24V ABS system.
2. Electronic Braking System (EBS) platform is an electronically controlled pneumatic brake system where the driver demands a vehicle deceleration rate via the brake pedal, and an ECU calculates the required brake application pressure to achieve this. EBS is typically found on European vehicles and operates at 24V. Increasingly, Japanese trucks are being fitted with EBS.

The ABS platform was originally designed to achieve the ABS function and prevent wheel lock up during braking thus allowing the driver to maintain directional control of the vehicle. The ABS function was not designed to reduce stopping distances and under some circumstances may increase it, however in emergency stops, ABS has proven to be highly effective and is widely accepted as an invaluable safety feature.

In the last ten plus years, the ABS platform has been considerably enhanced with the development of integrated features such as Automatic Traction Control (ATC) and full stability control to deliver the next generation of braking control. Full stability control includes the Yaw Control (YC) and roll stability control functions. Roll stability control is often referred to as Roll Stability program, or RSS, RSC or other similar acronyms. Fitment of full stability control (ESC/ESP) to the ABS braking platform is the gateway to be able to add further Advanced Emergency Braking (AEB) features.

Unfortunately, EBS (Electronic Braking System) has unintentionally become the de-facto term used to describe all stability systems regardless of the platform. This is not the case, both the ABS or EBS braking platforms can have the stability functions incorporated.

The major advantages of a true EBS braking platform includes quicker braking response times, improved brake distribution/balance and a feedback system that modulates braking force to maximum effectiveness. The type of components and therefore the level of functionality varies, AEB features can be enabled in EBS platforms also.

Note

> Having a vehicle fitted with EBS does not necessarily guarantee all advanced features such as roll stability support are available. Purchasers need to check with the vehicle supplier.

Why have stability control?

Crash Data

The 2015 NTI/NTARC report analysed its 2013 insurance claims and found "inappropriate speed for the prevailing conditions continued to be the predominant cause with major truck crashes, accounting for 27% of claims registered, 73.6% of speed losses resulted in a rollover." Some form of roll control technology may have avoided some of these crashes, as has been the case in the Victorian logging industry, where rollovers once averaged 40 a year (2006-2009) and nil thereafter for B-Doubles fitted with the technology.

However, the laws of physics still apply and a stability control system cannot prevent all rollover crashes. The driver must drive to the prevailing conditions and not rely on enhanced safety systems to manage inappropriate speed.

NSW EPA and dangerous goods tanker trailers requirements[1]

The NSW Environment Protection Authority (EPA) acted in 2014, to mandate roll stability control on all Dangerous Goods (DG) tanker trailers operating in that state with an ATM greater than 4.5 tonne and where the tank forms an integral part of the trailer. The mandate does not cover dangerous goods trailers carrying ISO tanks or bladders.

Timing - All tanker trailers from 1 January 2019 operating in NSW will need to be fitted with RSC. No matter their state or territory of registration, if travelling within NSW.

VicForests and mandating trailer stability control[2]

In 2014, VicForests required new permit conditions for operators of B-double vehicles in specific logging coops. To have their access permits approved, trailers must be fitted with EBS rollover stability systems within 12 months and update their vehicles to also include electronic braking systems within five years.

A subsequent case study[3] reported that the introduction of electronic braking systems with stability control has virtually eliminated truck and trailer rollovers in key logging coops. The success of the safety system has turned former opponents into advocates and driven widespread adoption of the technology across the industry. Since the safety policy was introduced as a condition of access permits for forestry heavy vehicles, no vehicle fitted with the system has reportedly rolled.

Findings

Rollovers before:	40 per year (averaged 2006 to 2009)
Rollovers after:	Nil (B-doubles, where the technology was fitted)

Australian Design Rules (ADR)

The ADRs now requires stability control on most trucks and trailers. Refer to Section 2 for details.

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[1] NSW EPA press release: http://www.epa.nsw.gov.au/epamedia/EPAMedia14090501.htm

[2] VicRoads press release: https://www.vicroads.vic.gov.au/newsmedia/2014/electronic-braking-system-stops-truck-rollovers-in- the-logging-industry

[3] NRSPP VicForests case study publication: http://www.vicforests.com.au/files/nrurkmrrkf/VicRoads_CS_Proof_6a.pdf

1. Definitions

The source for definitions is the ADR Definitions and Vehicle Categories.

ABS	Antilock Brake System (ABS) acts to prevent wheel lock-up on the controlled wheels during braking by altering ('modulating') the brake air pressure in response to wheel speed signals. In the first stage modulation involves first stopping brake pressure build-up and in the second stage releasing brake pressure before allowing brake pressure to build up again. ABS is not designed to improve absolute stopping distances, but to allow the vehicle to maintain control and avoid an accident situation.
ABS Platform	A pneumatically controlled braking system to which may have added additional functional elements such as ABS, ATC and ESC.
ADR	Australian Design Rules 3rd Edition.
AEB	Advanced Emergency Braking (AEB) is an advanced road vehicle safety system that uses sensors to monitor the proximity of vehicles in front and detects situations where the relative speed and distance between the host and target vehicles suggest that a collision is imminent. In such a situation, emergency braking can be automatically applied to avoid the collision or at least to mitigate its effect.
CAN	Controller Area Network (CAN) is an electronic communication bus (wiring system involving 2 or 3 wires in a twist) for communication of information between distributed micro-controllers and sensors on trucks and trailers.
EBS	Electronic Braking System (EBS) or "brake-by-wire" electronically control the braking system improving braking response time for reduced stopping distances. EBS integrates anti-lock braking system (ABS) technology, and can include automatic traction control (ATC), stability control and other key vehicle control system features to deliver the next generation of braking control. A key EBS feature is that it allows truck and trailers to communicate via a twisted pair set of CAN-Bus wires. An electronic signal takes priority over the air signal sent by the brake pedal to activate the brakes, improving stopping distances and braking system performance. All active EBS include full stability systems, although not all models of EBS trucks have this option activated. EBS may provide a platform for future advanced safety systems. In a brake system with electronic brake force distribution (EBD), the amount of brake effort, particularly on the drive axles, can be regulated according to the load imposed on each wheel set. The aim of this is to ensure all wheels do an appropriate amount of braking for the load carried, and no wheel set or axle group is over braked. Typically, EBS combines a range of air valves used in a traditional brake system into a single modulator unit. EBS is one of two avenues by which stability control can be implemented and arguably could be the best methodology for overall system performance and capability. EBS is available on European trucks and some Japanese trucks. It is not currently available with North American or Australian manufactured trucks.

EBS Platform	A electronically controlled braking system to which additional functional elements, such as stability control can be added. EBS provides electronic control signals which are faster than pneumatic signals, speeding up the application of brakes compared to ABS platform vehicles.
EBSS	Electronic Brake Safety System (EBSS) is a marketing term and not related to an Electronic Braking System (EBS). EBSS uses the ABS platform that may include ESP, ATC and ABS. EBSS level I, includes ABS and/or ATC only, while EBSS level II, includes ABS, ATC and ESP. The EBSS controls the braking units via the pneumatics. It is a marketing term for the Kenworth electronic brake control system being marketed in Australia.
ESC	Electronic Stability Control (ESC) acts automatically to prevent potential loss-of-control movements on a powered truck by reducing engine torque and if required applying selected brakes; that is, it can correct understeer, oversteer and pending roll-over. ESC includes Roll Stability Control (RSC) and is built on the foundation of the Antilock Braking System (ABS) platform and Automatic Traction Control (ATC). Note: ESC includes roll stability functionality as well as Yaw Control (YC) on a rigid truck or a prime mover, YC is not applicable to trailers as part of a Trailer Electronic Braking System (TEBS).
ESP	Electronic Stability Program – refer to ESC.
LSF	Load Sense Function (LSF) is the ability of a TEBS to change the braking characteristics based on the mass the trailer is carrying.
RSA	Roll Stability Advantage (RSA) is a marketing term used by Mack to describe ESP/ESC – refer to ESC.
RSC	Roll Stability Control (RSC) applies selected brakes to reduce the risk of rollover occurring when a potential vehicle rollover is sensed. The strategy is to reduce the speed of the vehicle in a controlled manner. Some RSC systems apply all the brakes autonomously (i.e. without driver input), other RSC systems apply selected brakes independently of the driver.
TEBS	Trailer Electronic Brake System (TEBS) is an EBS system for trailers, all TEBS include ABS, LSF and RSC functionality. RSC functionality may not be activated on all trailer types. The primary brake demand is via the CAN bus when the towing motor vehicle has EBS. The TEBS unit also manages the distribution of the braking effort on the trailer via the LSF and friction demand.
TRM	Trailer Roadtrain Module (TRM) generates an electronic brake demand for trailer(s) fitted with TEBS. The demand is based on a pneumatic brake demand from the towing motor vehicle. The electronic brake signal is a simplified CAN message sent via the CAN Bus to reduce lag compared to a pneumatic brake signal. Also referred to as Trailer Response Management (TRM) in marketing, or CAN Router
TRS	Trailer Response Signalling (TRS) - refer to TRM.
VSP	Vehicle Stability Program – refer to ESC/ESP.
VSC	Vehicle Stability Control (VSC) – refer to ESC/ESP

YC	Yaw Control (YC) describes a function of the ESP/ESC system to mitigate under steer and over steer conditions. Additional to the roll stability function, which mitigates against roll over scenarios, YC and roll stability combine to form a full stability solution. Often referred to as Direction Control also. Yaw control requires additional sensors (steering angle and yaw) to those used for roll stability control.

2. Braking Standards

Australia is principally a taker of technology and vehicle design rules. There are four major sources of truck technology and vehicle construction – Europe, Asia and North America along with locally produced product. To achieve an open market, truck (ADR35) and trailer (ADR38) braking standards allow compliance to the detailed requirements of the ADR plus UN R13, to allow access to the market for heavy commercial vehicles with different philosophical braking methodologies. This has resulted in a mix and match of different design and compliance philosophies, compounded with an average truck fleet age of 11.5 years.[4]

Stability control is mandatory in Europe via the UN R13 braking standard. It is applicable to all air braked category N2, N3, O3 and O4 (the equivalent of ADR categories NB, NC, TC and TD). If a trailer is used in a multi-trailer combination (i.e. Euro Combi/A-Double) the individual trailers will still comply R13 requirements. is the requirement for stability control only applicable to on-road two and three axle vehicles towing a single trailer.

In the US, FVMSS 136 standard defines the requirements of a stability control system for prime movers and was effective from 1 August 2017 and for other powered units (trucks and buses) from 1 August 2019, but this standard does not apply to trailers.

Australian braking standards and their evolution

ADR35/04 - commercial motor vehicle brake systems, mandatory as of 1 January 2015, requires ABS braking on every heavy commercial vehicle as the minimum requirement.

ADR35/05 - commercial motor vehicle brake systems, mandatory as of 1 November 2017. It requires stability control for light vehicles (NA ADR class), but will not impact heavy commercial, NB and NC class vehicles with a GVM above 3.5 tonne.

ADR35/06 - commercial motor vehicle brake systems, mandatory as of 1 January 2022. It requires stability control for heavy vehicles - NB and NC ADR class vehicles.

> **New requirement.**
> *Each vehicle designed to be used in 'Road Train' combinations, must be equipped with a special connector conforming to ISO7638-1:2003 together with a permanent electrical supply system configured for 24-volt operation. A ROAD TRAIN is defined as a combination of vehicles, other than a 'B-Double', consisting of a motor vehicle towing at least 2 trailers (counting as one trailer a 'Converter Dolly' supporting a 'Semi-trailer').*

ADR35/07 - commercial motor vehicle brake systems, becomes mandatory from 1 February 2025. NB and NC ADR class vehicles with a GVM above 3.5 tonne and requires Advanced Emergency Braking (AEB).

ADR38/04 - trailer brake systems, mandatory as of 1 January 2015, requires ABS braking or variable proportioning brake system on every heavy commercial trailer. Converter dollies and dollies are exempt from the requirement, but must provide through power to drive smart brake systems on any trailing units.

ADR38/05 - trailer brake systems, mandatory as of 1 November 2019, requires Roll Stability Control and removes the option of variable proportioning brake system.

[4] ABS 9309.0 - Motor Vehicle Census, Australia, 31 Jan 2015 for Australian articulated trucks.

3. Stability Control Systems and Suppliers

The stability control function is an active vehicle safety system that continuously checks and compares information against critical thresholds at which instability may occur. When the critical threshold is exceeded, the stability control system intervenes to slow and/or control the direction of the vehicle. Depending on the system, this could be by reducing engine torque, engaging the engine retarder (for a motor vehicle), diagonally applying the brakes (for a motor vehicle) and automatically applying the braking systems for a motor vehicle and/or the trailer. Frequently, system activation takes place before the driver is aware of it's need.

There are two basic varieties of stability control : -

- Roll stability controls a vehicle's tendency to roll due to excessive lateral acceleration, and is the only option for trailers. The roll stability function is an active vehicle safety system that continuously monitors the lateral acceleration of the vehicle and compares it to the calculated critical threshold at which point rollover may occur. When the critical threshold is exceeded, the roll stability function intervenes to slow the vehicle. Depending on the system, this could be by reducing engine torque, engaging the engine retarder (for the motor vehicle) and automatically applying the braking systems of the motor vehicle and/or the trailer.
- Full (direction/yaw and roll) stability control includes a yaw rate and steering angle sensor and will brake wheel groups independently to provide direction control of the vehicle. Full stability control is only found on powered units such as prime movers and rigid vehicles.

There are currently three suppliers of ADR compliant trailer electronic braking systems – Haldex, Knorr-Bremse/Bendix and ZF-Wabco. These systems are generically called Trailer EBS or TEBS. TEBS units are capable of CAN communications to other TEBS units with the support of a CAN router, and if connected the systems provide full system functionality including electronic brake activation via CAN. Roll stability control is available on all TEBS equipped trailers if there is a suitable power supply and the TEBS is in operational mode (fault free). A brake demand signal, CAN or pneumatic is not required for TEBS roll stability control operation.

There are currently two suppliers of truck (rigid and prime mover configurations) stability control systems that include both directional/yaw and roll (full) stability control - Knorr-Bremse/Bendix and ZF-Wabco. They can supply either ABS platform or EBS platform-based systems. The EBS platform on the truck provides CAN communication between brake control units, including to a TEBS equipped trailer, allowing full functionality of the TEBS. Typically, ABS-based full stability systems cannot directly provide a CAN brake signal, but still can make a limited pressure trailer brake application during stability events. ABS platform trucks can be fitted with a Trailer Roadtrain Module (TRM) which will produce a simple one-way electronic brake activation signal to the TEBS unit for an improved brake timing response.

Some new series ABS platform equipped trucks generate a CAN brake signal to the trailer connection within the ABS brake controller without the need for an external TRM.

Electronic Stability Program/Control (ESP or ECS) or and Roll Stability Control/ Program (RSC or RSP) packages	**Truck – Rigid or Prime Mover** [a]		**Trailer**
	ABS platform - with roll or enhanced stability control	**EBS Platform - all with enhanced stability control**	**EBS platform - Roll stability only** **TEBS** [b]
Haldex Gen 3 (distributed by SAFHolland)			EB+ - multi-volt system, from 9-32V
Knorr-Bremse/Bendix [c]	ESP - either 12V or 24V system	ESP - 24V system only	TEBS G2.x - multi-volt system, from 9-32V
ZF-Wabco E-Series [d] **Low current draw** **3.5 amps at 12V per unit**	ESC or RSC - 12V system or ESC only - 24V system	ESC - 24V system only	TEBS-E and iEBS (new) - 24V and multi-volt system, from 9-32V

Table 1: Summary of 2024 stability systems

Notes for table 1

a) All stability systems, particularly when fitted to rigid units, are sensitive to any changes in the vehicle's setup. This is similar to ABS, where changing the tyre size will require a parameter set upgrade. With stability systems, moving the yaw rate or lateral acceleration sensor, changing wheelbase, suspension types or brake groups are not allowed without updating the parameter set or the function of the stability unit is void.
b) TEBS units include features such as ABS, load sensing and roll stability control. Multi-volt units have been available for about 10 years, depending on the supplier. Multi-volt systems can operate with a supply voltage in a range from 9 to 32V, if they meet the ISO 7638 standard. The input voltage requirements of the trailer units must be confirmed to ensure they function correctly or at all. Do not mix and match power supply voltage and CAN signal based voltage see Section 4.
c) Knorr-Bremse multi-volt TEBS will accept an applicable electric control line with CAN that complies with ISO 11992:2003 standard. Electronic Stability Program (ESP) is the acronym used by Knorr-Bremse to describe a full stability system providing both vehicle directional and roll stability control.
d) The Electronic Stability Control (ESC) acronym is used by ZF-WABCO. Often vehicle manufacturers create their own acronyms for stability control features for use in marketing, however the function remains the same. The Wabco multi-volt TEBS from about 2012 will comply with ISO 11922:2003 and accept 12V CAN when powered by 12V.

4. Stability System Compliance, Diagnostic Hardware and Software

Stability System Compliance

ALL Stability Systems under go End Of Line programming to configure the system's parameter set to align with the vehicle's build specification. ANY change to the vehicle's mechanical build (specifications) could invalidate the stability system's parameter setup, thereby resulting non-compliance and could create an undesirable combination, negatively impacting safety features that do not function correctly.

Unapproved modifications include but not limited to the following: -

- Any change to brake components, such as valves, boosters, slack adjusters, or brake lines.
- Addition of trailer brake controls. Even if the unit has a significant GCM, the unit may not be preconfigured to support the addition of trailer brake controls.
- Any changes to steering equipment.
- The following vehicle specification changes may have limited alternative options available
    - Wheelbase
    - Tyres and wheels

Diagnostic Hardware and Software

All TEBS suppliers (Haldex, Knorr- Bremse and ZF-Wabco) have cost effective tools to manage their trailer systems and download system performance data for driver training. Additionally, trailer-based interfaces can be fitted for the driver to review system data.

Common to all suppliers, is the need for a Windows based laptop on which the supplier's software can be installed plus equipment to provide a trailer EBS power supply.

For motor vehicles, OEM tools will be required to interrogate the controllers and download data for driver training.

5. TEBS Units and Mixed Supply Voltages

All three suppliers of TEBS systems only have multi-volt trailer units available. Truck units, however, are either 12 or 24V, and never multi-volt.

TEBS units are designed to accept power and CAN voltages at matching voltage "levels". Trucks with mixed voltages at the trailer ABS/EBS connection do not meet the standard. There is a standard for 12V, and for 24V, but there is no standard for a mixture of voltages. Full TEBS functionality when connected to a mixed (supply and CAN) voltages, cannot be assured.

There has been a massive growth of PBS combinations over recent years. These often rely on a signal from the light circuit to control required functions via the TEBS units. Again, if the voltages don't align, some of the required functions may not be available.

There are multi-volt trailer ABS/EBS suzi cables available. The ATA recommends against using them. Although these cables will increase convenience, but it will be possible mismatch of voltages could result in the mistaken belief that there is full system functionality. Trailers are the only elements that can be multi-volt in a combination. It is therefore, preferable that multi-volt equipped TEBS trailers should be fitted with 2 sockets (12V and 24V)[5], or other means, to allow connection of any truck. This then enables them to support the use of either a pure 12V or a pure 24V cables.

Table 2 lists the possible combinations of supply and CAN voltages between the hauling unit and the result functionality available at the trailer.

Hauling unit	**Trailer functionality available for a multi-volt TEBS unit**		
Supply power and CAN voltage provided to the trailer	CAN communications	ABS / load sensing functionality [a]	RSC functionality [b]
12V power / 12V CAN signal	**YES**	**YES**	**YES**
24V power / 24V CAN signal	**YES**	**YES**	**YES**
12V power / 24V CAN signal	**NO**	**YES**	**Not guaranteed [b]**
24V power / 12V CAN signal	**NO**	**YES**	**Not guaranteed [b]**
12V or 24V power / no CAN signal	**NO**	**YES**	**YES[b]**

Table 2: Summary of power and CAN signal compatibility for multi-volt TEBS units

All TEBS units, sold today, are multi-volt and can will typically operate with a supply voltage from 9 to 32V.

[5] For further information, refer to the ATA ITC TAP Heavy Vehicle Electrical Wiring available from the http://www.truck.net.au/public/resource-library

Notes

a) ABS and load sensing may be optionally available, even without the ABS/EBS suzi cable connected, if the TEBS units is connected to the stop lamp circuit for power and braking signal - refer to the component supplier to clarify.

b) RSC function typically cannot be relied upon if there is any system warning activated such as the lamp. A fault will typically be experienced if the CAN voltages do not match supply voltages, but the TEBS unit will function without the CAN signal. For further details, refer to the component supplier to clarify.

Figure 1: Illustrative fault lamp.

The prime advantage of a truck supplying 24V to trailers with multi-volt TEBS, allows for voltage degradation along the combination. The units will still function down to a supply voltage of about 9V, however as the voltage deteriorates, the supply and CAN voltages will no longer match and the CAN communications will be lost.

Similarly, the lighting voltage will degrade along the combination, multi volt LEDs lights will mask this issue, while incandescent lamps will suffer and be unlikely to comply to the ADR

Fitting an inverter on the trailer can lead to a mismatch of supply power and CAN signal and therefore is not recommended. If a TRM unit is fitted, ensure its voltage matches the trailers. The TRM unit will then produce the appropriate CAN signal to match the power supplied.

An additional complication that is impacting PBS combination with steerable axle etc and other smart system, is a mismatch in light system voltages to CAN and TEBS supply again making these systems inoperable

Summary

- You should not mix and match voltages for power supply and CAN signal to a TEBS unit.
- You must not use multi-volt trailers ABS/EBS suzi cables.
- It is recommended that for multi-volt trailers be fitted with both 12V and 24V sockets.

6. TEBS Warning Lights

TEBS (ABS and roll stability control) on a trailer is required by the ADR38/05, but status indicator lamps are not an ADR requirement or in-service requirement.

If the ABS/EBS power cable is not connected to the trailer, the towing unit won't know there is a trailer and if there are any faults. In this state the TEBS safety features won't be functional or powered.[6]

Note

> NHVR's VSG25 [Link] requires that if fitted, the advanced trailer systems must be powered.

Adding status indicator lamps is a low-cost method to improve operational efficiency. Typically, these lamps can be fitted for a few hundred dollars, including lamps, connectors, wiring and installation labour.

Check with your TEBS supplier for the specific requirements for your unit.

Refer to appendices for further details

Recommendations

- The ATA recommends that each trailer is fitted with a TEBS power and status indicator lamp(s).
- That the lamps be fitted at different locations on the trailer to suit the businesses operational requirements
    - At the front RHS of the trailer, in a similar location to fridge indicator lights, this allows the driver to undertake a TEBS status check while in motion,
    - At the side of the trailer, which allows the site office to check the TEBS status on its departure, or
    - At the rear of the trailer, which allows the driver to check the TEBS status while undertaking pre-trip inspection.
- Use a "green" lamp for power and "amber" lamp fault status or similar which don't conflict with ADR13/00 lighting requirements.

[6] Some TEBS units can, as a backup, be powered via the brake light circuit, which will power ABS and load sense functions. Roll control is generally not available with brake light power.

7. TEBS Connectors and Connections

EBS, Electronic Braking System, is a term used to encompass the operation, in part or totally, of the activation of the brakes and communication between braking control units. It is not required under the ADR.

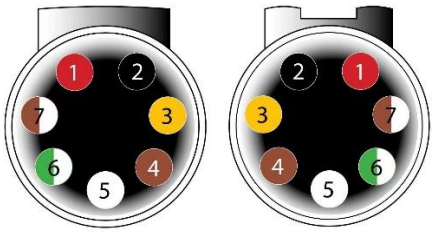
Note

NHVR's VSG25 [Link] requires that if fitted, the advanced trailer system must be powered.

ADR35/06 mandates 24V for road train combinations.

ABS/EBS Connector

PIN NO.	CIRCUIT	CABLE SIZE	ABS	EBS	COLOUR
1	Solenoid control valves (Pos+)	4.0mm²	●	●	Red
2	Electronics (Pos+)	1.5mm²	●	●	Black
3	Electronics (Neg-)	1.5mm²	○	○	Yellow
4	Solenoid control valves (Neg-)	4.0mm²	●	●	Brown
5	Warning device	1.5mm²	○	○	White
6	CAN bus (high)	1.5mm²		●	Green/White
7	CAN bus (low)	1.5mm²		●	Brown/White



7 Pin Plug 7 Pin Socket

Figure 2: ABS/EBS connector wiring

24V connector key at 6 o'clock position. 12V key at 3 o'clock. Connector from the towing vehicle side

The WA PBS scheme [Link] requires all vehicles to be fitted with and have a functioning EBS wiring network to support CAN communications across the entire combination, with adequate power to support the Trailer Electronic Braking System (TEBS) of all trailers and dollies in the combination. Additionally, WA has released their Road Train TEBS Voltage Test Procedure [Link] to assist with clarifying what is adequate power. NHVR's PBS scheme is currently considering mandating EBS communications between braking units.

Check with your TEBS supplier for the specific requirements for your TEBS unit.

EBS signal

European and some Japanese brands feature EBS, but all trucks can cost effectively be adapted to provide a CAN brake activation signal based on the pneumatic signal to a TEBS equipped trailer. The European regulation limits combinations to 5 linked TEBS units, which could cover a BAB quad or an A Triple Road Train combination but not necessarily longer combinations. With some suppliers, for the 6th and subsequent TEBS unit, the EBS communication will not be supported, while for others the 6th and subsequent TEBS units will be treated as the 5th unit with faults and communications from these units treated as one. Please contact your supplier to clarify limitations.

Recommendations

- That TEBS equipped trailers be provided with EBS brake demand (CAN) signal from the truck. If the truck is not EBS equipped, a CAN router fitted with pressure transducers will be required.
- In a multi-unit combination, it is recommended that trailers be sequenced in the combination to improve TEBS communication and therefore braking effectiveness.

8. Systems Operating in Extreme Environments

Regular maintenance is required to ensure any system operates effectively and that any fault or trouble codes flagged are addressed using the appropriate diagnostic equipment.

Smart brake systems are overlays to the combination's foundation brake system. If the smart brake system fails for any reason, the foundation brakes, treadle valve and air control circuits, will take total control and require the driver to adapt accordingly. Smart brake systems are highly capable and will adjust to changing situations. However, an unwanted consequence of smart brake systems is that they may mask fundamental issues within the foundation brake systems or their performance may be degraded due to wear of the foundation brakes.

The foundation brakes should always be checked regularly to ensure roadworthiness and compatibility with the smart brake system's parameter set. Maintaining the foundation brake system to match the parameters uploaded into the smart brake systems at the time it was configured is paramount. Any change to brake components, such as valves, boosters, slack adjusters, brake pads or vehicle specification wheelbase, wheels and body will potentially void the smart brake system's compliance and could create an undesirable combination or safety features that do not function correctly.

It is a requirement of the ADR that both the ABS and TEBS systems have an in-cab warning light to advise the driver of system faults. The vehicle owner's or operator's handbook should include instructions on how to retrieve fault or trouble codes for fault diagnostics.

Suggestions to improve the robustness of brake systems.

I. Electrical wiring is often the weak link, because it perishes easily if not fitted properly. Ensure the wire gauge is adequate and the wire harness is adequately strapped and routed for maximum protection from debris. The harness may need to be provided with additional shielding, such as sturdier corrugated or rubber tubing covering, particularly when operating on unsealed surfaces. Cable lengths, particularly on multi trailer combinations, must be kept as short as practical.
For further details on wiring, refer to the ATA heavy vehicle wiring TAP.

II. Wheel speed sensors should, if possible, be located on the neutral bending axis of the axle, resulting in the sensor requiring less frequent adjustment to maintain its proximity to the pole ring. An additional consideration for the wheel sensor location is protection of the wiring from hot air coming off the brakes during their operation. This can be a particular issue with disc brake units, which can melt the wiring.

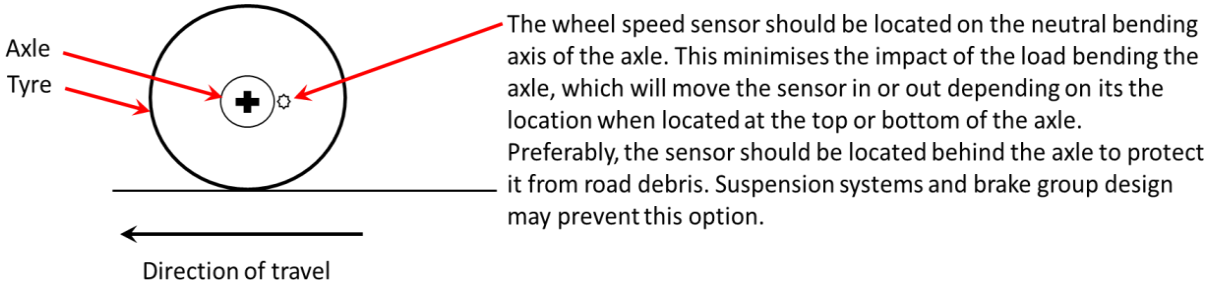


Figure 3: Wheel speed sensor located on the neutral axis

III. The pole ring can benefit from having its grooves filled with a non-metallic material to prevent debris being trapped. This is a particular concern where unsealed roads have a high iron content, typically indicated by their red colour. The gap filler needs to have a high temperature rating, greater than 160 degC, however, the pole ring surface must still be smooth to allow the wheel speed sensor to be correctly positioned.

IV. Inspection and maintenance of wheel bearings is critical to reliable operation of smart brake systems. With an air gap between the pole ring and wheel speed sensor of less than 0.7mm, worn bearings may cause the wheel assembly to wobble changing this gap. The pole ring will either strike the wheel speed sensor, damaging it or pushing the sensor back, increasing the air gap beyond its prescribed limit. This will result in it exceeding the maximum air gap or generating a fault code.

V. Inspect the pole ring during routine servicing for cleanliness and particularly investigate sources of oil and grime contamination. Oil will attract dust and debris, which can bridge the air gap and possibly grind the wheel speed sensor face, resulting in its failure.

VI. Inspect wheel end seals during routine servicing. Leaking oil or grease will attract grime and cause issues as noted above.

VII. Ensure the trailer (EBS/ABS) suzi cable connectors are greased with high quality dielectric grease. This will delay the onset of corrosion on the connector pins. If a trailer does not have EBS/ABS, ensure that the connector on the truck is adequately secured and protected from the elements.

VIII. All TEBSs for trailers need to have completed an End of Line (EoL) programming/setup confirmation. Ask your supplier for a copy of the report for future reference. This operation may have been completed overseas, but should still be available from the authorised service agent. Additionally, the configuration uploaded into the TEBS needs to be customised to suit your combination's mechanical and operating environment as the factory standard settings may not be suitable. Ensure that you discuss your needs with your TEBS supplier, so they can assist with initial set up. This includes replacement units fitted in the field.

IX. Ensure that all trailers in a combination achieve an adequate voltage at the rear to drive the TEBS units for both the CAN communications and power. For further details on wiring, refer to the ATA Heavy Vehicle, Low Voltage Electrical Wiring and Lamps TAP.

X. After taking delivery of a new trailer, inspect it before placing it into service to ensure the above items (1-9) have been considered and actioned appropriately.

XI. All brake component suppliers have laptop software tools available to undertake diagnostics, which will allow for root cause analysis to be undertaken. In most cases, when the in-cab warning lamp is active there are two key faults – power supply or wheel speed sensor. These items can frequently be resolved in your yard's workshop.

Appendix A - Frequently Asked Questions (FAQs)

A1: Can a truck be retrofitted with ESC?
A1: **No**. An ESC system with full functionality includes a yaw rate and steering angle sensors and additional controls within the brake system, putting it beyond all suppliers due to both complexity and cost.

Q2: Do the safety features of a TEBS equipped trailer function if I don't have an EBS/ESC on my truck?
A2: **Yes.** Provided the TEBS unit is provided with a constant power supply, the benefits of ABS, RSC and load sensing functions will be available on the trailer. Additionally, a Trailer Response Management (TRM) system could be fitted to the dumb truck (ie no EBS) and this will produce a simple electronic (CAN) brake activation signal to the TEBS trailer.

Q3: If I have 12V prime movers with or without ABS and if I provide power to the TEBS units, are the benefits of ABS and RSC available?
A3: **Yes**. The ABS, RSC and load sensing functions are independently available provided there is constant power supply and the TEBS unit is a multi-volt unit or 12V capable.

Q4: Is EBS available for multi trailer combinations?
A4: **Yes,** but for best results, a CAN router or repeater should be fitted to all trailers. For dumb trucks (ie no EBS signal available), a TRM unit can be fitted to the truck to provide a CAN signal to the trailers. This will be generated from the towing motor vehicle pneumatic signal.

Q5: Do I have to have disc brakes to specify TEBS?
A5: **No**. The TEBS system is independent of brake type. With the introduction ADR38/04 (mandatory from 1 January 2015), it is a mandatory requirement that ABS equipped units are also fitted with automatic adjusting brakes. This should also apply to retrofitted ABS or stability systems from that date. Refer to Vehicle Standards Bulletin number 6 (VSB6) for further guidance. TEBS also needs to be set up correctly at installation to adjust for different elements in the foundation brake system.

Q6: Is my truck supplier providing power and CAN signals at the correct voltages?
A6: **Not always.** It is particularly an historical issue with European truck models where a 24V to 12V power converter is being used or current issue with North American truck models where a 12V to 24V power inverter is being used. The CAN signal provided must match the EBS/ABS power supply, otherwise there is a voltage mismatch and the CAN signal will be ignored.

A7: CAN-bus is a system of communication between two or more electronic systems. Controller Area Network (CAN or CAN-bus) is a BUS standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer. The power train systems (engine, transmission, and instrument panel) will typically communicate on a CAN system and the EBS system will link the braking elements is via a CAN bus.

Use of CAN communication enables far greater speed of signal to trailing units, and the sharing of data between systems, allowing the truck master system to alter trailer braking as appropriate.

The key to this system is the CAN communication between vehicles and trailers in a combination. Through each vehicle providing information to the prime mover, deceleration can be matched between prime mover and trailer. Brake timing is also improved this means that the brakes come on together when correctly setup. If the combination is loaded differently over each axle group, the brake effort will be adjusted to give a far smoother deceleration, with no wheel lockup and no pull or push at the couplings. The best CAN performance is achieved with a 24V system.

Q8: What is the technical operation of RSC and load share functions?
A8: For trailers equipped with TEBS, Roll Stability Control (RSC) logic control units can prevent roll-over within the vehicle's physical limits. RSC is a function integrated in the software and hardware of the TEBS modulator. The system assesses vehicle wheel speed, load information and lateral (transverse) acceleration data to determine if the roll threshold has been reached and will automatically apply the brakes.

No system can defy the laws of physics, and a trailer can still tip if the side forces are extreme or increase significantly during braking, but RSC significantly reduces this risk.

Operation is normally as follows: at a calculated point of lateral acceleration, the Trailer EBS (TEBS) will apply a test pressure to the brakes. This is a very low, short duration pressure of which the driver should not normally detect, if the TEBS has been setup correctly - if not the driver will feel the test pulses and think they are RSC interventions. TEBS then monitors wheel speed reaction on both sides of the axle. If both wheels react together, the calculated test point is allowed to increase. If a higher lateral acceleration is measured the test procedure repeats until the inside wheel speeds react differently from the outside, representing a loss of traction on the inside wheel. At this point the TEBS applies braking to slow the combination road speed.

Q9: Does TEBS have a weight scale function?
A9: **Yes.** TEBS has an integrated load function, which can be accessed through an optional trailer monitor unit. Refer to your system supplier. The load information is also available on the CAN bus.

Q10: Do I require a modification plate sign off for retrofitting TEBS to the trailer?
A10: **Yes**. An authorised vehicle examiner (AVE) signatory needs to inspect the installation and approve as per regulatory requirements in your state or territory. This is because the brake system is being altered from original settings. Ask your AVE to include a clause regarding roll stability function on the sign-off form.

Q11: Does a roll stability unit need commissioning?
A11: **Yes.** This must be completed by an authorised installer or system supplier. This procedure is referred to as End of Line (EoL) inspection and can only be done using special equipment by a person authorised by the brake system supplier. On completion of the EoL, the supplier should be able to issue the customer with a completion report specific to that component.

Q12: For a B-Double combination, does the A trailer need to be equipped with power and an EBS/ABS connector to power the B trailer.
A12: **Yes**. Each trailer and convertor dolly that can tow another trailer must be equipped with a rear connector in accordance with ADR38, to enable any following trailers to have their smart brake systems powered.

Q13: Does a prime mover with a roll-stability function enhance the operation of a trailer roll-stability control system?
A13: **Yes.** The prime-mover with full or enhanced roll stability function has yaw rate and steering wheel position sensors that indicates the driver's intended path. It can interpret early information about the severity of a bend and the truck brake can depower or apply the brakes to the combination as required earlier than had the trailer measured the lateral acceleration occurring.

Q14: I currently operate a fleet of American prime movers (12V) some with and some without ABS. What should I specify in a TEBS system?
A14: The best benefits from TEBS are obtained with a full 24V system (prime mover and trailer/s). The higher potential of a 24V system allows electrical current to be carried over a longer distance. By fitting trailers with 24V TEBS systems and providing a 24V power supply (inverter) from non-ABS prime movers, and 24V signal/supply (inverted) from 12V ABS prime movers, a superior electrical performance outcome will result. There will also be further benefits when using a multi-volt trailer TEBS in long combinations. For a long vehicle, 24V systems have the advantage over 12V, provided all other variables remain the same. These variables include the quality of connections, quality of crimping at connectors, and wire size. 12V systems are generally limited to two trailers. Refer to the ATA Industry Technical Council heavy vehicle electrical wiring TAP for further information.[9]

Appendix B - Status Indicator Supplier Information

SAF-Holland / Haldex

The Haldex Trailer EB+ systems offer as standard the option to have a Trailer EBS Warning Lamp output and or a Trailer EBS Status Lamp output. The trailer EB+ Configuration files can be updated by contacting service@safholland.com.au to recommend a service provider or if you have the Haldex EB+ Diagnostic equipment we can send you an updated file or remotely connect to update you're your system. You can use a range of our auxiliary cables and your choice of warning lamps to suit your application. If you have any questions, you can contact service@safholland.com.au or call on (03) 9971-7900.

ZF-Wabco

Power lamp is possible on all ZF/WABCO TEBS. Fault light is available on iEBS, being launched in Australia 2024. There are 3rd party suppliers of cable/lamp systems to allow fault lamp fitment on earlier systems.

Field queries should be addressed to Technical Service Department technicalservice.au@zf.com or 02 9679 5555

Knorr-Bremse Australia

23 - 29 Factory Street, Granville NSW 2142
Phone:+61 2 8863 6500 or rvs.aus@knorr-bremse.com

OPERATOR INFORMATION SHEET

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TEBS WARNING LIGHT KIT

Lights may be mounted on the side of the trailer near the TIM module and/or raise lower valve or at the front of the trailer for monitoring via the driver side mirror. One set of lights is required per trailer in a combination to understand the operational status of each TEBS module fitted. Warning Light kits are retrofittable by our TruckServices Partners or KB TEBS Authorised service agents. The TEBS module must be programmed to interact correctly with the Warning Light Kit.

The Knorr-Bremse Warning Light Kit is designed to work on any KB TEBS equipped trailer when programmed accordingly. This kit is a two light system which utilises a green light to indicated that the TEBS module on the local trailer is active and an amber light which will flash if there are any active faults.

Only a brightly lit and flashing amber warning light will signify a fault. If a TIM module is fitted, operators can view the nature of the fault via this device. Lights are 12 and 24v compatible.

Trailer EBS Module Powered

Check Trailer EBS Module

For retrofit application, service agents please order CV6366 - Warning Light Kit - Standard offering utilises AUX 5 and 6 of the TEBS G2.2 Premium Module. For TEBS G2.0/1 applications, TEBS G2.2 Standard or where AUX 6 is not available, please use CV6336 pinned for AUX 1 and 2 of the TEBS Module.

KNORR-BREMSE TRUCKSERVICES

Drafting

Editors
- Chris Loose – ATA

Contributors
- David Frazer/Haldex - SAF Holland
- Brett Nicoll/Knorr-Bremse
- Tony Cheyne/ZF-Wabco
- Ian Thomson/BPW Transpec

Peer Review
- Doug Latto, Transport and Mechanical Consulting Ltd, New Zealand.

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