RSC and ESC systems for trucks and trailers

AUSTRALIAN TRUCKING ASSOCIATION

Technical Advisory Procedure

Developed by the ATA Industry Technical Council
Second edition, May 2016

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About this Technical Advisory Procedure (TAP):

This Technical Advisory Procedure is published by the Australian Trucking Association Ltd (ATA) to assist the road transport industry to improve its technical understanding of stability control systems for trucks and heavy trailers plus the relationship to ADR35/ADR38 braking standards. It is not, nor is it intended to be, complete or without exceptions.

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Table of Contents

1. Introduction

This Technical Advisory Procedure (TAP) was developed by the ATA Industry Technical Council (ITC) to provide operators with key information about the fitment and operation of stability control systems for improved vehicle safety. It has been updated in 2016 to reflect technical advances.

Antilock Braking Systems (ABS) emerged more than 20 years ago and were designed to prevent wheel lock up during braking thus allowing the driver to maintain directional control of the vehicle. ABS 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 five to ten years, ABS systems have been considerably enhanced with the development of Electronic Braking Systems (EBS), which integrate with Automatic Traction Control (ATC) and key stability control system features to deliver the next generation of braking control. A further development has been the inclusion of the roll stability function, often referred to as RSS, RSC or other similar acronyms.

EBS (Electronic Braking System) has become the de-facto term for all stability systems. The major advantages of EBS include 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, however, once EBS is fitted it is also a technology enabler, providing a platform for other advanced braking features to be added.

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.

The 2015 NTI/NTARC report[1] 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.[2]

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.

[1] The 2015 NTI/NTARC report can be found at http://www.nti.com.au/files/files/NTARC/2015_Major_Accident_Investigation_LR.pdf
[2] Refer to section 9 of this TAP for further details.

2. Stability control systems and suppliers

The roll stability control function is an active vehicle safety system that continuously checks and calculates the lateral acceleration of the vehicle and compares it to the 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 prime mover) and automatically applying the braking systems (prime mover and/or the trailer). Frequently, system activation takes place before the driver is aware of the need.

There are two levels of stability control:

- Roll Stability Control (RSC) which controls a vehicle's roll. It is the only option for trailers, but may be fitted to powered units as a low cost retrofittable solution.
- Electronic (Enhanced) Stability Control (ESC) which includes a steering angle sensor and capability for braking wheel groups independently to provide direction control of the vehicle. This feature is only found on powered units such as prime movers and rigid vehicles.

ESC, with its greater capability, provides vehicles with the most capable stability control system.

There are currently three suppliers of trailer stability systems – Haldex, Knorr-Bremse/Bendix and Wabco. Currently, EBS platform based systems capable of CAN communications between units are available. These systems provide for full system functionality including brake activation and faster braking force requests via wire. These systems are generally called Trailer EBS or TEBS. Stability control is available on a trailer without the CAN communication as long as the fitted TEBS unit has a power supply, however the control signal is pneumatic.

There are currently two suppliers of truck (rigid and prime mover configurations) stability systems - Knorr-Bremse/Bendix and Wabco. Today, they supply either ABS or EBS platform based systems. The EBS platform on the truck provides a direct CAN output of key parameters to support the full functionally of a TEBS equipped trailer unit. The ABS platform based stability control systems does not, but can be fitted with a separate and optional Trailer Response Management (TRM) system which will produce a simple one way brake activation signal to the TEBS unit.

Enhanced Stability Control (ESC) and Roll Stability Control (RSC) 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]
BPW Econtronic (Haldex Gen 2)			EB+ - 24V system only[c]
Haldex Gen 3 (distributed by BPW)			EB+ - multi-volt system[d], from 9-32V
Knorr-Bremse/Bendix	ESP[f] (or ESC) - either 12V or 24V system	ESP[f] (or ESC) - 24V system only	TEBS 4[e] - 24V system only
			TEBS G2.x[e] - multi-volt system, from 9-32V
Wabco D-Series[g] **High current draw** **15 amps at 12V per unit**	ESC or RSC - 12V system or ESC only - 24V system	ESC only -24V system only	RSC[h] only - 24V and multi-volt system, from 9-32V
Wabco E-Series [g] **Low current draw** **3.5 amps at 12V per unit**	ESC or RSC - 12V system or ESC only - 24V system	ESC only - 24V system only	RSC[h] only - 24V and multi-volt system, from 9-32V

Table 1: Summary of 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 sensor, changing wheelbase, suspension types or brake groups are not allowed and will void the function of the stability unit.

(b) TEBS units include features such as ABS, load sensing and roll stability control. It is only recently that multi-volt units have become available. Multi-volt systems can operate with a supply voltage in a range from 9 to 32V, if they meet the ISO 7638 standard. Confirm the input voltage requirements of the trailer units 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) BPW Econtronic TEBS unit was manufactured by Haldex and is a Haldex Gen 2 system. It is a 24V unit. Which when supplied with 12V, the system will provide a low voltage warning and not provide any system functions. This model has been superseded by the Haldex Gen 3 unit which is multi-volt compatible.

(d) Haldex Gen 3 multi-volt TEBS unit will function with either 12V or 24V power supply and will accept either 12V or 24V CAN as long as the CAN is based on the power supply, as per the ISO 11922:2003 standard.

(e) Knorr-Bremse TEBS G2.x replaced TEBS 4 about 8 years ago. Knorr-Bremse multi-volt TEBS will accept an applicable electric control line with CAN that complies with ISO 11992:2003 standard.

(f) Electronic Stability Program (ESP) is Knorr-Bremse terminology for a full stability system providing both vehicle directional and roll stability control.

(g) Wabco E-Series replaced Wabco D-Series about 2011/2012.

(h) The original Wabco multi-volt TEBS (circa 2008-2012) on being fed 12V power will ignore any CAN signal, but from about 2012 will comply with ISO 11922:2003 and accept 12V CAN when powered by 12V.

Note: TEBS systems are only available with Roll Stability Control (RSC).

3. Identifying TEBS model evolutions

Haldex

Figure 1: Haldex Gen 2, branded and distributed by BPW

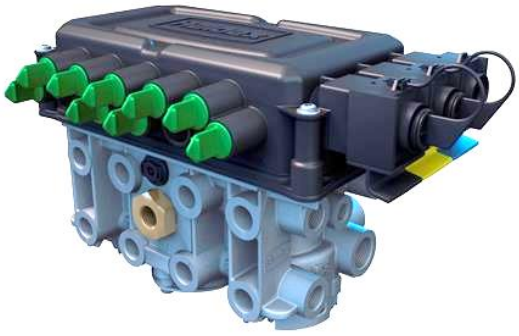


Figure 2: Haldex Gen3

Knorr-Bremse

Figure 3: TEBS 4

Figure 4: TEBS G2.x

Wabco

Figure 5: Wabco D

Figure 6: Wabco E

4. Purchasing stability system diagnostic hardware and software

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

a) Haldex Gen 3, distributed by BPW Transpec

Software is provided on a UBS thumb drive with the required hardware, instruction and parts manuals. Additionally, a trailer EBS power supply or prime mover power supply is required.

Hardware is available from BPW Transpec at $1,600 + GST for fleet operators.
Applicable part numbers are:-
09 5080 0910 Gen 3 Interface Kit for Fleet Plus+ with Dongle
09 5080 0912AUS Gen 3 Diagnostic Kit Fleet Plus

Training is required and usually held at a BPW Transpec site. It is currently complementary, however some fleets can arrange to do it on site in combination with other BPW Transpec product training sessions.

b) Knorr-Bremse/Bendix

Software for Knorr-Bremse/Bendix brake system and related technologies is available at no cost with the hardware available from a Knorr-Bremse distributors.

For European based multi volt EBS platform systems **ECU Talk** is the European based technology Diagnostic Software.
Part # CV1100 UDIF USB-link (interface unit and cabling) $1,150 + GST
Software can be downloaded from http://www.knorr-bremsecvs.com/en/

For US based 12V ABS platform, **Acom** is the US based technology diagnostic software and Nexiq UBS-link (interface unit & cabling) – generic tool (for US Acom software).
This can be downloaded from
http://www.bendix.com/en/servicessupport/abssoftware/diagnostics_subpages/acom65.jsp

For trailer based multi volt systems, the Trailer Information Module (TIM) and cable is available as a dedicated service unit. It is also available as a service tool.

c) Wabco

Software is available for free to download for fleet users, however for businesses that earn income using the software there is a cost for purchase.

http://www.wabco-auto.com/service_support/wabco-diagnostic-services-for-commercial-vehicles-wabco/wabco-system-diagnostics/download-software

Interface hardware is available for purchase from their distributors and ranges in price up to $1,200 + GST.

Note:
The service tool pricing noted above is a general retail price and was indicative at the time of writing, February 2016.

5. Multi-volt TEBS units

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

Any TEBS unit, be it 12V, 24V or multi-volt, is designed to accept power and CAN voltages at the same level. 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.

There are multi-volt trailer ABS/EBS suzi cables available. The ATA recommends against using them. Although these cables will increase convenience, it will then be possible to connect a 24V truck to a 12V dedicated ABS trailer or vice versa. A 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)[3], 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.

If the truck ABS/EBS socket has a mixture of voltages, this may cause issues with the TEBS systems and could be further exacerbated in multiple trailer combinations. 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

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 for clarify.

Illustrative fault lamp

Note: If there is a trailer warning light "on" in the truck cab, assume there is no RSC functionality.

Summary

- You must 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.
- You should fit multi-volt trailers with both 12V and 24V sockets.

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

6. Smart trailer braking 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 etc, will take total control and require the driver to adapt accordingly. Smart brake systems are highly capable and will adjust to changing situations. An unwanted consequence is that they may mask fundamental issues within the foundation brake system or degraded brake performance due to wear.

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.

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

Suggestions to improve the robustness of trailer brake systems.

1) 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.

2) 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.

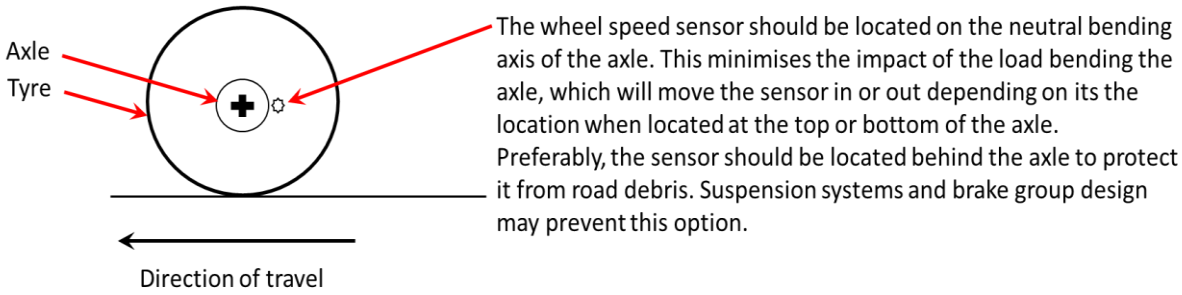


Figure 7: Wheel speed sensor located on the neutral axis

3) 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.

4) 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 about 0.7 mm, 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 result in it exceeding the maximum air gap or generating a fault code.

5) 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.

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

7) Ensure the trailer (EBS/ABS) suzi cable plugs are greased with high quality approved dielectric grease. This will delay the onset of corrosion on the plug pins. If a trailer does not have ESC/EBS/ABS, ensure that the plug on the truck is adequately secured and protected from the elements. These leads can be expensive.

8) All TEBS and ABS units for both trucks and trailers need to have completed an End of Line (EoL) programming/setup confirmation. Ask your supplier for a copy of the report for your record and 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 will not typically be suitable. Ensure that you discuss your needs with your TEBS supplier, so they can assist with initial set up. This will reduce the initial tethering problems and unnecessary experimenting with software settings.

9) 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 wiring TAP.

10) Ensure that any documented specification requirements you provided to your trailer supplier before the trailer is built have been acknowledged. Build a good relationship with your trailer supplier.

11) After taking delivery of a new trailer, inspect it before placing it into service to ensure the above items (1-10) have been considered and actioned appropriately.

12) 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.

7. 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. In order to achieve an open market, truck (ADR35) and trailer (ADR38) brake standards have been broadened to allow less restrictive 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 ECE R13 braking standard. This regulation is only applicable to two and three axle prime movers with a single trailer.

In the US, FVMSS 136 standard defines the requirements of a stability control system for prime movers and is 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.

Current Australian braking standards

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

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

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.

Possible future Australian braking standards

At the time this document was published, the Australian Government had not provided policy directions regarding the future direction of stability control systems for commercial vehicles. At present, there is no public draft ADR or Regulatory Impact Statement to indicate when stability control will be required or with what standard the stability control system should comply.

The ATA Industry Technical Council recommends that purchasers of truck and trailer equipment, should purchase stability control systems compatible and compliant to the latest Australian Design Rule 35 for trucks and 38 for trailers.

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

8. NSW EPA and dangerous goods tanker trailers requirements for RSC

The NSW Environment Protection Authority (EPA) took action in 2014[5], to impose mandatory stability control on all Dangerous Goods (DG) tanker trailers operating in that state. In this case, the mandate is applicable to a tanker trailer with a GVM greater than 4.5 tonne and the tank forms an integral part of the trailer. The mandate does not cover dangerous goods trailers carrying ISO tanks or bladders.

Timing
All new tanker trailers from 1 July 2014 need to be fitted with RSC, no matter where they are registered, if travelling within NSW.

All tanker trailers from 1 January 2019 operating in NSW will need to be fitted with RSC, no matter where they registered, if travelling within NSW.

9. VicForests and mandating trailer stability control[6]

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[7] 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.

Summary

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

[5] NSW EPA press release: http://www.epa.nsw.gov.au/epamedia/EPAMedia14090501.htm
[6] VicRoads press release: https://www.vicroads.vic.gov.au/newsmedia/2014/electronic-braking-system-stops-truck-rollovers-in-the-logging-industry
[7] NRSPP VicForests case study publication: http://www.vicforests.com.au/files/nrurkmrrkf/VicRoads_CS_Proof_6a.pdf

10. Optional TEBS trailer monitor unit

Recommendations when specifying EBS

1. Preferably fit multi-volt systems to trailers for modular combinations. Ensure that all trailers are appropriately wired and fitted with both 12V and 24V ABS/EBS plugs.

2. Fit base sockets conforming to ISO 7638-1 (24V) and 7638-2 (12V) to both prime mover and trailers as appropriate.

3. Trailers should be fitted with CAN communications. If the prime mover is not providing a CAN signal, the speed of brake application can be improved by fitting a signal generator system to the truck such as TRM.

4. Fit inverters to 12V prime movers to provide a 24V power supply to trailers where there are more than 2 trailers in the combination. 12V power supply from the prime mover is permissible if no more than two trailers are to be powered up and the overall length is no more than 26m. However, 24V supply to the trailers is optimal. The CAN signal and power supply voltage supplied to the trailer must match even for multi-volt TEBS units otherwise CAN function will be lost. See section 4.

5. The prime advantage of a running multi-volt TEBS is in long multi-trailer combinations, where a 24V supply is used at the front, and if there is more than 9 volts at the last trailer when the system under load or an estimated 11.5V during a yard test, the system should still operate appropriately.[8]

6. When determining where to place an inverter to overcome power differences, for a 12V prime mover supplying 24V to a trailer, the positioning of the inverter is important. The inverter should be fitted close to the strongest power source, such as the batteries on the truck. The closer the inverter is to the power source, the better the result. 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.

Note
Should you have any doubts or enquiries when considering or using TEBS, contact your supplier. Remember to include your prime mover supplier, as not all prime mover systems are the same.

[8] The multi-volt TEBS units are designed to operate down to 9V under load, but incandescent lights require higher voltage to comply with the ADR lighting requirements – refer to the ATA heavy vehicle wiring TAP, http://www.truck.net.au/resource-library

11. Frequently Asked Questions (FAQs)

A1: Can I retrofit stability control to my prime mover?

A1: Yes and no. An EBS system with full functionality includes a steering angle sensor and additional controls within the brake system, putting it beyond almost all suppliers due to both complexity and cost. But basic stability control or roll stability control is far simpler and typically once automatic traction control is fitted requires an additional solenoid to manage the steer axle brakes and a new ABS ECU, which has very specific mounting requirements.

Q2: Can I have a TEBS equipped trailer and get benefits if I don't have an EBS or ABS on my prime mover?

A2: Yes. Provided the TEBS unit is provided with a constant power supply, the benefits of ABS and RSC will be available. Additionally, a Trailer Response Management (TRM) system could be fitted to the dumb truck (ie no EBS) and this will produce a simple brake activation signal for the TEBS trailer.

Q3: If I have 12V prime movers with and 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 share 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 pneumatic signal for trailers towed by conventional prime movers.

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 issue with European truck models where a 24V to 12V power converter is being used. The CAN signal provided will still match the original 24V power supply. This creates a voltage mismatch and the CAN signal will be ignored.
See section 4 of this TAP.

Q7: What is CAN-bus?

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 have a system and the EBS system linking the braking elements is another.

Use of CAN communication enables far greater speed of signal to trailing units, and also 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, and if the combination is loaded differently over each axle group, 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 data such as wheel speed, load information, and by means of an integrated sensor, lateral (transverse) acceleration data. By analysing this data, the TEBS unit detects the chances of roll-over and automatically applies 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 is normally unaware. TEBS then monitors wheel speed reaction on both sides of the axle. If both wheels react together, the acceleration is allowed to increase, all the while applying test pressures, until the inside wheel speeds react differently from the outside, representing a loss of traction on the inside wheel. At this point, 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 such as that shown in section 11 of this TAP.

Q10: Do I require a blue or modification plate sign off for retrofitting the roll stability function to the trailer?

A10: Yes. An authorised vehicle examiner engineering (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 engineer to include a clause regarding roll stability function on the sign-off form.

Q11: Does a roll stability unit need commissioning?

A11: Yes. This has to be done 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-bouble combination, does the A trailer need to be equipped with power and an ABS/EBS plug/socket to power the B trailer?

A12: Yes. Each trailer and convertor dolly that can tow another trailer must be equipped with a rear plug/socket in accordance with ADR38/04, 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 a steering wheel position sensor 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]

A15: What electrical connectors should be used between elements in a vehicle combination?

A15: ISO 1185 or SAE J560 electrical connectors (AS 4735-2003) are approved in ADR 42. These should be used for all multi trailer combinations, and are recommended for all combinations. Wire size and quality, crimping and maintenance are important, and earth/ground wires should be given the same care and attention as power or positive wires. Trailer electrical connections have multiple power wires for different functions but only a single earth wire. A smaller diameter (cross-section) or compromised/damaged earth wire would render the complete trailer system (lighting and/or ABS/TEBS systems) non-functional. Refer to the ATA's Industry Technical Council heavy vehicle electrical wiring TAP for further information.[9]

[9] The advisory can be found at http://www.truck.net.au/resource-library

12. Glossary of advanced braking terms

Acronym	Glossary of terms	Brand
ABA	**Automatic Brake Adjuster**	**Haldex**
See ASA.		
ABS	**Antilock Brake System (ABS)**	**Generic**
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	**ABS Platform**	
A basic ABS system to which may have added additional functional elements such as ESC, ACC or Brake Assist.		
ADR	**Australian Design Rules**	**Federal**
The national standards for new vehicles. The current applicable braking rules are ADRs 35/05 (trucks) and ADR 38/04 (trailers)		
AEB	**Autonomous Emergency Braking**	**Generic**
Is an autonomous 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.		
ASA	**Automatic Slack Adjuster**	**Generic**
A mechanical device that adjusts individual service brakes at each brake application to keep the individual brake in good adjustment. An ASA must be set-up correctly each time the brake linings / pads are changed. Commonly known as auto slacks or automatic slack adjusters.		
ASB	**Anti Skid Brakes**	**Generic**
See ABS		
ASR	**Automatic Slip Reduction**	**Generic**
See ATC		
ASS	**Advanced Safety Systems**	**Generic**
A collective term for an undefined range of system features typically braking related.		
ATC	**Automatic Traction Control**	**Generic**
Acts to control drive wheel slip under tractive effort. It does this in two ways. Firstly applying brakes to the wheels that have lost traction, this then transfers torque to those drive wheels which have maintained traction. Secondly. if the wheel slip is prevalent on all drive wheels of the vehicle, the ATC instructs the engine to reduce its torque output level.		
Auxiliary brakes		
A mechanical or electrical device that produces retarding action at the drive wheels of a truck that does not involve service brake action. Typically the auxiliary brake action is provided by an: • engine brake, • exhaust brake, • tail-shaft retarder, • transmission retarder, • regenerative braking transmission. Future developments might involve auxiliary brakes on trailers.		

BA	**Brake Assist**	**Generic**
A system that manages a severe service brake application so as to achieve optimum stopping distance performance without loss of directional control.		
Brake Chamber – single diaphragm		**Generic**
The brake chamber converts the energy of the compressed air to mechanical operation. It consists of a chamber separated by a rubber diaphragm. When the brake pedal is depressed air flows into the chamber and pushes the diaphragm against the push rod. The push rod moves out from the chamber and pushes the lever making the brake shoes apply. When the driver releases the brake pedal the compressed air flows out of the cylinder and the spring pushes the diaphragm and push rod back again.		
Brake Chamber – double diaphragm, spring brake		**Generic**
The spring brake chamber is used to apply both the service brakes and parking brake. The forward section of the spring brake chamber applies the service brakes when compressed air from the relay valve flows into the entrance. The function is the same as that of a single brake chamber. The rear section of the spring brake chamber applies the parking brake when the compressed air system is empty or when the control for the parking brake is applied. This is catered for by a powerful spring which, when the parking brake is on, pushes the piston which then transmits the spring force to the lever and the brakes are applied. To release the parking brake compressed air is sent to the chamber in front of the piston and the powerful spring is compressed. If no air is in the parking brake circuit the vehicle will not be able to be moved because the brakes will still be on. The ATA's Industry Technical Council park brake operation TAP provides further information on the operation of the park brake.[10] Note: the UN ECE R13 braking standard can allow a trailer to be parked on air, which is not recommended by the ATA.		
CAN	**Controller Area Network**	**Generic**
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.		
CFC	**Coupling Force Control**	**Generic**
A system that manages the control signal level to the trailer(s) in order to improve the brake compatibility balance. Also called Trailer Response Management (TRM)		
Control Valve for Trailer Brakes		**Generic**
The control valve for the trailer brakes is mounted in the truck chassis and has a number of functions. When the service brakes or hand control for the trailer brakes are applied the regulated air passes through the control valve to influence the trailer brake system. When the parking brake hand control is moved to position 1, the wheel brakes on the trailer are applied via the control valve. The air that applies the trailer brake flows from the parking brake reservoir. Should the airlines between the truck and trailer rupture or start leaking the control valve shuts off the air supply to the trailer brakes and the emergency brakes are applied. The control valve has adjustable settings to permit the accomplishment of a good braking balance between the truck and trailer.		
Disc Brakes		**Generic**
Disc brakes are a wheel brake system comprising a brake disc, brake calliper and brake pads. The brake disc is mounted to and rotates with the wheel hub. The calliper applies a force to the pads which in turn squeezes the disc, which in turn slow its rotation.		

[10] The TAP is located http://www.truck.net.au/resource-tags/technical

Drum Brakes		**Generic**
Drum brakes are the common name for wheel brakes: the brakes are applied by the brake shoe being pressed against a brake drum. There are a number of different types of drum brakes, where the difference is in the mechanism that transmits the braking force. The most common types are S-Cam / Z-Cam and Wedge brakes.		
DSS	**Dynamic Stability System**	**Generic**
See ESC		
DTC	**Drag Torque Control**	**Generic**
A system that increases the engine fuelling level to overcome drag on the rear (drive) axles. The auxiliary retarder may also be disabled.		
EBD	**Electronic Brake Distribution**	**Generic**
Improves the brake-balance between the front and the rear-axle groups of a vehicle by distributing the braking effort for the two axle groups to produce a similar level of wheel slip on each sensed axle. It reduces the brake effort to the rear axle group in a controlled way. The front-axle group brake level is not altered.		
EBS	**Electronic Brake System**	**Generic**
EBS or "brake-by-wire" electronically control the braking system improving braking response time for reduced stopping distances. Frequently, as is the case with the European suppliers, EBS integrates anti-lock braking system (ABS) technology, 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 Electronic Stability Control (ESC), 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	**Enhanced Brake System**	**Generic**
Generalised term to cover advanced braking systems.		
EBS Platform		**Generic**
A basic Electronic Braking System to which is added additional functional elements, such as ESC, ACC and Brake Assist. Electronic control signals are faster than pneumatic signals, seeding up the application of brakes.		
EBSS	**Electronic Brake Safety System**	**Kenworth**
EBSS is not an Electronic Braking System, but an ABS platform that may include enhanced roll stability for trucks and can as well include feature traction control, ABS and EBD. EBSS I covers ABS while EBSS II includes stability control. It is marketing term of the Kenworth electronic brake control system being marketed in Australia.		
ECBS	**Electronic Controlled Braking System**	**Kenworth**
See EBS		

EDL	**Electronic Differential Lock**	**European**
The electronic differential lock permits smooth, comfortable starts on split-friction road surfaces with differing levels of grip. If one wheel starts to spin, the electronic differential lock will brake the wheel as necessary, directing power to the wheel with better grip in the process. The electronic differential lock reduces tyre wear and operates at speeds of up to around 40 km/h. As a software function, it forms part of the enhanced stability control (ESC) and traction control (ASR).		
ESC	**Electronic Stability Control**	**Generic**
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 the roll-stability capabilities of Roll Stability Control (RSC) and is built on the foundation of the Antilock Braking System (ABS) and Automatic Traction Control (ATC). Note: ESC or Full Stability with Yaw Control is only a truck or prime mover system and is not applicable to trailers.		
ESC	**Enhanced Stability Control**	**Generic**
Broad term for roll control with yaw control. See also ESC above		
ESP	**Electronic Stability Program**	**Knorr-Bremse**
ESP (Electronic Stability Program) causes automatic stabilisation of the vehicle in critical driving situations and thereby also results in a considerable reduction in the risk of tipping over or skidding. With ESP, the direction of travel and speed of the complete combination is automatically corrected in critical situations. By selective intervention to individual wheel brakes and in engine management, ESP provides an automatic support system for the driver in critical situations.		
ESR	**Electronic Slip Reduction**	**Japanese**
See ATC		
PI-Vent	**Pilot Valve**	**European**
When vehicles are fitted with a load-sensing valve, the quick release valve is superseded by a pilot valve. This valve reduces the air pressure to the front wheel brakes progressively through the influence of the load-sensing valve.		
Quick Release Valve		**Generic**
To avoid the air having to go all the way back through the footbrake valve when the brakes are released, a quick-release valve is installed between the footbrake valve and the brake chamber. This valve evacuates the air from the brake chamber allowing the brakes to release more quickly when the driver takes his foot off the pedal.		
RSC	**Roll Stability Control**	**Generic**
Applies selected brakes to reduce the risk of rollover occurring when a dangerous situation 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 automatically.		
RSP	**Roll Stability Program**	**Generic**
See RSC.		
RSS	**Roll Stability Support (or System)**	**Generic**
See RSC.		
Roll Stability	**Roll Stability**	**Generic**
Generic term which could cover both truck and trailers, see RSC		

S and Z-Cam Drum Brakes		**Generic**
There are two different types of cam brakes: S-Cam and Z-Cam. The greatest difference between these cam brakes is the brake shoe attachment and the torsional device that presses the brake shoe against the drum. The cam brakes are applied when the brake chamber rod pushes against the lever which then turns the cam. At the inner end of the cam there are two tappets. When the brake cam turns, the tappets influence their individual lugs on the brake shoes which then press on the brake drum. The S-Cam brakes are journalled at the one end and forced out against the brake drum with the aid of an S shaped cam. The Z-Cam mechanism is floating and housed in a greased cam housing. The brake shoes on Z-Cam brakes are not attached to the backing plate, which means that they float and are self-centring as the brake linings wear.		
TEBS	**Trailer Electronic Brake System**	**Generic**
TEBS only provides roll control for trailers. For maximum benefit, the TEBS unit should be provided with a CAN connection from the truck via either a TRM or EBS system. The TEBS unit manages the distribution of the braking effort between axle groups on a trailer. That is, it attempts to improve the use of the available road friction by managing brake balance. On a semi-trailer it sets the braking level on the rear group. See also RSC.		
TC	**Traction Control**	**Generic**
See ATC.		
TRS	**Trailer Roll Stability**	**Haldex**
See RSC		
TRS	**Trailer Response Signalling**	**Haldex**
Electronic communication of desired braking level between a truck and its trailer(s) via the CAN Bus.		
Wedge brakes		**Generic**
In the wedge brake system, a wedge is used to press the brake shoes against the drum. The brake chamber rod pushes a wedge into a cylinder. With the mechanical aid of the wedge two pistons in the cylinder push out the brake shoes making them apply pressure to the brake drum. The wedge brake shoes are floating, self-centring and self-adjusting.		
VSP	**Vehicle Stability Program**	**Generic**
See ESC		

TAP development process, history and validation

The TAP development process

The ATA will approve the need for the creation of a new TAP or the triennial routine review of an existing TAP. The nominated editor(s), who are listed below, with support of the ITC and specialist industry technical members as required, will agree on the TAP content with approval by a majority vote of ITC members. A suitably qualified and experience ATA appointed peer reviewer will further review the publication and if necessary, recommende changes. These changes will then be reviewed and approved again by a majority vote of ITC members before the document is released

Document version control

Edition	Date	Nature of change / comment	Editor(s)
First	July 2012	Initial release	David Coonan ATA, National Manager - Policy
Second	March 2016	Substantially updated and expanded.	Chris Loose, ATA, Senior Adviser Engineering

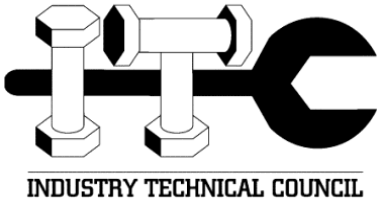
The next review is expected on or before February 2019.

Drafting committee, second edition

Member	Organisation	Title	Qualification
Ian Thomson	BPW Transpec	Engineering Manager	BEng
Kevin Gibson	Knorr-Bremse Australia	Account manager OE	BEng and Fellow Institute of Engineers.
Tony Cheyne	Wabco Australia	National Service Manager	National Technical Service & Training

Peer review, second edition

Edition	Date	Peer Reviewer	Organisation / Qualifications
Second	April 2016	Anthony Germanchev	ARRB Group Ltd, Team Leader, Freight & Heavy Vehicles Congestion, Freight and Productivity. BEng.



About the ATA Industry Technical Council:

The Industry Technical Council (ITC) is a standing committee of the Australian Trucking Association (ATA). The ITC's mission is to improve trucking equipment, its maintenance and maintenance management. The ITC was established in 1995.

As a group, the ITC provides the ATA with robust professional advice on technical matters to help underpin the ATA's evidence based policymaking. It is concerned with lifting technical and maintenance standards, improving the operational safety of the heavy vehicle sector, and the development of guidelines and standards for technical matters.

ITC performs a unique service in the Australian trucking industry by bringing operators, suppliers, engineers and other specialists together in a long-term discussion forum. Its members provide expert and independent advice in the field to inform the work of the ITC. The outcomes from ITC benefit all ITC stakeholders and the heavy vehicle industry at large.

The ITC operates under the Australian Trucking Association's Council, which formulates industry policy for implementation by the organisation.

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