TCD Technical Customer Documentation

Image represents the product family. For specific product, please refer to the sales drawing.

Product designation:	Trailer Safety Control ECU
Product version:	1.0
Date:	19th May 2023

Table of contents

1 General

A different use other than the vehicle specifications listed in chapter 0 Intended Use is not permitted for the product.

1.1 General Information

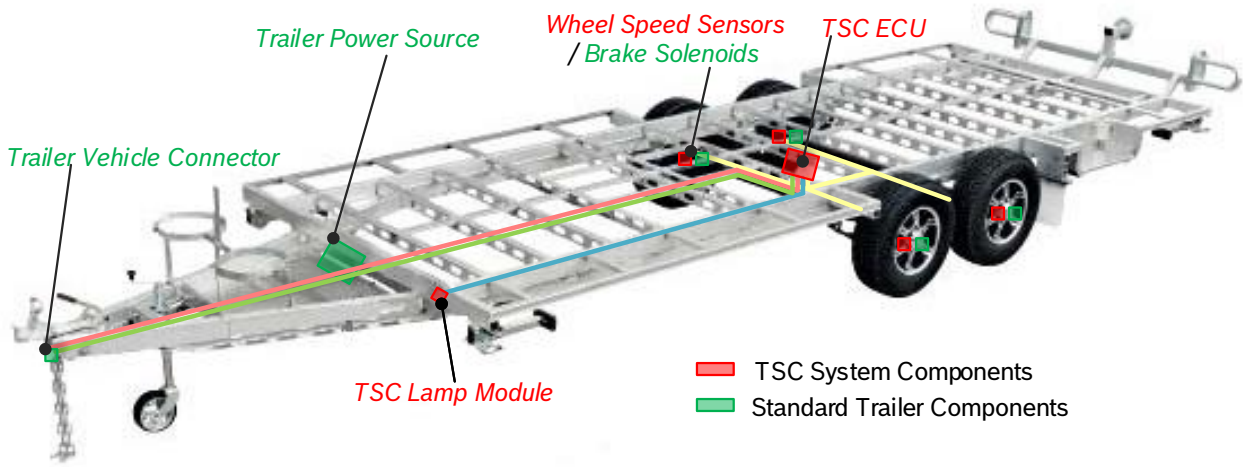
Modern trailers are designed for a range of applications from cargo hauling to recreational use. This Trailer Safety Control (TSC) product aims to improve electric braked trailer safety over a large range of trailers, by applying technologies and knowledge developed and applied to modern vehicle braking systems. Towing a trailer can be dangerous due to situations like unexpected driving conditions or driver inexperience. TSC works with and provides support to the existing electric trailer braking system, whilst increasing the level of trailer safety for the driver.

Trailer Safety Control (TSC) is a Bosch developed product which aims to provide this increased level of safety to the trailer, towing vehicle, and passengers. Incorporating functions such as trailer Antilock Braking System (ABS), Trailer Sway Mitigation (TSM) and Trailer Lane Change Control (LCC) provides a new level of safety control on electric braked trailers.

The trailer Antilock Braking System (ABS) detects wheel slip and modulates the brake request to avoid wheel locking. This keeps the trailer steerable and improves directional stability especially during emergency braking. The ABS function provides the stability foundation for the Trailer Safety Controller (TSC).

The Trailer Sway Mitigation and Lane Change Control features detect critical driving situations like trailer sway or swerving manoeuvres and apply the brakes independently of the driver to keep the trailer stable.

The principal components of a TSC system are depicted in the following figure.



1.2 Abbreviations

Trailer Safety Control	TSC
Electronic Control Unit	ECU
Technical Customer Documentation	TCD
Automotive Safety Integrity Level	ASIL
Anti-lock Brake System	ABS
Trailer Sway Mitigation	TSM
Lane Change Control	LCC
Permanent Supply Voltage at the ECU connector	UB
Ground	GND
Human Machine Interface	HMI
Diagnostic Trouble Code	DTC
Design Validation	DV
Production Validation	PV
Microcontroller	uC
Hardware	HW
Software	SW
Open Circuit	O/C
Short Circuit	S/C
Pulse Width Modulation	PWM
Robert Bosch GmbH or any affiliated company designated by Robert Bosch as responsible for the respective customer project.	BOSCH

1.3 TSC System Components

TSC Electronic Control Unit (ECU)

The control unit processes information received from the sensors according to defined mathematical procedures (control algorithms). The results of these calculations form the basis for the control signals sent to the brakes. The ECU increases and decreases the electric current to the brakes of the trailer according to the functional requirements.

A yaw-rate and two acceleration sensors are integrated into the ECU. The signals of the yaw-rate sensor (and optionally the acceleration sensors) are used to calculate the actual motion of the trailer. If the TSC determines the motion of the trailer exceeds the predetermined safe limits for trailer sway, the TSM and LCC functions attempt to correct the trailer motion by applying the trailer brakes.

Image represents the product family.

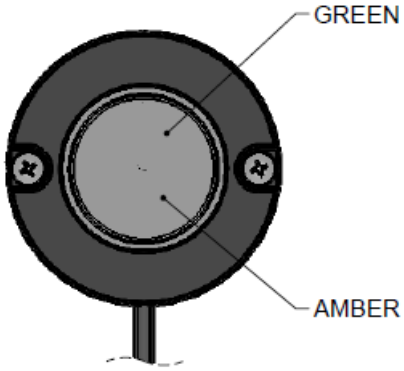
Wheel Speed Sensor

The speed of rotation of the trailer wheels is an important input variable for the control system. Wheel-speed sensors detect the speed of rotation of the wheels and pass the electrical signals to the electronic control unit. The speed signals are used to calculate the degree of slip between the wheels and the road surface.

Lamp Display Module

The Lamp Display Module is required to alert the driver to the status of the TSC system. This lamp module must be mounted in a location which is visible to the driver whilst operating the tow vehicle. The lamp will indicate operational status and fault warnings to the driver.

In case of Bosch lamp supply:



Part No.	F005 E00 262
Target Markets	Australia, New Zealand
IP rating	IP66
Operating voltage	10.0V ... 16.0V
Under-/Over-Voltage Range	8.0V ... 19.0V
Operating temperature	- 40°C ... + 85°C
Connector	Deutsch DTM04-3P P1: +12V AMBER P2: Ground P3: +12V GREEN

Diagnostics adapter

The diagnostics adapter is used to connect to the TSC ECU via Bluetooth to a mobile device, e.g. smart phone. This enables reading the trailer odometer value and diagnostic trouble codes DTCs.

In case of Bosch supply:

Image represents the product family.

Part No.	F005 E00 263
Target Markets	Australia, New Zealand
Operating voltage	9.0V ... 16.0V
Operating current	Max. 45mA
Operating temperature	- 20°C ... + 55°C
Storage temperature	- 40°C ... + 85°C
Weight	60 g

Wiring Harness

All components shall be connected to the inputs and outputs of the TSC ECU via a wiring harness (as specified by Bosch). The wiring harness consists of two components, power harness and axle harness

In case of Bosch harness supply, the following wiring harness components are available for single and dual axle trailers (triple axle trailer harnesses available on request).

	Part number	**Sales drawing**
Power Harness		
Power Harness 2.5m	F005 E00 253	F005 ES0 176
Power Harness 4.0m	F005 E00 254	F005 ES0 177
Power Harness 5.0m	F005 E00 255	F005 ES0 178
Axle Harness		
Dual axle harness	F005 E00 256	F005 ES0 179
Single axle harness	F005 E00 257	F005 ES0 180
Target Markets (all harnesses)	Australia, New Zealand	

Conditions for customer design of wiring harness

All values specified in this TCD are calculated based on the characteristics of a suitable vehicle wiring harness.

The harness shall meet the electrical requirements as determined by Bosch. Wiring harness design guideline for customer wiring harness can be provided on request.

Bosch is only responsible for the compliance of the product side plug (interface) with the agreed upon customer specification. Since the plug system is used per customer request. Bosch is not responsible and does not warrant for the connection assembly entirely, especially not for its electrical function, durability, and sealing.

1.4 Standard Trailer Components (Electric Braked)

Brake Magnet (Solenoid)

Each braked trailer wheel is fitted with an electrical brake assembly. The Brake Magnet (solenoid) is the interface component between the TSC ECU and the physical brakes of the system. The control output from the TSC (in the form of electrical current) is converted into magnet force via each solenoid and results in a determined level of wheel braking.

Trailer Power Source

The TSC can be powered from an on-board trailer power source (typically a battery bank) or a power source from the tow vehicle via the Trailer Vehicle Connector. The supply shall be capable of maintaining the nominal 12V supply voltage and have capacity to supply the trailer with the required braking current.

Trailer to Vehicle Connector

All trailers require an electrical connector between the tow-vehicle and trailer. This connection can take several physical forms depending on the country of manufacture and the manufacturer. Electrical signals of interest to the TSC in this connection include Service Brake, Power Supply (from tow-vehicle) and Ground (from tow-vehicle).

1.5 Intended use

This Technical Customer Documentation (TCD) applies to the electronic control unit (ECU) of the TSC (Trailer Safety Control).

The product is released based on the regulatory requirements directly applicable to the product at the time of TCD creation in the following target market(s):

Target Markets of TSC ECU:
United States of America, Canada, Australia, New Zealand

The product can be used in a released target market in the a forementioned applications, subject to the limits, conditions and other specifications described in this TCD ("Intended use").
In the case that the customer wants to use the product outside the Intended Use, the customer shall (1) on its own responsibility evaluate and comply with any regulatory requirements resulting there from for the product and evaluate and ensure the usability of the product for the area of application intended by the customer or (2) obtain a new, extending Bosch release, which shall be ordered separately from Bosch (e.g. by means of a change request).
Provided that Trailer Safety Control is used within the conditions (environment, application, installation, loads) as described in this TCD and the corresponding agreed upon documents, Bosch ensures that the product complies with the agreed properties. Agreements beyond this require the written approval by Bosch. The product is considered fit for the intended use when the product successfully has passed the tests in accordance with the TCD and agreed upon documents.
It is the responsibility of the customer to ensure the proper application of the product in the overall system/vehicle. Bosch does not assume any responsibility for changes to the environment of the product that deviate from the TCD and the agreed upon documents.
The customer is responsible for the system usage, which includes ensuring that the agreed product application and all environmental, installation and stress conditions to which the product is exposed to are not to be exceeded.

This document contains the parameters of the TSC ECU for trailers within the following constraints:

- Minimum 1 axle fitted with electric brakes.
- Maximum 3 axles fitted with electric brakes.
- 12V Power Supply available to the TSC with capacity to meet the operational demands of the system.
- Used with a compatible electric trailer brake controller.

This document describes the permissible operational conditions for the TSC ECU. The figures quoted are applicable assuming that proper safety measures have been taken, routing of leads and sensors used have been approved.
The use of this product is only permitted for brake systems and under the specified conditions and according to the environmental and loading conditions specified in this document. A prerequisite for the functioning of the TSC is that trailer brakes and in-vehicle brake controller are in the appropriate operating condition (e.g. typical maintenance interval of brakes, brake magnets, brake drums and brake pads) and a driver controls the brake system.
Use and operation of the TSC is not meant to replace or substitute a primary electric brake controller within the tow-vehicle. Trailer braking remains the responsibility of the primary brake controller and TSC requires a correctly operating primary brake controller to be available at all times. TSC will assist the primary brake system when necessary for improved trailer safety and stability.

Overview of further applicable documents:

Details regarding the suitable installation of the system in the vehicle are described in document Y265K30237.
Technical details regarding individual sensors supplied by Bosch such as the wheel-speed sensor are described in individual documents titled ”Technical Customer Documentation”.

1.6 Legal requirements

Product specific regulations will not be documented in this TCD.

1.7 Project Data

ECU Part No.	0265.805.318
Customer	This ECU is a non-customer-specific standard product. BOSCH may implement changes to the product over the course of time which do not influence the product's characteristics and/or functions as described in this TCD (without customer information).
System Variant	TSC Gen 1.0 Electric
Automotive Safety Integrity Level (ASIL) rating	B
Dimensions *including bracket* (W x H x D)	210mm x 125mm x 46mm
Weight *including bracket*	615g

1.8 Reference Documents

This reference table provides an overview about the additional specification which builds the basis for this Technical Customer Documentation.

TSC Installation Guideline	Y265K30237
Wiring Harness Guideline	Y265K30239
TSC User Manual	F005EP0085
TSC Brake Controller Guideline	F005EP0086

1.9 TSC Signal Interface

Customer Signal	RB Signal	Function Description
SERVICE BRAKE	BRS	Brake Request Signal (from tow vehicle controller)
DIAG+	CANH	Controller Area Network High (plus)
DIAG-	CANL	Controller Area Network Low (minus)
HMI WARNING	HMI_WARN	Lamp Module Warning Lamp Signal
HMI STATUS	HMI_OP	Lamp Module Status Lamp Signal
HMI COMMON	HMI_GND	Lamp Module Common / Ground Signal
EBC_LOAD	EBC_LOAD	Optional Load Simulator for Electric Brake Controller
EBC_GND	EBC_GND	Optional Load Simulator Ground
GROUND	KL31	TSC Supply Ground
POWER	KL30	TSC Supply Positive
SOL_FL	SOL_FL	Solenoid Output Signal Front Left
SOL_FR	SOL_FR	Solenoid Output Signal Front Right
SOL_RL	SOL_RL	Solenoid Output Signal Rear Left
SOL_RR	SOL_RR	Solenoid Output Signal Rear Right
SOL_CL	SOL_CL	Solenoid Output Signal Center Left
SOL_CR	SOL_CR	Solenoid Output Signal Center Right
WSP_FL	ASP_FL	Wheel Speed Sensor Power Front Left
WSP_FR	ASP_FR	Wheel Speed Sensor Power Front Right
WSP_RL	ASP_RL	Wheel Speed Sensor Power Rear Left
WSP_RR	ASP_RR	Wheel Speed Sensor Power Rear Right
WSP_CL	ASP_CL	Wheel Speed Sensor Power Center Left
WSP_CR	ASP_CR	Wheel Speed Sensor Power Center Right
WSS_FL	ASS_FL	Wheel Speed Sensor Signal Front Left
WSS_FR	ASS_FR	Wheel Speed Sensor Signal Front Right
WSS_RL	ASS_RL	Wheel Speed Sensor Signal Rear Left
WSS_RR	ASS_RR	Wheel Speed Sensor Signal Rear Right
WSS_CL	ASS_CL	Wheel Speed Sensor Signal Center Left
WSS_CR	ASS_CR	Wheel Speed Sensor Signal Center Right
WSS_S_FL	WSS_S_FL	Wheels Speed Sensor Shield Front Left (optional)
WSS_S_FR	WSS_S_FR	Wheels Speed Sensor Shield Front Right (optional)
WSS_S_RL	WSS_S_RL	Wheels Speed Sensor Shield Rear Left (optional)
WSS_S_RR	WSS_S_RR	Wheels Speed Sensor Shield Rear Right (optional)
WSS_S_CL	WSS_S_CL	Wheels Speed Sensor Shield Center Left (optional)
WSS_S_CR	WSS_S_CR	Wheels Speed Sensor Shield Center Right (optional)

1.10 Definition of categories

The characteristic values which describe the function are divided into three categories, which are marked with (I), (II) and (III).

(I) Characteristic values for description of interface and application.

(II) Characteristic values and design verification test conditions.

(III) Characteristic values, proven by in-process tests or product audits which are performed with a representative ECU of the assembly line.

Chapters which need to have a category defined will include a reference to the relevant category/categories to the right of the text.

1.11 Safety and Warning Notes

- Repairs or modifications of the ECU by the customer or by a third party are not permitted. The decommissioning must be performed by authorized personnel only.
- It must be considered that the whole system has to include the corresponding system components (wheel speed sensors, lamp module and software).
- In the event of modifications to the Bosch product, e.g. with additional add-on components, which have not been explicitly released by Bosch, the customer is responsible for the verification and validation of such modifications. Bosch shall have no liability for any defect or damages arising from any modification that has not been explicitly released by Bosch.
- If the customer uses the signal outputs from the ECU for other components application in the vehicle, BOSCH shall not be liable for damages to these components.
- Drop of the ECU: The ECU must not be used after it has been dropped due to the non-visible damages inside can impact its proper operation.
- Service work must be performed exclusively by authorized personnel and with original replacement parts.
- The correct functioning of all important electrical components is monitored by an electronic monitoring system before drive-off and while the vehicle is being driven.
- Self-check of the Trailer Safety Control is done during Power-Up. Results must be shown to the driver e.g. with the lamp, on a display or in a similar way.
- In case of a failure or malfunction, the Trailer Safety Control will report or publish the resultant status via a Bus system (CAN) and/or lamp. If such a failure occurs, it is also to be expected that the Trailer Safety Control will degrade its functionality and performance.
- If the Trailer Safety Control reports such a fault, then the vehicle manufacturer has the responsibility of informing the driver via displaying a warning signal (e.g. indicator lamp) in accordance with the legal requirements dictated to by the country in which the vehicle is to be driven or used.
- The vehicle manufacturer must provide the driver with clear instructions as to how the warning signal is to be physically identified, as well as interpreted. The provided information must reveal to the driver the severity of the system status being displayed as well as advise on the required action to be undertaken (e.g. by reduced system performance or functionality - whether to: e.g. contact dealer, drive with caution, stop vehicle immediately).
- Before disconnecting the cable harness connector, it must be ensured that the control unit is in off/sleep mode (e.g. power off, no wake-up, etc.).
- If the connector is removed in active mode, data may not be updated, or implausible error memory entries (also in other control units) may occur.
- During the programming process it is not allowed to disconnect the connector from the ECU or to interrupt the power supply. Violations can lead to a defect in the ECU.
- Do not touch the connector pins of the ECU (ESD protection).
- To ensure proper connection, the latch mechanism of the connector must not be damaged and must be fully engaged. Circumstances that lead to condensation within the connector system must be avoided.
- It must also be ensured that the connector on the wiring harness side is only removed or plugged in when it is dry and clean in the vicinity.
- It is not allowed to put any liquids or other materials onto the ECU connector.
- Diagnostic hints:
  The contents of the failure memory are readable. They can be used for accident expertise or in cases of product liability only if there is no doubt about the time wise connection of the events.
- It is the responsibility of the vehicle manufacturer to inform potential affected persons.
- No modification of hardware and of software is permitted except when authorised by Bosch. It is not permitted to modify signals sent to the ECU or sent by the ECU.

1.12 Restrictions for reprogramming

The ECU is reprogrammable. The vehicle manufacturer must assure that only SW released from BOSCH for this ECU is programmed. The person who is doing reprogramming is responsible for correct reprogramming.

Reprogramming may only be done at ambient conditions suitable for this ECU (Voltage - see chapter 5.1 Operating Voltage and Temperature - see chapter 2.4.3 Active Operation).

The number of reprogramming cycles is limited to 20 (I)

The number of reprogramming cycles is stored in the ECU. The vehicle manufacturer must ensure that this number is not exceeded.

1.13 Product Safety

1.13.1 Functional Safety

Bosch indicates that the ASIL-classified requirements as per ISO 26262:2011, their implementation and the assumptions made for this purpose are documented in the following documents:

Contact BOSCH for "Safety Case".

1.13.2 Data Protection, Cyber Security and Over-the-Air Aspects

If the product contains functions which can store or transfer driving data, which can be related to the driver of the vehicle, then legal requirements concerning data protection laws must be complied with by the customer.

Being responsible for the data, the customer designs the data processing in the vehicle. Therefore, the customer must check whether the protective measures of the product are sufficient. Requirements based on data protection should be documented in the Cybersecurity Interface Agreement (CIA).

1.13.2.1 General information and limits about Cybersecurity

Bosch regularly reviews its products to ensure cybersecurity is in line with State-of-the-Art. If the State-of-the-Art or the applicable laws change prior to the end of product delivery, Bosch reserves the right to propose the necessary changes to the product via the change request process.
In case a security vulnerability is discovered or disclosed by the customer which affects a Bosch product, Bosch must be informed prior to its publication. Bosch will deliver necessary updates only with the approval of the customer on the basis of contractual agreements. The installation of security relevant updates must be performed by the customer’s software logistic infrastructure.

1.13.2.2 Cybersecurity access points

The product or embedded control unit contains engineering access points in hardware and software to execute Bosch services for manufacturing and development purposes. This includes the capability to perform a software reflash. These Bosch interfaces are secured by:
- the constraint of physical access to the product itself
- ECU Hardware Design
- dedicated device passwords

1.13.2.3 Denial of Service

The product is not protected against any Denial of Service attacks (DoS and DDoS) on the vehicle internal communication network. If Denial of Service attacks on vehicle internal networks have been evaluated as critical, the customer must develop further security methods on the vehicle level.
The product is not designed to withstand fault injection or side channel attacks.
The software used in the product contains intellectual property (“IP”) from Bosch. For IP protection and avoidance of re-engineering, the software shall be handled as confidential during the distribution process into plants, workshops, etc., or shall be distributed by authorized persons. This shall be considered by appropriate measures within the customer’s software logistic infrastructure and associated processes.

1.13.2.4 Cybersecurity assumptions

Cybersecurity measures can be implemented differently in the vehicle and its environment (security layer). Therefore, Bosch presumes that the following conditions are satisfied by the customer's security design of the overall system.

- The customer may not provide interfaces that enable the modification of memory content except for software updates and intended changes by secured and documented services (e.g. UDS, XCP).
- The product contains Intellectual Property and confidential data e.g. cryptographic material. The interfaces defined by the customer shall not read out this data without Bosch agreement.
- Any software designed or implemented by the customer or 3rd parties does not compromise the intended function of the product.
- A "defense in-depth" approach is applied to the vehicle E/E architecture.
- Only secured (authenticated) software updates (reflash) via diagnostic access points are possible.

1.13.2.5 Security aspects during product decommissioning

Any alteration of hardware, software or data by the customer may limit the available protection of the product, potentially leading to security assets becoming accessible without authentication or authorization.
During product decommissioning the customer is responsible to prevent unauthorized access to any security assets (including but not limited to personal data collected and stored by the customer in the product).

1.14 Labelling of the product

Refer to

TSC Sales Drawing for markets Australia, New Zealand	F005ES0184
TSC Sales Drawing for markets United States of America, Canada	F005ES0175

2 General Conditions

2.1 Protection Class

The TSC ECU has a rating of IP6K7 and IP6K9K. The IP6K7 and IP6K9K is met only when the appropriate connectors are inserted and correctly locked.

2.2 Storage time

		Category
Maximum storage time past manufacturing date	5 years	(I)

2.3 Operating time

The defined values regarding vehicle lifetime and mileage requirements serve solely as a basis for the determination of the durability specified in chapter 7 Test Methods.
They do not represent a guarantee towards the design / durability of this product.

With respect to the use and usage conditions described in this TCD, the life of the product is designed for

Assumed lifetime of vehicle	15 years	(I)
or		
assumed mileage	200,000 km	(I)
or		
assumed ECU operating time	6,700 h	(I)
or		
assumed wake-up cycles	34,000	(I)
or		
assumed number of brake applications	800,000	(I)

The commercial warranty and liability are independent of this information and is governed by the delivery conditions.

2.4 Permitted temperature range

2.4.1 Storage and shipping

At an average relative humidity of	25 ... 75 %	(I)
At a temperature for the entire storage and shipping time between	- 20°C ... + 50°C	(I)
not to exceed a duration of 24h at (Background: unheated cargo hold in airplane)	- 40°C ... - 20°C	(I)

For a storage and transport time of max. 48h is valid for a temperature range of	+ 50°C ...+ 75°C	(I)

During storage the ECU must not be exposed to UV-light-irradiation.

It is necessary to contact BOSCH when the storage and shipping conditions are outside of the specified range.

2.4.2 Passive Operation

Passive operation (internal supply off) is permissible at ambient temperatures between	- 40°C ... + 75°C	(I)

2.4.3 Active Operation

Permitted active operating range for ABS / TSM / LCC at ambient temperatures between	- 40°C ... + 75°C	(I)

2.5 Permitted control and operating period

The operational safety of this product is only ensured if the permissible conditions are maintained.

The system components are not designed for unlimited power-on time.

To avoid thermal damage to components under testing conditions, an appropriate cooling time between driving manoeuvres is necessary.

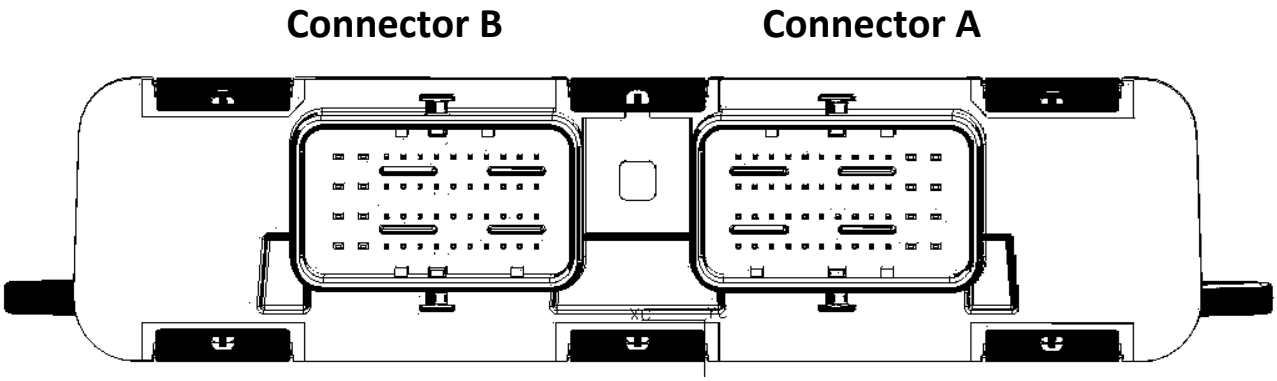
3 ECU Data and Interfaces

3.1 Dimensions and Installation Data

		Category
Delivery condition according to sales drawing see	F005ES0184 (AU, NZ) F005ES0175 (USA, CA)	(I)
TSC Installation guideline see	Y265K30237	(I)

Restricted trailer mounting tolerances are required.
Failure to adhere to the instructions can lead to system impairment (malfunction or system failure).

3.2 ECU Connector



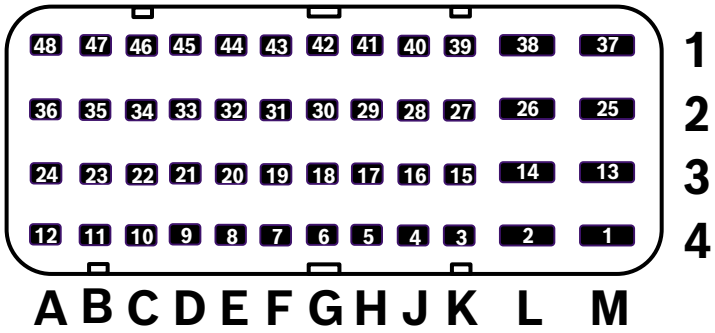
Connector	# of high current pins	Pin # on Connector	# of low current pins	Pin # on Connector
A	8	1, 2, 13, 14, 25, 26, 37, 38	40	3-12, 15-24, 27-36, 39-48
B	8	11, 12, 23, 24, 35, 36, 47, 48	40	1-10, 13-22, 25-34, 37-46
Total	16		80	

Air venting principle of ECU

The ECU has an air ventilation system in the connector.

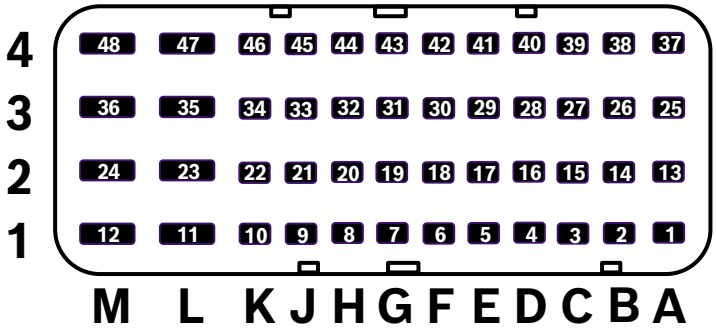
Pin Assignment (ECU Connector)

Connector A
(ECU Pin External View)



Connector A												
1	WSP_CR 48	- 47	WSP_CL 46	- 45	- 44	- 43	- 42	- 41	- 40	- 39	SOL_FR 38	SOL_RL 37
2	WSS_CR 36	WSS_S_CR 35	WSS_CL 34	WSS_S_CL 33	- 32	- 31	- 30	- 29	- 28	- 27	EBC_GND 26	SOL_RR 25
3	- 24	WSP_FR 23	WSS_FR 22	WSS_S_FR 21	WSP_RL 20	WSS_RL 19	WSS_S_RL 18	WSP_FL 17	WSS_FL 16	WSS_S_FL 15	SOL_CR 14	EBC_LOAD 13
4	WSP_RR 12	WSS_RR 11	WSS_S_RR 10	- 9	- 8	- 7	- 6	- 5	- 4	- 3	SOL_CL 2	SOL_FL 1
	A	B	C	D	E	F	G	H	J	K	L	M

Connector B
(ECU Pin External View)



Connector B												
4	KL30 48	KL31 47	- 46	- 45	- 44	- 43	- 42	- 41	- 40	CAN_GND 39	CANH 38	CANL 37
3	KL30 36	KL31 35	- 34	- 33	- 32	- 31	- 30	- 29	- 28	HMI_GND 27	HMI_OP 26	HMI_WARN 25
2	KL30 24	BRS 23	- 22	- 21	- 20	- 19	- 18	- 17	- 16	- 15	- 14	- 13
1	BRS 12	BRS 11	- 10	- 9	- 8	- 7	- 6	- 5	- 4	- 3	- 2	- 1
	M	L	K	J	H	G	F	E	D	C	B	A

3.3 Critical System Information

TSC supply ground (KL31) must be connected to ground at a common point on the trailer with the following component connections:

- Solenoid Ground Connections,
- Trailer Brake Ground Connection (from Tow-Vehicle),
- Trailer Supply Ground Connection (from Tow-Vehicle if separate from Trailer Brake Ground)

All TSC ECU Ground Pins (KL31, pin B35, B47) must be connected to the main harness ground wire. At no time should different voltage potentials be connected to separate KL31 pins (pin B35, B47). Failing to adhere to this wiring may result in damage to the TSC ECU.
Power supply to the TSC must be of good condition and must have sufficient current output for actuators to generate necessary braking force (refer to chapter 5.5 Required Power Supply Capacity).

All TSC ECU Battery Supply Pins (KL30, pin B24, B36, B48) must be connected to the main harness battery supply wire. At no time should different voltage potentials be connected to separate KL30 pins (pin B24, B36, B48). Failing to adhere to this wiring may result in damage to the TSC ECU.
TSC ECU Battery Supply must be protected with a suitable fuse (max. 40A), located between the vehicle power supply terminal and the TSC wiring harness supply wire.

All TSC ECU Brake Request Input Pins (BRS, pin B11, B12, B23) must be connected to the main harness brake signal wire (from electric brake controller). At no time should different voltage potentials be connected to separate BRS pins (pin B11, B12, B23). Failing to adhere to this wiring may result in damage to the TSC ECU.

TSC ECU Brake Request Input must be protected with a suitable fuse (as per manufacturer recommendation), connected to the power supply of the electric brake controller.

The supply and mounting of a Lamp Module on the trailer in sight of the driver is critical to the safety concept of the TSC system and its ability to alert the driver of system operation or malfunction.

Refer to Appendices 8.1 TSC System Environment Diagram for further explanation of system connections.

Please take the following safety notes into account and include an appropriate note in the operating instructions (owner manual) of the system:

- The correct function of all TSC ECU components is monitored by an internal monitoring system before drive-off and while the trailer is being moved.
- The TSC Lamp Module is the primary system status indicator to the driver.
- In case of a failure or malfunction, the Trailer Safety Control system will report the status via the Lamp Module. The trailer manufacturer must provide the owner (via the owner manual) with clear instructions as to how the warning signal are physically identified, as well as interpreted. The provided information must reveal to the driver the severity of the system status being displayed as well as advice on the required action to be undertaken. (e.g. by reduced system performance or functionality - whether to: e.g. contact dealer, drive with caution, stop vehicle). If such a failure occurs, it is also to be expected that the Trailer Safety Control system will degrade its controller functionality and performance.
- If the Trailer Safety Control system reports such a fault, the TSC has the responsibility of informing the driver via displaying a warning signal (e.g. warning lamp).
- If the warning lamp turns on and the operation lamp remains on, this indicates that the system has detected a failure, but will continue to operate in a reduced state.
  If the warning lamp turns on and the operation lamp is off, this indicates that the system has detected a failure, the TSC will not operate.
  In both cases the driver can continue to use the primary braking system. Therefore, when the warning lamp is lit during driving extra care is recommended. The system should be checked/serviced by a qualified repair shop/dealer at earliest opportunity.
- To ensure proper connection, the latch mechanism of the connector must not be damaged and must be fully engaged. It is not allowed to put any liquids or other materials onto the ECU connector.

4 Functional Description

4.1 Brake Control Functionality

4.1.1 Normal Trailer Braking

With the operation of the TSC system, primary braking remains the responsibility of the trailer electric brake controller (EBC). The TSC product is compatible and enhances numerous aftermarket and integrated brake controller models (refer to document TSC Brake Controller Guideline).

4.1.2 Anti-Lock Braking ABS

ABS (Anti-lock Braking System) functionality within the TSC monitors the wheels for brake locking due to over-braked wheels for the road surface. When the ABS function detects that a trailer wheel has locked it will isolate the locked wheel brake control from the tow-vehicle brake controller and control the brake with a determined braking algorithm.

ABS Function Key Points:

- ABS detects wheel slip and modulates the individual brake requests to avoid wheel locking, depending on surface and brake efficiency.
- Brake control is restored to the electronic brake controller once the TSC has determined that wheel slip is at a suitable non-locking level.
- ABS activation can occur at any speed above 5kph.
- When active, ABS will indicate operation to the driver by a flashing operation lamp.

4.1.3 Trailer Sway Mitigation

TSM (Trailer Sway Mitigation) functionality within the TSC monitors the trailer's movement around the vertical axis for an oscillating sway pattern that indicates trailer sway is gaining momentum. When the TSM determines that true trailer sway is in progress it actively applies the trailer brakes on all wheels without the need of braking input from the driver.

TSM Function Key Points:

- TSM activates only above 65 kph (40 mph) when the lateral sway conditions are met.
- TSM will cancel active braking if the driver braking level (from the electronic trailer brake controller) exceeds the TSM braking level.
- If wheels lock during TSM activation, TSM will continue to operate on those wheels with the support of the ABS function.
- When active, TSM will indicate operation to the driver by increasing the brightness of the operation lamp.

4.1.4 Lane Change Control

LCC (Lane Change Control) functionality within the TSC monitors the trailer's movement around the vertical axis for a rapid change which indicates the trailer has had a sudden change in direction event. When the LCC determines that a critical lane change event is in progress it actively applies the trailer brakes on all wheels without the need of braking input from the driver.

LCC Function Key Points:

- LCC activates only above 65 kph (40 mph) when the lateral change conditions are met.
- LCC will cancel active braking if the driver braking level (from the electronic trailer brake controller) exceeds the LCC braking level.
- If wheels lock during LCC activation, LCC will continue to operate on those wheels with the support of the ABS function.
- When active, LCC will indicate operation to the driver by increasing the brightness of the operation lamp.

4.1.5 Odometer

Trailer Odometer functionality within the TSC measures the distance travelled by the trailer. The odometer works by counting the number of revolutions of the trailer's wheels, and then converting that count into distance travelled based on the wheel size.

4.1.6 Break-away Control Combability

Compatibility with trailer break-away systems is treated the same as the brake input from an electronic trailer brake controller with 100% braking. If the TSC power supply is direct from the tow vehicle, during a break-away event the TSC will not be powered and act as a pass-through between the break-away system and the trailer brakes. If the TSC remains powered during a break-away event the ABS will activate if the trailer wheels become locked, until the trailer comes to a speed of less than 5 kph (3 mph). TSM and LCC will not occur during a break-away event as the input braking level (100%) will always be equal or higher than that provided by a TSM or LCC activation.

5 Electrical characteristic data

5.1 Operating Voltage

		Category
TSC Supply Voltage Range (at the ECU Connector)	**min ... max**	
Full Functionality Voltage Range	10.0V ... 16.0V	(I)
Reduced Operation Under-voltage Range	8.0V ... 10.0V	
Reduced Operation Overvoltage Range	16.0V ... 19.0V	

5.2 Overvoltage capability of the complete system

When power supply applied to TSC	UB <= 19V	(I)
for a period of	1h	
at ambient temperature of	+ 23°C +/- 5°C	

5.3 Jump-start of complete system

Jump start is a start-assist feature which allows use of increased voltage from a truck battery (24 V) or rapid charger (24 V).

The ECU is not damaged when operated at a battery voltage of:	UB <= 24 V	(I)
for a period of	≤ 60 sec	
at ambient temperature of	+ 23°C +/- 5°C	

5.4 Reverse-polarity protection

As protection in case of battery connection mix-up	UB : = -13.5 V	(I)
for a period of	1 min	
at ambient temperature of	+ 23°C +/- 5°C	

5.5 Required Power Supply Capacity

Depending on the number of braked axles the power requirements of the TSC ECU vary. Supply capacity can be met via an on-board power source (charged by the tow vehicle) or a power source directly from the tow-vehicle. In all cases the supply voltage should be at a minimum of 12.0V at the ECU connector whilst the TSC is not braking. The figures below represent the supply requirements of each configuration.

Single Axle Trailer

TSC Powered, TSC not braking (@ 12.0V at the ECU connector)	2A (continuous, including max. lamp output)
TSC Powered, TSC braking active (@ 12.0V at the ECU connector)	10A (for min. 30 sec)

Dual Axle Trailer

TSC Powered, TSC not braking (@ 12.0V at the ECU connector)	2A (continuous, including max. lamp output)
TSC Powered, TSC braking active (@ 12.0V at the ECU connector)	18A (for min. 30 sec)

Triple Axle Trailer

TSC Powered, TSC not braking (@ 12.0V at the ECU connector)	2A (continuous, including max. lamp output)
TSC Powered, TSC braking active (@ 12.0V at the ECU connector)	26A (for min. 30 sec)

6 Electrical Interfaces

6.1 Brake Solenoid outputs

		Category
Signal name: SOL_FL SOL_FR SOL_RL SOL_RR SOL_CL SOL_CR	 Pin A1 Pin A38 Pin A37 Pin A25 Pin A2 Pin A14	(I)
Output voltage (PWM amplitude)	BRS voltage (TSC passive) UB (TSC active)	
PWM frequency	EBC frequency (TSC passive) 300 Hz (TSC active)	
Brake Solenoid Resistance Range (nominal)	3.2 – 3.9 Ohms	
Maximum current (inductive load)	6.0 A	

6.2 Brake Request input

Signal name: BRS BRS BRS	 Pin B11 Pin B12 Pin B23 All pins must be connected to the brake signal in parallel.	(I)
Limiting voltage	0 – 18 V	
PWM amplitude voltage for valid signal	8 – 18 V	
Maximum current	36.0 A	
Frequency Range for valid signal	50 Hz – 2000 Hz	

6.3 Power Supply

Signal name: Battery KL30 KL30 KL30	 Pin B24 Pin B36 Pin B48 All pins must be connected to power supply in parallel.	(I)
Operating voltage	See chapter 5.1	
Maximum voltage	See chapters 5.2, 5.3, 5.4	
Fuse is necessary as documented in wiring guide	Maximum 40A	

6.4 Ground

Signal name: Ground KL31 KL31	 Pin B35 Pin B47 All pins must be connected to ground in parallel.	(I)

6.5 Wheel Speed Sensor inputs

Wheel Speed Sensor Type	Bosch DF11 (or equivalent)	(I)
Signal name: WSP_FL WSP_FR WSP_RL WSP_RR WSP_CL WSP_CR WSS_FL WSS_FR WSS_RL WSS_RR WSS_CL WSS_CR WSS_S_FL (optional) WSS_S_FR (optional)	 Pin A17 Pin A23 Pin A20 Pin A12 Pin A46 Pin A48 Pin A16 Pin A22 Pin A19 Pin A11 Pin A34 Pin A36 Pin A15 Pin A21	

WSS_S_RL (optional) WSS_S_RR (optional) WSS_S_CL (optional) WSS_S_CR (optional)	Pin A18 Pin A10 Pin A33 Pin A35	
Operating Voltage Sensor	4.5 V – 20.0 V	
ECU output voltage	UB (within operating voltage)	
High current level	14 mA	
Low current level	7 mA	

6.6 Lamp Module outputs

Signal name: HMI_OP HMI_WARN HMI_GND	 Pin B26 Pin B25 Pin B27	(I)
Output Voltage (PWM amplitude)	UB	
PWM frequency (for dimming)	300 Hz	
Maximum current each	400 mA	
Minimum current each @ 100% duty cycle under worst case conditions (low temperature, 10V power supply) (to prevent incorrect diagnosis of open load)	30 mA	
Minimum / Maximum duty cycle for dimming	10% / 100%	
Maximum number of LEDs in series (maximum allowed voltage drop)	2	

6.7 Communication

Signal name: CANH CANL	 Pin B38 (twisted pair with B37) Pin B37 (twisted pair with B38)	(I)
General remark	The CAN-Bus is specified by "CAN Specification of the CAN-physical layer for High-Speed-Application up to 1 MBit/s" of October 1989. The following typical values are stated in this specification.	
Bit rate	500k bit/s	
Internal termination resistor	120 Ohm	
Output bus voltage (Dominant) VCAN_H, U_CANP_dom	Typical 3.5 V Min 2.75 V Max 4.5 V	
Output bus voltage (Dominant) VCAN_L, U_CANM_dom	Typical 1.5 V Min 0.5 V Max 2.25 V	
Output bus voltage (Recessive) VCAN_H, U_CANP_rec	Typical 2.5 V Min 2.0 V Max 3.0 V	
Output bus voltage (Recessive) VCAN_L, U_CANM_rec	Typical 2.5 V Min 2.0 V Max 3.0 V	

6.8 Electronic Brake Controller External Simulated Load

Signal name: EBC_LOAD EBC_GND	 Pin A13 Pin A26	(I)
Limiting voltage (from EBC)	0 – 18 V	
Maximum current	6.0 A	

7 Test Methods

The individual tests and customer returns are considered passed / assessed without defects if the functional electrical test have passed. Additionally, the pass / fail criteria of the single test modules apply.

The customer must verify the proper function of the unit on the trailer through a vehicle test under realistic field conditions.

The climatic tests are carried out with a connected wiring harness without any mechanical stress.

7.1 Climatic Tests

7.1.1 Low Temperature Storage Test

		Category
Purpose:		(II), (III)
Pre-aging of the specimen for additional tests.		
Test according to	IEC 60068-2-1 Test Ab	
Storage temperature	- 40°C	
Duration of stress	24 h	
ECU	passive	
Electric connector and wiring harness is not connected to the system.		
Monitoring	none	
Evaluation:		
The electric function test must be passed. Visual inspection.		

7.1.2 High Temperature Storage Test

Purpose:		(II), (III)
Exposure of ECU to high temperatures, e.g. during shipment. Pre-aging of the specimen for additional tests.		
Test according to	IEC 60068-2-2 Test B	
Storage temperature	+ 75°C	
Duration of stress	48 h	
ECU	passive	
Electric connector and wiring harness is not connected to the system.		
Monitoring	none	
Evaluation:		
The electric function test must be passed. Visual inspection.		

7.1.3 Composite Temperature Humidity Cyclic Test

Purpose:	(II), (III)
High levels of humidity combined with temperature cycling result in a corrosion of electronic components caused by water condensation in the ECU. This simulates the condition in tropical environments.	
Test Z/AD according to	IEC 60068-2-38
Upper test temperature	+ 65°C +/- 2°C
Lower test temperature	- 10°C +/- 2°C
Relative air humidity	93%
Duration of cycle	24 h
Number of cycles	10
Monitoring	active
ECU	powered
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.1.4 Temperature Cycle Test (Thermal Shock)

Purpose:	(II), (III)
This test simulates a very high number of slow temperature cycles in the vehicle.	
Test according to	IEC 60068-2-14 Issue 2009 description Na
Storage at temperatures of	
Maximum	+ 85°C +/- 2°C
Minimum	- 40°C +/- 2°C
Each for a duration of	53 min
Number of cycles	455
Max. transition time	< 2 min
ECU	passive
Tight electric dummy connector is connected to the system.	
Monitoring	none
Evaluation:	
The electric function test must be passed. Visual inspection.	

7.1.5 Stepped Temperature Test

Purpose:	(II)
This test checks the mechanical and electrical device for malfunctions which may occur within a small section of the operating temperature range.	
Test according to	IEC 60068-2-2 Test B
Start temperature	+ 20°C
Minimum test temperature	- 40°C
Maximum test temperature	+ 75°C
Step increments	5°C
Dwell at each temperature	15 min
Relative air humidity	30%
Monitoring	active
ECU	powered
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.1.6 Low Temperature Operation Test

Purpose:	(II), (III)
This test simulates the exposure of the ECU to low temperatures with electrical operation.	
Test according to	IEC 60068-2-1
Test temperature	- 40°C
Duration	24 h
Relative air humidity	30%
Monitoring	active
ECU	powered
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.2 Mechanical Tests

The mechanical tests are performed with the wiring harness connected.

7.2.1 Random Vibration Test

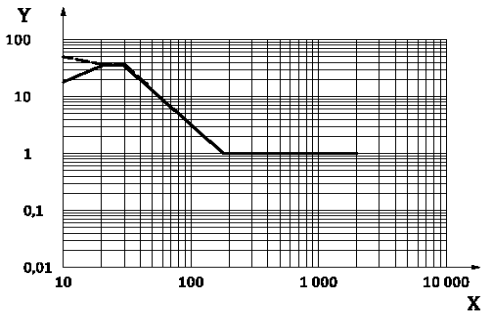
Purpose:		(II), (III)
This test checks the influence of vibration on the function of the ECU.		
Test according to	ISO 16750-3 Issue 2012 Test VII Commercial Vehicle, sprung masses	
Frequency range	10Hz ... 2000Hz	
Duration of the loading per principle axis	8 h	
Total test duration	24 h	
ECU	powered	
Monitoring	active	

Evaluation:

During the test, no electrical failures are allowed.
The electric function test must be passed.
Visual inspection.

Test spectrum

according to		ISO16750-3 Issue 2012, Test VII Commercial Vehicle, sprung masses
Frequency [HZ]	acceleration spectral density in $(m/s^2)^2$ / HZ	
10	18	
20	36	
30	36	
180	1	
2000	1	
total r.m.s. value aeff,ges / aRMS,total	57.9 m/s^2	



Key
Y PSD $[(m/s^2)^2/Hz]$
X frequency [Hz]
standard random test profile
additional profile in case of f_n < 30 Hz

7.2.2 Mechanical Shock Test

Purpose:	(II), (III)
The functional influence of the shock acceleration on the ECU is evaluated.	
Test according to	ISO 16750-3 Issue 2012
Shock acceleration (exciter)	500 m/s²
Duration of the nominal shock	6 ms
Shock form	half-sine
Number of shocks per principal axis and direction	5
total	30
ECU	powered
Monitoring	active
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.2.3 Gravel Bombardment Test

Purpose:	(II)
This test checks the TSC and bracket assembly resilience to gravel and stone impact.	
Test according to	ISO 16750-3 Issue 2012
Temperature	-40°C
Soak time before test	1 h
Weight of mass	0.25 kg
Diameter of mass	38 mm
Height of drop	30 cm
Number of target points	11
Number of drops to each target point	1
ECU	passive
Monitoring	none
Evaluation:	
The electric function test must be passed. Visual inspection.	

7.3 Solids, Fluids and Chemical Resistance Tests

7.3.1 Salt Spray Mist Test

Purpose:	(II)
Salt spray results in corrosion of the metal surfaces of the ECU and identifies weak areas quickly.	
Test according to	IEC 60068-2-11
Temperature	+ 35°C
Number of cycles	2
Test duration per cycle	24 h
ECU	passive
Monitoring	none
Evaluation:	
The electric function test must be passed. Visual inspection.	

7.3.2 Salt Spray Corrosion Test

Purpose:	(II)
Salt spray results in corrosion of the metal surfaces of the ECU and identifies weak areas quickly.	
Test according to	IEC 60068-2-52 Test Kb
Temperature	+ 15 - 35°C
Salt solution	5% NaCl
Severity	Class 4
Number of cycles	2
Test duration per cycle	168 h
ECU	passive
Monitoring	none
Evaluation:	
The electric function test must be passed. Visual inspection.	

7.3.3 Compatibility with Liquids

Purpose:		(II)
This test evaluates the resistance of the ECU against aggressive media.		
Test procedure according to	ISO 16750-5	
Media:		
Diesel Fuel		
Gasoline unleaded		
Engine Oil		
Hydraulic fluid		
Greases		
Urea NOx (reduction agent) – “Ad Blue”		
Cavity protection		
Protective Lacquer		
Protective Lacquer remover		
Vehicle Washing Chemicals		
Wheel Cleaner		
Cold cleaning agent		
Ammonia containing cleaner		
Denatured alcohol		
Runway de-icer saline solution		
ECU	passive	
Monitoring	none	
Evaluation:		
No liquid may enter the sealed areas. The electric function test must be passed. Visual inspection.		

7.3.4 Dust Protection Test

Purpose:	(II)
The resistance to the intrusion of dust under extreme conditions is tested.	
Test according to	ISO 20653
Degree of protection	IP6K
Duration of test	5 h
Dust type	Arizona Dust according to ISO 12103-1
Concentration of dust	5.0 +/- 2.0 g/m³
Air speed	1.5 m/s
ECU	passive
Monitoring	none
Evaluation:	
No dust may enter the sealed areas. The electric function test must be passed. Visual inspection.	

7.3.5 Mud Protection Test

Purpose:	(II)
This test is to ensure the ECU is not impaired in functionality and also dissipate adequate heat while covered in mud.	
Temperature	+ 75°C
Mud mixture	A mixture of Arizona Dust, and water “2.7:1” ratio by volume
Exposure time in mud mixture	1 min
Test duration at temperature	33 h
ECU	powered
Monitoring	active
Evaluation:	
No mud may enter the sealed areas. During the test, no electrical failures are allowed The electric function test must be passed. Visual inspection.	

7.3.6 Water Resistance - High Pressure Cleaner Test

Purpose:	(II)
This test examines the sealing tightness of the ECU while using commercially available high pressure cleaners.	
Test according to	ISO 20653
Degree of protection	IPX9K
Distance from nozzle to test specimen	150 mm
Duration of test per nozzle position	30 s
Nozzle arrangement	0°, 30°, 60°, 90°
Rotary-table speed	(5 +/- 1) 1 / min
Water temperature	+ 15°C +/- 5°C
Specimen temperature before test	+ 80°C +/- 5°C
Nozzle pressure	9 MPa +/- 1 MPa (90 bar +/- 10 bar)
Water flow rate	(15 +/- 1) l/min
ECU	passive
Monitoring	none
Evaluation:	
No effects due to ingress of water. The electric function test must be passed.	

7.3.7 Water Tightness - Immersion

Purpose:	(II)
This test simulates immersion of the ECU.	
Test according to	ISO 20653
Degree of protection	IPX7
Preconditioning temperature	+ 23°C
Water temperature	+ 23°C +/- 5°C
Immersion duration	30 min
Immersion depth	1 m
Number of immersion cycles	1
ECU	passive
Monitoring	none
Evaluation:	
No effects due to ingress of water. The electric function test must be passed.	

7.3.8 Water Tightness – Immersion and Thermal Shock

Purpose:	(II)
This test simulates immersion of the ECU and a thermal shock induced by water.	
Preconditioning temperature	+ 60°C
Preconditioning time	2h
Percentage of NaCl in salt water	5%
Water temperature	+ 20°C +/- 5°C
Immersion duration	10 min
Number of immersion cycles	10
ECU	passive
Monitoring	none
Evaluation:	
No effects due to ingress of water. The electric function test must be passed.	

7.3.9 Flowing Mixed Gases Corrosive Test

Purpose:	(II)
This test simulates the use of the ECU in the presence of corrosive gases, e.g. highly polluted atmospheres.	
Test according to	IEC 60068-60 Test Ke
Temperature	+ 25°C +/- 1°C
Relative Humidity	75% +/- 3%
Test method	4
Gas composition	
H_2S (10^{-9} vol/vol)	10 +/- 5
NO_2 (10^{-9} vol/vol)	200 +/- 20
Cl_2 (10^{-9} vol/vol)	10 +/- 5
SO_2 (10^{-9} vol/vol)	200 +/- 20
Test duration	21 days
ECU	passive
Monitoring	none
Evaluation:	
The electric function test must be passed. Visual inspection.	

7.4 Lifetime Endurance Tests

These tests are performed in order to get an indication of the lifetime durability behaviour of the ECU in a short period of time.

7.4.1 Powered Temperature Cycling (PTC) / Powered Temperature Cycling Endurance (PTCE)

Purpose:	(II), (III)
This test exposes the ECU to a rapid change temperature to excite any thermal mismatches and to generate stress between the CTE mismatches.	
Test according to	IEC 60068-2-14
Number of thermal cycles	420
Temperature Cycle Definition	-40°C to 75°C
Relative Humidity	30%
Dwell time	30 min
Ramp time	40 min
ECU	powered
Monitoring	active
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.4.2 High Temperature High Humidity Endurance Test

Purpose:	(II)
This test exposes the ECU to a sustained high temperature high humidity environment to evaluate the module's reliability in the field.	
Test according to	IEC 60068-2-67
Test Temperature	+85°C +/- 2°C
Test Humidity	85% +/- 3%
Test Duration	785 hours
ECU	powered
Monitoring	active
Evaluation:	
During the test, no electrical failures are allowed. The electric function test must be passed. Visual inspection.	

7.4.3 High Temperature Operational Endurance Test (HTOE)

Purpose:		(II)
This test exposes the ECU to a sustained high temperature to evaluate the module's reliability in the field.		
Test according to	IEC 60068-2-2	
Temperature	+75°C	
Relative Humidity	30%	
Duration	494 hours	
ECU	powered	
Monitoring	active	

Evaluation:

During the test, no electrical failures are allowed.
The electric function test must be passed.
Visual inspection.

Load profile

The endurance test conditions contain the wear relevant part in the following standard function modules.

The number of ABS and TSM/LCC events has been derived from

Total number of brake applications	800,000	(I)
Total duration of brake applications	1,300 h	

ABS

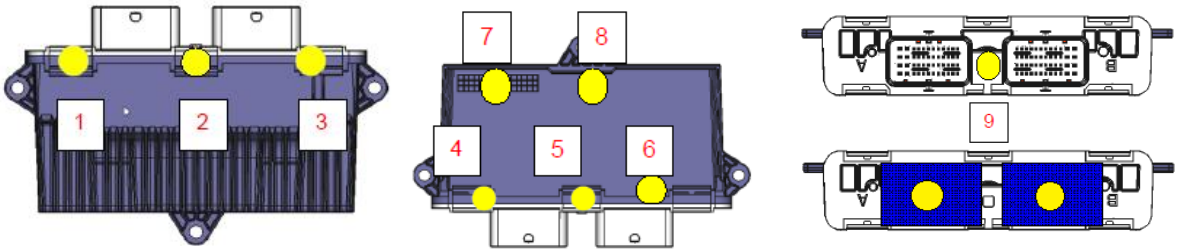
Total number of ABS events	10,500	(II)
Total ABS control time	9.1 h	

TSM/LCC

Total number of TSM/LCC events	10,000	(II)
Total TSM/LCC control time	13.9 h	

7.5 Electrical Tests

7.5.1 Electrostatic Discharge (ESD)

Tests according to	ISO/TR 10605 2008-07	(II)
Tests completed include		
Handling Level ESD (unpowered): To verify that electrostatic discharges that occur from handling of the unit during manufacture, packaging and assembly into the vehicle do not inadvertently damage or reduce the units function in the field.		
Number of discharges per point	3	
System Level ESD (powered): To verify that adequate ESD protection has been employed for normal occupant/user handling and/or servicing. The System Level ESD, which is a powered test with loads and switches connected and covers situations which will be seen in the field both during servicing and occupant use.		
Number of discharges per point	10	
ESD Powered with field coupling (powered): The ESD coupling test assesses the ECU tolerance to ECU discharges that occur to other groundings in system of the vehicle not localized to the ECU.		
Number of discharges per point	10	
Common Parameters		
Ambient Temperature	25 °C ± 10 °C	
Relative Humidity	20 % to 65 %	
Time Interval between Discharges	>1s	
Number of Test Points	9 + ECU Pins	
		
Evaluation: ECU's must meet functional class A during test. ECU's must meet functional class A post test. Class A: All functions of a device/system perform as designed during and after exposure to disturbance.		

7.5.2 Voltage Immunity

Tests according to ISO 16750-2:2012 (II)

Tests completed include

***Test 4.3 Overvoltage*:**
The ECU may experience during its life, voltages brought about by system failures or uncommon exposures to excessive voltages, such as a 12V vehicle being jump started from a 24V source, or failure of a clamping diode on the alternator exposing the ECU to voltages above specification.

Test 4.6* Supply Voltage Discontinuities*:
These tests simulate supply voltage dips and interrupts which may occur over the lifetime of the vehicle. They are aimed at verifying a defined and controlled response of the ECU (hardware and software) to discontinuities in the supply voltage and ensuring the ECU's correct reset behaviour.

Test 4.4 Supply Voltage Ripples:
This test simulates AC noise superimposed over the DC, a condition which is common to all vehicles with the engine running.

Test 4.5 Supply Voltage Variations:
This test simulates gradual variations in the supply voltage due to varying loads or poor charging capability. It is also aimed at verifying the ECU's power up sequence and detecting thresholds at which malfunctions may begin.

Test 4.8 Ground Voltage Offsets:
The purpose of this test is to verify ECU functional performance when subjected to different potentials at the ground offsets.

Test 4.10 Short Circuit Test:
This test simulates a short circuit applied to the products inputs and outputs. After removal of the short all inputs and outputs should resume their normal function. During the short circuit condition all functions should operate correctly except those directly related to the short circuited input or output.

Test 4.9 Open Circuit Test:
This test simulates an open contact condition and line interruptions caused by faulty wiring harness in the vehicle. Note this is not a test for connectors.

7.5.3 Transient Disturbances along Supply Lines

Tests according to	ISO 7637-2:2004	(II)

Tests completed include
Test Pulse 1: simulates the switch-off of a supply voltage to an inductive load that remains switched in parallel to the ECU.

Test Pulse 2a: simulates transients due to sudden interruption of currents in a device connected in parallel with the DUT due to the inductance of the wiring harness.

Test Pulse 2b: simulates transients from DC motors acting as generators after the ignition is switched off.

Test Pulse 3a and 3b: simulation of transients, which occur as a result of the switching processes. The characteristics of these transients are influenced by distributed capacitance and inductance of the wiring harness.

Test Pulse 5b: simulates the sudden disconnection of a battery in a vehicle that makes use of central load dump protection while the battery is being charged by the alternator thereby leaving all the loads in the vehicle connected to the alternator circuit.

Pulse Application	Supply Lines (KL30)
Ambient Temperature	25°C ± 10°C
Relative Humidity	20 % to 65 %
Nominal DC Test Voltage (Ua)	14V ± 0.5V

7.5.4 Transient Disturbances Conducted along I/O Lines

Tests according to	ISO 7637-3:2016	(II)

Tests completed include
Pulse a and b: simulate noise bursts generated during switching operations coupled to signals lines of the ECU.

Pulse Application	Supply Lines (KL30)
Ambient Temperature	25°C ± 10°C
Relative Humidity	20 % to 65 %
Nominal DC Test Voltage (Ua)	14V ± 0.5V

7.5.5 Transient Emissions Conducted along Power Supply Leads (Voltage Method)

Test according to	ISO 7637-2:2004	(II)

Tests Purpose:
These tests are intended to determine transients emitted by the module along the battery-fed or switched supply lines that may interfere with or damage other on-board electronic subsystems. The transients are generated during the switching of inductive loads contained within the module.

7.6 EMC Tests

7.6.1 Conducted Emissions from Components/Modules – Voltage Method

Test Purpose
This test measures radio interference introduced to the vehicle power distribution system via conduction on the power supply lines of the device under test. This may be interference to systems within the vehicle and external to the vehicle. Such interference can effect AM/FM, mobile bands, Bluetooth etc.

Engineering Requirements
IEC CISPR 25 Edition 3.0 2008-03 Clause 6.2. Or IEC CISPR 25 Second Edition 2002-08 clause 6.2 where this superseded Standard must be used.

7.6.2 Radiated emissions from components/modules

Test Purpose
This test measures radio interference radiated from the ECU. The source of which can be classified into two groups, narrowband such as microprocessors and logic, and broadband such as wipers and relay switching.

Engineering Requirements
IEC CISPR 25 Edition 3.0 2008-03 Clause 6.4.

7.6.3 Radiated Immunity – BCI

Test Purpose
For testing automotive electronic systems, the applicable frequency range of the BCI test method is 1MHz to 400MHz. The purpose of the test is to ensure ECU maintains functional performance when exposed to radiated interference.

Engineering Requirements
ISO 11452-4 Third edition 2005-04-01 Road vehicles Component test methods for electrical disturbances from narrowband radiated electromagnetic energy Part 4: Bulk current injection (BCI).

ISO 11452-1 Third edition 2005-02-01 Road vehicles Component test methods for electrical disturbances from narrowband radiated electromagnetic energy Part 1: General principles and Terminology.

7.6.4 Radiated Immunity – Absorber-lined Shielded Enclosure ALSE

Test Purpose
Electronic devices are exposed to RF interference regularly. Systems running software, and/or with discrete and integrated circuits can be affected to the detriment of performance and safety of the vehicle.

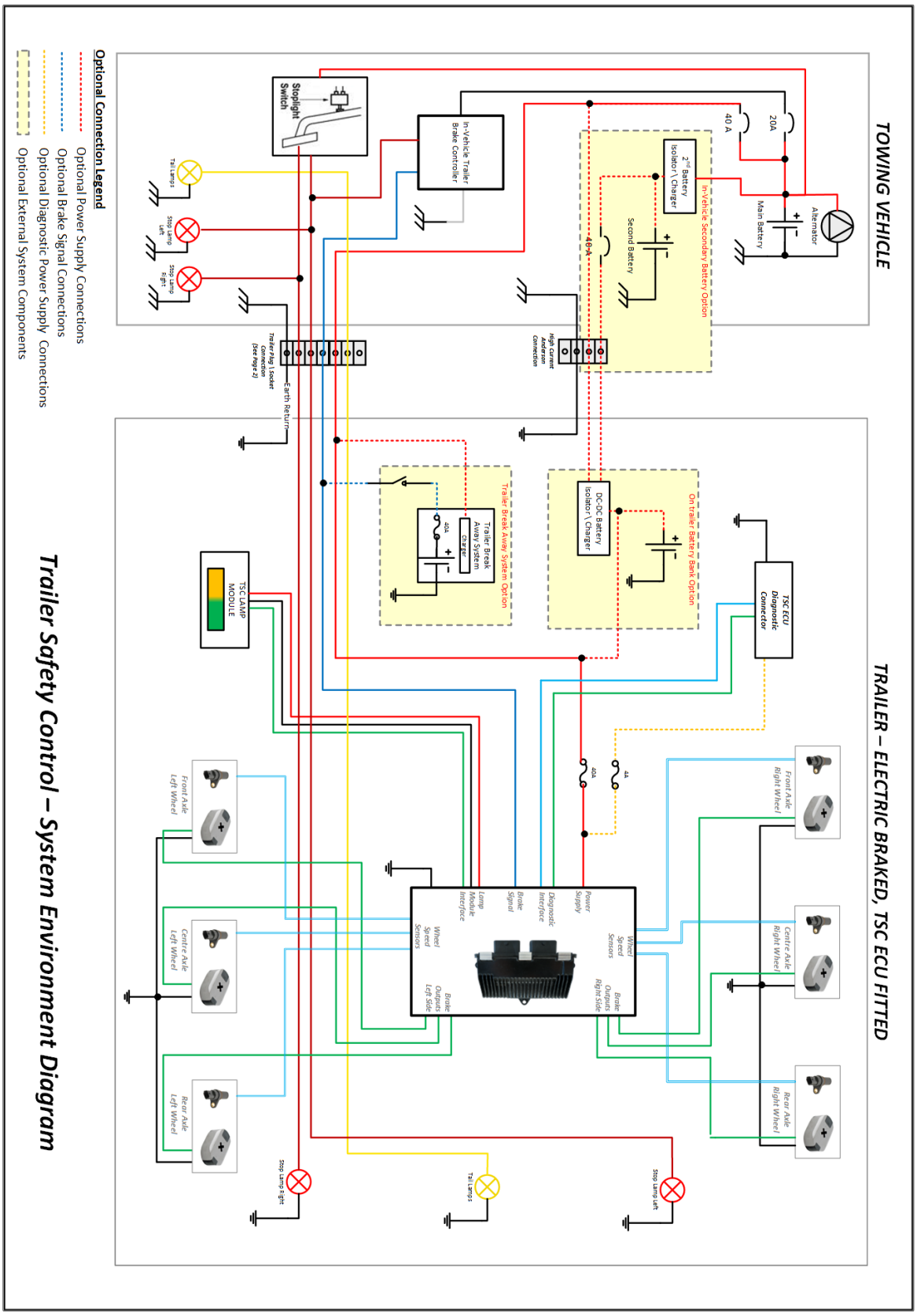
Engineering Requirements
ISO 11452-2: Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy Part 2: Absorber-lined shielded enclosure

7.7 Testing by the customer

There is no agreement between Bosch and the customer to perform additional product tests at the customer.

8 Appendices

8.1 TSC System Environment Diagram



9 History

Release	Date	Edited by	Release description
3.0	19th May 2023	P. Frueh	Update new template
2.0	26th Sept 2019	M. Power / P. Frueh	1st release
1.0	21st July 2017	M. Power / P. Frueh	Preliminary Edition

10 Contact person

Contact person: CC/PJ-TS Philipp Frueh